



AUDIT2MEASURE

D2.3 Report of barriers affecting the uptake of ESM in companies

A statistical analysis of barriers in the European manufacturing sector



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ABOUT

Industry is a key player in energy consumption and economic impact in the European Union (EU) and energy audits represent an important tool to improve energy efficiency in the sector; despite both the spread of energy audits and the knowledge of their benefits, the actual implementation rate of the Energy Savings Measures (ESM) proposed by energy audits is relatively low. **The main aim** of the AUDIT2MEASURE (Leading businesses towards climate neutrality by speeding up the uptake of energy efficiency measures from the energy audits) project **is to support companies in the uptake of audits measures necessary to reduce the energy consumption supporting their energy transition**. AUDIT2MEASURE will develop and implement a new engagement strategy (called “Audit2Action”) to put into action the opportunities emerging from energy audits.

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ABBREVIATIONS

A2M	AUDIT ₂ MEASURE
BAFA	German Federal Office for Economic Affairs and Export Control
EED	Energy Efficiency Directive of the European Union
EMAS	Eco-Management and Audit Scheme
EMS	Energy Management Systems
ESM	Energy Saving Measure(s)
HVAC	Heating, ventilation and air conditioning
ISO	International Organization for Standardization
NEBs	Non-Energy Benefits
SMEs	Short and Medium size Companies (EU definition)

INTRODUCTION

Despite mandatory energy audits for large industrial companies in EU Member States and the recommendations in these audits to implement Energy Saving Measures (ESM) to save energy costs and greenhouse gas emissions, the actual implementation of these measures remains low. There are reasons for this, in the form of obstacles or barriers, which this report examines as the final building block in a three-part series of reports on audit systems in the European Union and ESM implementation in European industrial companies.

The aim of this report is to examine which economic, organisational, behavioural, informational and regulatory barriers have the greatest impact on the uptake and non-take of ESM in industrial companies and, in the end, provide a basis for further project activities of the AUDIT2MEASURE project. In particular, it examines the differences between different ESM types, companies of different subsectors of the manufacturing sector, including all sectors classified under the NACE C code, varying sizes and companies with different ESM and/or climate protection strategies. The results of the report will be relevant to the following steps of the A2M project. The development of the Audit2Action strategy, the capacity building programme for companies and the direct and continuous support to companies to improve their energy efficiency are all based on the identification of the most relevant barriers to ESM implementation in industrial companies. The Audit2Action strategy will be designed to overcome each of the identified barriers by supporting decision makers in industrial companies to adopt ESM considering the energy audits conducted. They will be supported through trainings and capacity building activities that build on the Audit2Action strategy. Ongoing support will be provided to companies to enable them to address new barriers as they arise, to ensure the sustainability of the project. The project concludes with a report with policy recommendations, which primarily addresses regulatory and political barriers to the implementation of ESM in the industry and builds on the results of the entire project.

METHODOLOGY & STRUCTURE

The report begins with a review of the most relevant literature on barriers to ESM, looking at prevailing general barrier taxonomies as well as more detailed lists of barriers and drivers analysed in the context of European manufacturing industries. The literature analysis also focuses on existing differentiation in the prevalence of barriers based on different parameter such as company typology and company “lifestyle” or philosophy. The aim is to identify existing knowledge and research gaps which can provide indications for the further analyses of barriers based on the data at our disposal.

Based on this theoretical background work, the second chapter starts with a presentation of the shortlists of barriers and drivers that were used in the company survey on ESM implementation conducted by the A2M consortium. This survey was conducted on 31 companies from the five project countries: Czech Republic, Greece, Italy, the Netherlands and Spain. The survey was created by ADELPHI and distributed to the A2M country partners which then reached out to companies in their respective country and languages. The aim was to obtain information on ESM implementation, decision-making processes, barriers and drivers. Most of the survey was already analysed in deliverable D2.2 “Top Management Decision Process”; however, the sample size is quite small to go beyond a simple ranking of barriers in general and the relevant barriers in the five countries surveyed. Nevertheless, the results can indicate if significant differences exist in perceptions of ESM implementation between the five countries.

As there is not enough empirical evidence on differences in relevant barriers across EU countries and the sample selected in the survey is not large enough to detect such differences in a robust way, a company survey on ESM implementation conducted by the German Federal Office for Economic Affairs and Export Control (BAFA) is additionally analysed. The sample focuses in particular on companies that have received support from energy service companies and, due to its sample large size, can provide more differentiated insights into the prevalence of barriers in German manufacturing companies, from which indicative trends can also be drawn for other EU countries. Different company typologies were differentiated based on multiple criteria such as: the number of employees, energy costs, the existence of an EMS, the “lifestyle” or mindset of companies, etc. The data set can also provide first clues whether specific barriers are correlated with the implementation of certain ESM. The conclusion of the report summarises the most important results and limitations from these data analyses.

For clarity, the details of the specific analytical approaches, assumptions made and potential biases are discussed in relation with the findings in the respective sections of the report.

1. LITERATURE REVIEW OF BARRIERS AND DRIVERS FOR ESM IMPLEMENTATION

The aim of barriers' theory is to achieve a comprehensive perspective explaining the gap between optimal and realized levels of energy efficiency by considering different parameters (Nehler et al. 2018). Over the last ten years, a substantial amount of research projects and literature has been analysing barriers and drivers to ESM implementation in the manufacturing industry in Europe. Yet, results are not comprehensive. Some of the central academic contributors are the British researcher Steve Sorrell and the Italian researchers Enrico Cagno and Andrea Trianni whose focus has mostly been on manufacturing SMEs in Italy. Additional research drawing on their analytical framework has since been led in other European countries. Although large companies and certain sub-sectors and ESM technologies have rarely been addressed, these frameworks from energy efficiency literature constitute a useful groundwork to further investigate drivers and barriers in the context of the AUDIT2MEASURE project.

1.1. Identifying barriers to energy efficiency in the industry

1.1.1. A taxonomy of barriers, according to literature

When approaching barriers to ESM implementation, multiple classifications can be found in literature. (Sorrell et al. 2000) were among the first to develop a comprehensive taxonomy of barriers to ESM implementation in public and private organisations, distinguishing three main types: economic, behavioural and organisational barriers. Economic barriers are further divided into economic barriers due to market failures and non-market failures. Trianni and Cagno, Nehler and others ground their research on this theoretical basis:

- **Economic non-market failure barriers:** Economic non-market failures include, for example, the heterogeneity of the ESM in terms of cost-effectiveness. For example, some measures may be cost-effective in general, but not in specific cases. Moreover, ESM may have hidden costs. Another obstacle in this category is the lack of sufficient capital for the measures. Unwillingness to invest in risk is also a barrier that ensures that only ESM with short payback periods are implemented (Trianni und Cagno 2012);
- **Economic market failure barriers:** Barriers in the economic market failure category include, first, a lack of information about cost-effective ESM. Misaligned incentives fall into this category. If certain departments in decision-making roles do not benefit from ESM, its implementation may be seen as less relevant. Other economic market failure barriers include adverse selection and principal-agent relationships (ibid.);
- **Behavioural barriers:** Behavioural barriers include limited rationality in decision-making, i.e. decisions based on intuition rather than on well-processed information. The form of information can also be a barrier, for example if it is too general or too complex. Lack of trust in information also hinders the decision to implement ESM. Another behavioural barrier is a lack of willingness to change within the organisation or among decision-makers. The last barrier in this category is a lack of values or ambitions for energy savings (ibid.);
- **Organisational barriers:** By organisational barriers, the authors mean the distribution of authority within the company. If, for example, energy management has a lower status, this will lead to energy-related issues being neglected. Corporate culture is also included

in this group. If a company has a value culture that is geared towards environmental protection and sustainability, it is more likely to invest in energy efficiency than if it does not (ibid.).

1.1.2. Identification of individual barriers

For the empirical investigation of barriers through surveys, (Cagno et al. 2013) suggest a more detailed classification of barriers. Trianni and Cagno have mainly been using this classification since (2014; 2015; 2016):

Table 1: Barriers to ESM implementation in companies according to Cagno et al. (2013)

Technology-related
<ul style="list-style-type: none"> • Technologies not adequate • Technologies not available
Information-related
<ul style="list-style-type: none"> • Lack of information on costs and benefits • Information not clear by technology providers • Trustworthiness of the information source • Information issues on energy contracts
Economic
<ul style="list-style-type: none"> • Low capital availability • Investment costs • External risks • Intervention not sufficiently profitable • Intervention-related risks • Hidden costs
Behavioural
<ul style="list-style-type: none"> • Other priorities • Lack of sharing the objectives • Lack of interest in energy-efficiency interventions • Imperfect evaluation criteria • Inertia
Organisational
<ul style="list-style-type: none"> • Lack of time • Divergent interests • Lack of internal control • Complex decision chain • Low status of energy efficiency
Competence-related
<ul style="list-style-type: none"> • Implementing the interventions • Identifying the inefficiencies • Identifying the opportunities • Difficulty in gathering external skills
Awareness
<ul style="list-style-type: none"> • Lack of awareness

Gründig et al. (2017) a slightly different categorisation of barriers to ESM implementation, highlighting regulatory and operational barriers, which the previously discussed taxonomy broadly categorised as economic non-market failures aspects:

- **Financial barriers** (e.g. too high investments, long payback time, lack of financial resources);
- **Organisational barriers** (e.g. status of energy-efficiency, competing priorities, difficulties to change existing routines, lack of time and staff);
- **Staff-related barriers** (e.g. lack of motivation, lack of know-how, flawed execution);
- **Operational barriers** (e.g. technical or legal difficulties for the implementation, disruptions, risks for production or product quality);
- **Regulatory barriers** (e.g. unclear political frameworks and guidelines, difficult to access to subsidies, low qualification and market standards);
- **Informational barriers** (e.g. lack of awareness, lack of information, unprecise recommendations).

For empirical evaluations, researchers often resort to detailed lists of the most common barriers in order to assess their prevalence through surveys. Results are usually presented in the form of barriers rankings (Nehler et al. 2018; Sardianou 2008; Gründig et al. 2017).

1.2. Identifying drivers for energy efficiency in the industry

1.2.1. Classification of drivers

Although drivers to increase ESM implementation in the industry have not been subject to the same amount of research as barriers (Nehler et al. 2018), a similar approach for their identification can be used. Based on empirical research, (Cagno und Trianni 2013) suggest the following classification, which they have been using since (Trianni et al. 2015):

Table 2: Drivers to ESM implementation in companies according to Cagno and Trianni (2013)

Regulatory
<ul style="list-style-type: none"> • Long-term energy strategy • Willingness to compete • Green image • Voluntary agreements • Clarity of information • energy audit/submetering • Increasing energy tariffs • Efficiency due to legal restrictions • Technological appeal • Trustworthiness of information
Economic
<ul style="list-style-type: none"> • Cost reduction from lower energy use • Information about real costs • Management support • Public investment subsidies • Private financing
Informative

<ul style="list-style-type: none"> • Management with ambitions • Staff with real ambitions • Knowledge of non-energy benefits • External cooperation • Availability of information • Awareness
Vocational training
<ul style="list-style-type: none"> • Programs of education and training • Technical support

Based on this framework, Nehler et al. (2018) identify the following list of most prevalent drivers for ESM implementation in companies:

- People with real ambitions commitment from top managers;
- Long-term energy strategies;
- Rising energy prices;
- Cost savings;
- Successfully implemented and efficient measures;
- NEBs.

They highlight Non-Energy Benefits (NEBs) as drivers in decision-making processes, citing (Cagno et al. 2015), who describe NEBs as affecting almost all categories of barriers. When NEBs are monetised and considered in investment decisions, the financial aspects of investments improve. One argument is that taking NEBs into account and monetising them could cut payback periods in half. One problem, however, is that some NEBs are easier to quantify than others. NEBs related to production, operation, maintenance, waste or emissions reduction are easier to monetise than those related to improving the working environment. Whether quantifiable or not, NEBs and their benefits should always be considered (Nehler et al. 2018).

A common approach to enable effective action towards ESM implementation is to link identified barriers with the adequate drivers in order to overcome them (Cagno et al. 2015, Trianni et al. 2016, Cagno et al. 2016, Nehler et al. 2018). Looking at the decision-making and implementation process to identify is a relevant approach to anticipate when barriers can occur and adequately address by actioning specific drivers.

1.2.2. Linking barriers and drivers along the decision-making process

Cagno et al. (2013) present a four-stage model of decision-making process for implementing ESM in companies and the related barriers, that can prevent the decision phase. The first stage describes the status quo before the measure is implemented. This is where awareness of energy reduction begins. Lack of time, resources and personnel, lack of interest, inertia, prioritisation of other costs or inefficiencies that are not identified or difficult to identify are barriers that can interrupt this stage. The second stage is the decision or plan to invest in reducing energy costs. The company starts by identifying inefficient processes and looking for potential savings. Complex decision-making structures, lack of access to external expertise and lack or inadequacy of information are barriers at this stage. In the third stage, information on inefficiencies and potential is available, an investment analysis is carried out and finally the investment is made. Possible barriers are insufficient evaluation criteria,

unavailable technologies, lack of objectives, lack of control and lack of expertise to implement the investment. In the fourth phase, the measure is implemented and energy efficiency is improved (Cagno et al. 2013).

Cagno et al. (2016) have analysed which drivers are most relevant to address specific barriers along the decision-making process. Drawing on the literature on ESM drivers (Cagno et al. 2013, Cagno et al. 2016) and the previous A2M report¹, Figure 1 summarises the main barriers and the associated relevant drivers along the decision-making process of companies towards ESM implementation.

Decision process	Main barriers	Relevant drivers
Awareness	Awareness: lack of awareness Behavioural: lack of interest, other priorities, lack of sharing objectives	Regulatory int: long-term energy strategy, voluntary agreements Regulatory ext: clarity of information
Need and opportunity identification	Informational: lack of information on costs and benefits, lack of transparency and trust Organisational: lack of time, lack of staff	Regulatory ext: clear, trustworthy information Informative int: ambitious management Vocational ext: technical support capacities
Technology identification	Informational: unclear market information Operational: inadequate technologies, risks for production, third-party premises	Regulatory ext: clear, trustworthy information Informative int: available information Vocational ext: technical support capacities
Planning	Organisational: lack of time and staff, divergent interests, lack of internal control, complex decision chain	Vocational ext: technical support Informative int: internal know-how and ambitions Regulatory int: long-term energy strategy
Sustainability analysis	Economic: lack of capital, long payback period, hidden costs Informational: lack of information on cost	Economic int: NEBs, inform on real cost savings Regulatory ext: public subsidies, tariff increases Regulatory int: voluntary agreements
Installation start-up and training	Behavioural: lack of motivation Organisational: other priorities Competences: lack of internal know-how	Informative int: staff with real ambitions Vocational ext: technical support Vocational int: internal know-how

Figure 1: Overview of main barriers and drivers along the decision-making process of companies (based on: Cagno et al. 2016, Cagno et al. 2013)

1.3. Differentiation of barriers and drivers by company types and context

Findings from barriers literature indicate that a differentiation of the prevalence and impact of specific barriers and drivers based on context, ESM technology and company types is relevant (Trianni et al. 2013). However, comprehensive analyses are lacking as research has been carried out with limited scopes and small sample sizes (Cagno et al. 2015). Company size and mindset, as well as Energy Management Systems (EMS), have been the most frequently analysed parameters in regard to ESM implementation to date. Specific ESM, sub-sectors and national context have only been analysed sporadically and with limited means of comparison. Although EU member states are expected to report on the energy efficiency in the industry, comprehensive national evaluations are only publicly available in Italy and in Germany currently (July 2023).

¹ AUDIT2MEASURE D2.2 “Report of top management decision process”.

1.3.1. Differentiation by company size

Trianni and Cagno (2012) suggest that the barriers are different for companies of different sizes. In smaller companies, lack of time, resources and staff tends to be a bigger barrier, while in large companies more complex decision-making processes play a bigger role. It is therefore meaningful to distinguish between small, medium and large companies when it comes to barriers to ESM implementation (ibid.).

Hirzel et al. (2016) also talk about SMEs facing different barriers, as their energy needs and costs are lower than those of larger companies. Accordingly, energy and cost savings are also lower, which makes ESM less relevant. As mentioned above, SMEs lack time and staff expertise, which leads to an information deficit on energy efficiency. The budget available to SMEs is significantly lower than that of larger companies. However, measures can be implemented more quickly due to less complex decision-making structures. One of the challenges for SMEs is to convince individual decision-makers of the benefits of ESM (Hirzel et al. 2016).

Overall, large industrial companies have been significantly less scrutinised in their ESM implementation gap and related barriers and drivers as compared to SMEs. There is little to no literature on the impact of company size on ESM implementation among non-SMEs.

1.3.2. Differentiation by manufacturing sub-sectors and energy intensity

Due to typically small sample sizes, there has not been a comprehensive comparison of the ESM implementation gap between the different manufacturing sectors in recent literature. Nevertheless, it is likely that the energy intensity of a sub-sector may be an important factor influencing ESM implementation, since high energy costs in comparison to turnover and profitability of energy efficiency investments are prime reasons for ESM implementation.

Barriers and drivers in certain sub-sectors (Thollander et al. 2013; Caragliu 2021) have been the subject of some specific research, however rarely in direct comparison to the rest of the manufacturing sector. Trianni and Cagno (2013) highlight some differences identified between the primary metal manufacturing sector and other manufacturing industries.

The impact of EMS on the implementation gap has been analysed mostly in the German context (Nehler et al. 2018).

1.3.3. Classification of companies by “lifestyle”

Palm (2009) takes a different approach to identifying barriers. Rather than categorising barriers, they are identified as characteristics of certain types of businesses. Dividing companies into lifestyle categories, to which certain characteristics are assigned that have a positive or negative impact on the implementation of ESM. Four lifestyle categories are identified: the ignorant company, the implementer of easy measures, the economically interested company and the innovative environmentalist (Palm 2009). The categories should be understood as ideal-typical and simplified. In reality, the categories overlap. However, the categories are helpful in better classifying the factors and barriers that influence decision-making processes in companies. The lifestyle categories are defined as follows:

- **The ignorant company** does not focus on energy issues and lacks appropriately trained staff. It is focused on its core activities and has little interest in energy efficiency, mostly due to low energy costs;

- **The implementer of simple measures** focuses primarily on low-cost, quick and easy-to-implement measures to reduce their energy consumption. This type of company does not actively seek energy efficiency solutions and is satisfied with its low level of engagement in this area. The most important criterion for implementing measures is a fast payback period;
- **Economically interested** companies will only implement measures if the investment brings them an economic benefit. The payback period is the key factor. Another reason for investing in ESM is legal requirements. If there are no incentives or requirements, no measures will be implemented. These companies do not see much benefit in dealing with energy issues if they do not pay off;
- **The innovative environmentalists** companies are aware of both environmental and energy issues. They implement both simple and more complex measures. Their decision-making structures are mostly determined by people with enthusiasm and conviction about climate protection and energy efficiency, who implement ESM as a driving force. This type of company is constantly interested in improving its energy efficiency and is willing to invest large sums of money (Palm 2009).

1.4. Key findings and research gaps in the literature

From the literature review, it can be deduced that many studies on barriers to ESM in industrial companies use different detailed and specific categorisations. Broader categorisations such as Sorell et al. (2000) allow for a higher level of abstraction, while specific categorisations such as Cagno et al. (2013) provide a detailed characterisation of the barriers. It also becomes clear that different types of barriers can occur at different stages of a decision-making process. Drivers, just like barriers, can be classified into similar categories. Barriers and drivers vary with different company sizes and energy consumption. For example, larger companies are often more inhibited by complex and lengthy decision-making processes, while smaller and medium-sized companies tend to lack time, resources and staff. In addition, different corporate philosophies or "lifestyles" face different drivers and barriers due to their corporate governance.

It is difficult to determine from the literature whether the barriers to ESM implementation in industrial companies vary significantly across European countries. Although there are studies on individual countries (Cagno et al. 2015; Cagno et al. 2016), they are difficult to compare as they are often linked to other very specific parameters, such as a specific industrial sector. Similarly, studies on barriers in specific manufacturing sub-sectors and ESM technologies are difficult to compare. The following chapters of this report aim to address these gaps and provide indication for the upcoming capacity building and technical assistance activities of the A2M project. However, this is only possible to a limited extent due to the limited data at our disposal.

2. ANALYSIS OF A2M SURVEY RESULTS

The AUDIT2MEASURE consortium carried out an extensive qualitative survey of 31 manufacturing companies from the 5 project countries. Companies were notably asked to rank barriers, reasons for implementation and reasons for non-implementation by order of prevalence. Due to the small sample size, certain interesting differentiations, for example by ESM technology or by sub-sector, could not be assessed. An assessment of the implementation gap by ESM technology group based on the survey was carried out in previous report D2.2 “Report of top management decision process”. The results nevertheless provide an overview of barrier and drivers as well as an indicative comparison of their prevalence between the partner countries.

2.1. Definition of short lists of most common barriers and drivers

Based on the literature review on barriers and drivers (see 1.4 Key findings and research gaps in the literature) and on prior research and surveys led by adelphi in the German context (Fjornes et al., 2023), we elaborated the two following lists of barriers. The first one was presented as a list of barriers which surveyed companies were asked to score based on their relevance: this gives us an indication of the perceived barriers to implementation. The second list was presented to companies as reasons why they did not implement recommended ESM: this gives us an indication of impact of actual barriers to implementation. Comparing results from these two distinct questions helps to avoid the self-assessment bias of surveyed companies and potentially identify barriers company may be less aware of.

Surveyed companies were asked to assess the relevance of following barriers:

- Mistakes in the planning of measures;
- Mistakes in the implementation of measures;
- Lack of suitability of measures;
- Lack of motivation of employees;
- Difficulty to change existing routines;
- Lack of time;
- Lack of personnel resources;
- Lack of financial resources;
- Externalities.

Surveyed companies were asked to choose among the following which reasons prevent the implementation of recommended ESM:

- No interest in energy efficiency;
- Lack of motivation of employees;
- No availability of skilled workforce;
- Lack of knowledge of decision makers;
- Disrupt operational processes and production safety;
- Low potential cost savings;
- Low reduction in CO₂ emissions and energy;
- Funds tied up to other investments;
- Lack of time;

- Lack of resources;
- No availability of funding;
- Prioritisation of other expenses;
- Long payback period;
- High investment cost;
- Others.

Similarly, companies were also asked to select among the following short list the main reasons why recommended ESM were effectively implemented:

- Reduction of energy costs;
- Short Payback Period;
- Improve economic efficiency;
- Reduction of CO₂ emissions;
- Low investment costs;
- Advance climate protection efforts;
- Improvement of financial capabilities;
- Legislative requirements;
- Customer/ employee requirements;
- Attractive funding;
- Other.

2.2. Assessment of barriers and drivers from 31 companies

For the perceived barriers, surveyed companies were invited to score each listed barrier (see above) on a scale from 1 “not relevant at all” to 6 “very relevant”. Overall, the lack of financial resources was ranked as the most relevant barrier, followed by lack of time, difficulty to change routines, lack of staff and unsuited measures. Mistakes, lack of motivation and externalities were rated as rather less important (Figure 2).

For the actual barriers, surveyed companies were asked to selected from a list (see above) which reasons prevented them from implementing recommended ESM, multiple answers could be selected (Figure 2). The most frequently cited reason was high investment costs, followed by long-payback periods, other priorities as well as lack of funding, resources and time. Lack of awareness, skills, motivation and interest appeared to play a lesser role.

Overall, the comparison of actual barriers with the perceived barriers corroborates that economic and organisational barriers are the primary causes of non-implementation, while awareness and informational barriers seem less important. More specifically, it seems that the lack of time is actually less frequently a difficulty than perceived, which, however, points towards other influential organisational factors such as the difficulty to change routines and the prioritisation of other investments.

Coherently, the most frequent reasons for implementation are of economic nature (Figure 4): reduction of energy costs, short payback times and improved economic efficiency. Climate protection appears to play a secondary role. Interestingly, public policy measures such as legal requirements and attractive funding are least likely to incentivise implementation, along with customer and employee demands.

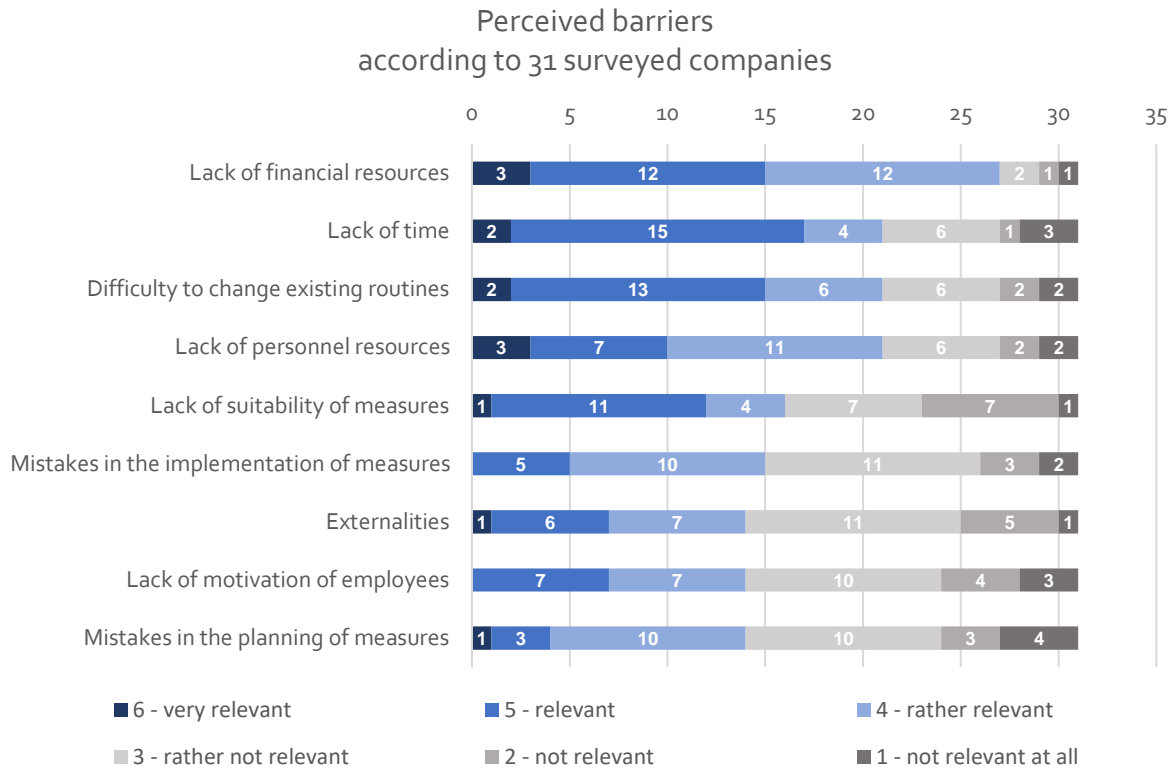


Figure 2 : Relevance of barriers according to 31 companies (data: AUDIT2MEASURE company survey)

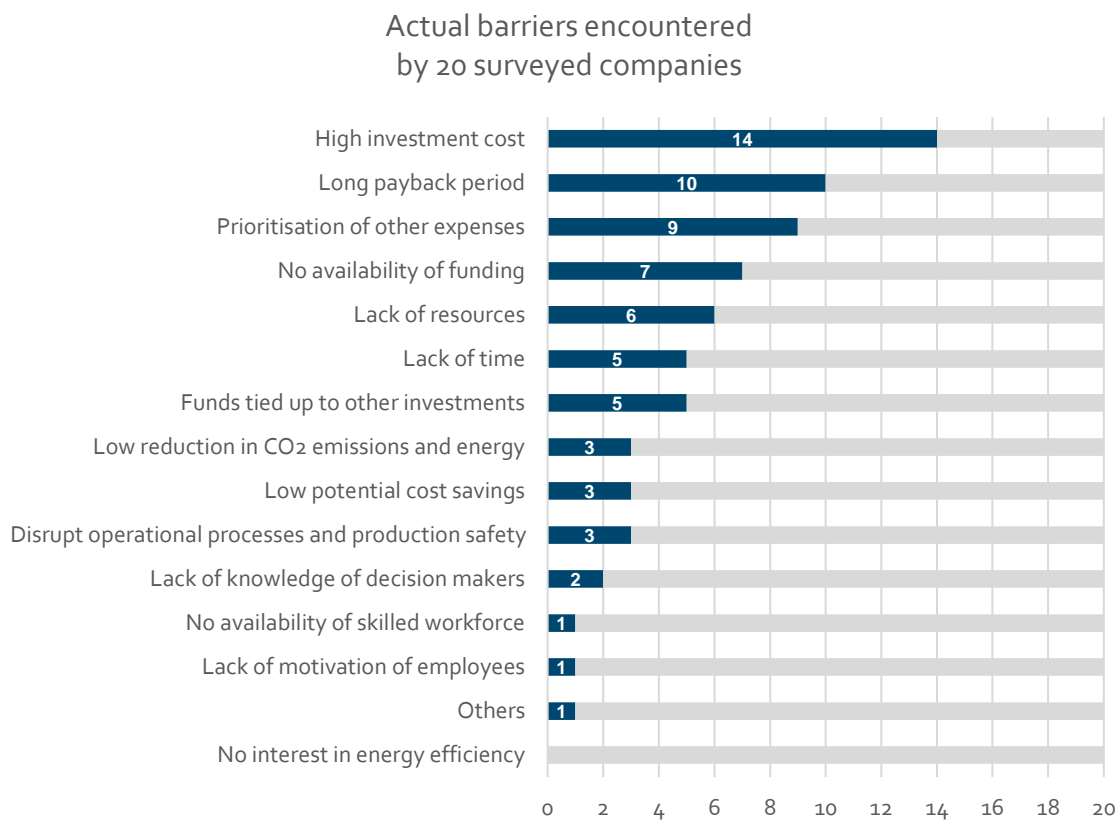


Figure 3: Reasons for non-implementation of recommended ESM in 20 companies (data: AUDIT2MEASURE company survey)

Drivers to ESM implementation in 31 surveyed companies

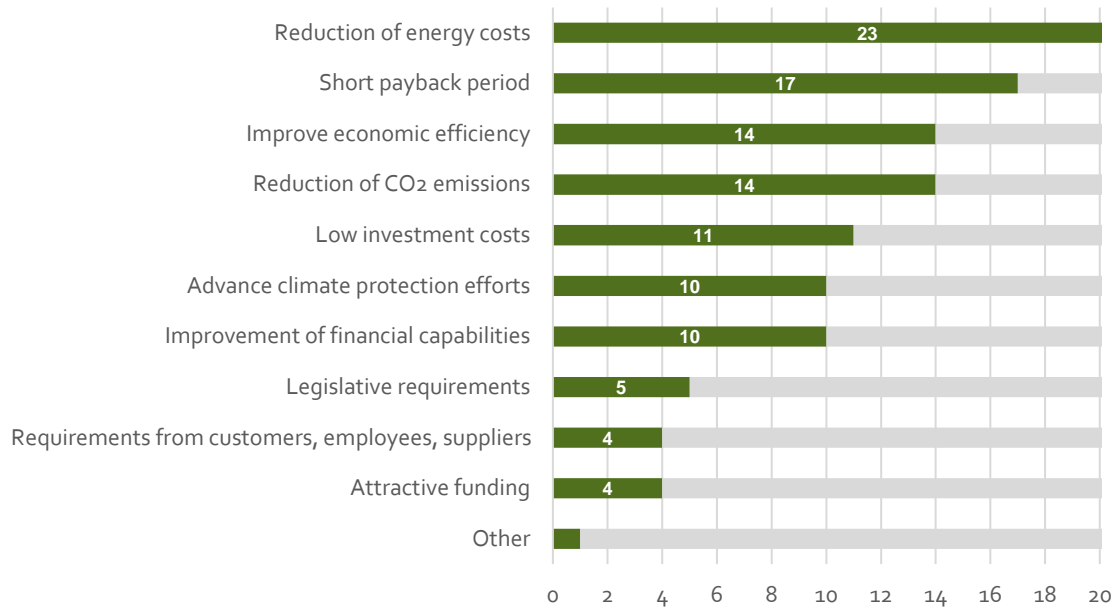


Figure 4: Reasons for the implementation of ESM in 31 companies (data: AUDIT2MEASURE company survey)

2.3. Comparison of barriers between the 5 project countries

Between 4 and 7 companies were surveyed from each country, thus this small sample size does not allow any precise assessment of the prevalence of barriers in each country. However, the results can provide an indication whether major discrepancies in the perception of ESM implementation exist between the five countries (Figures 5 to g). This comparison was carried out focusing on perceived barriers, which companies were asked to score by relevance from 1 to 6 (see above). The occurrence of actual barriers (i.e. reasons for non-implementation) could not be compared due to the small sample size.

Below there is an overview of the perceived barriers ranked based on their relevance score in each project country:

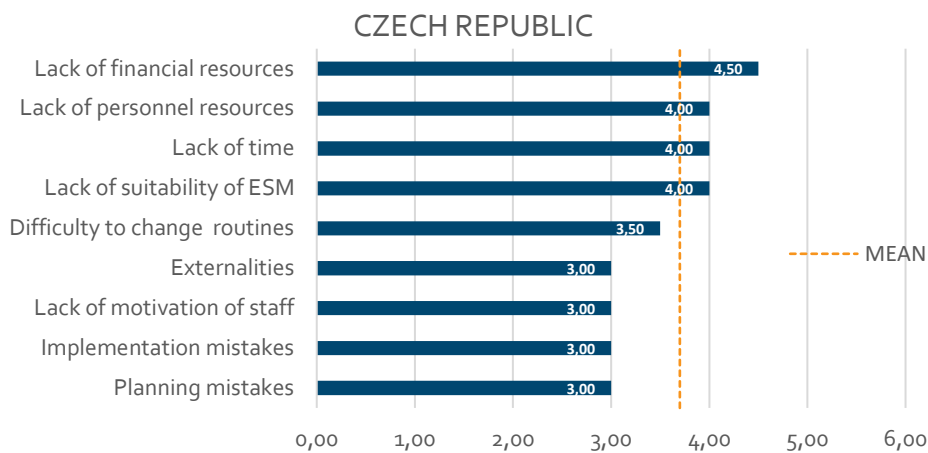


Figure 5: Relevance of barriers according to Czech companies (data: AUDIT2MEASURE company survey)

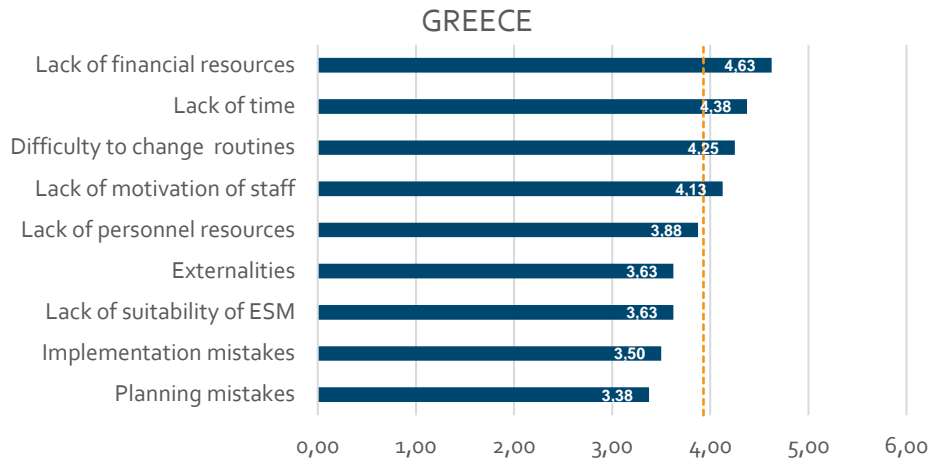


Figure 6: Relevance of barriers according to Greek companies (data: AUDIT2MEASURE company survey)

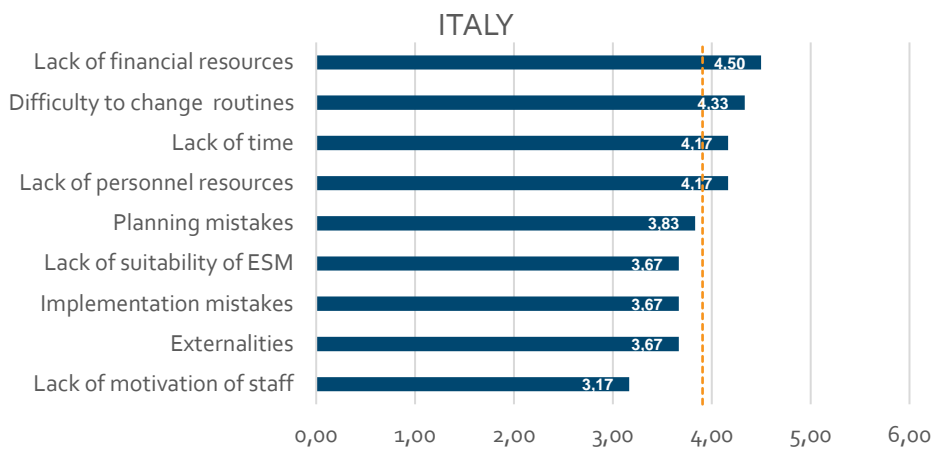


Figure 7: Relevance of barriers according to Italian companies (data: AUDIT2MEASURE company survey)

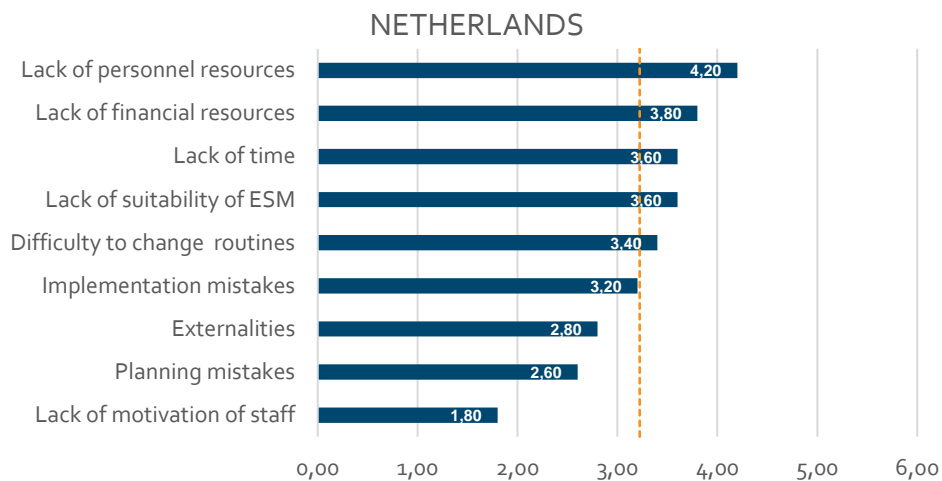


Figure 8: Relevance of barriers according to Dutch companies (data: AUDIT2MEASURE company survey)

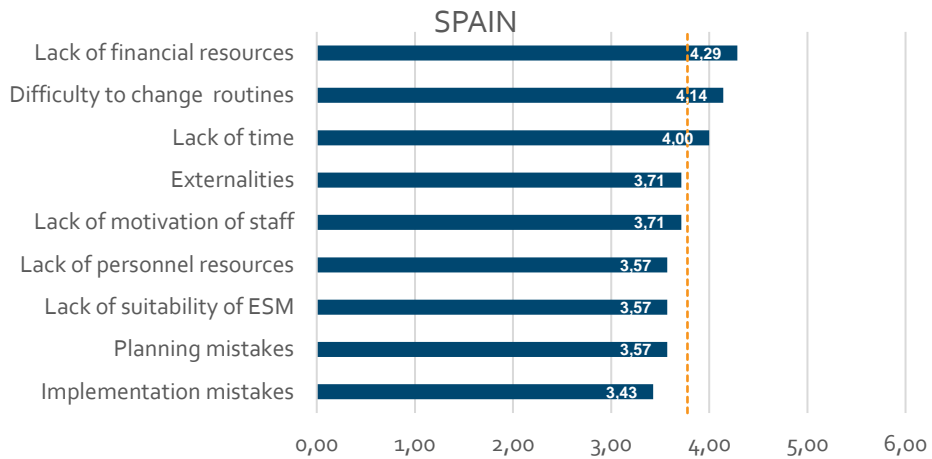


Figure 9: Relevance of barriers according to Italian companies (data: AUDIT2MEASURE company survey)

Based on these results, there are no structural differences between the countries: lack of financial resources and lack of time are foremost barriers in all countries. In all countries planning and implementation mistakes are considered less important barriers. In Italy and the Netherlands, companies rank mistakes slightly higher than in other countries. In Czech Republic and in the Netherlands, the lack of personnel resources plays a primary a role. Difficulties to change existing routines seem more prevalent in Spain, Italy and Greece.

More data based on larger sample sizes is needed to confirm or invalidate these trends. Generally, the analysis of the survey results shows that companies across the five countries perceive similar economic and organisational barriers as being the strongest. For the further analyses of barriers in this report and given the lack of cross-country data, it will therefore be assumed that overarching findings and trends on barriers and drivers from one national context can be transferred and generalised to the five project countries, while keeping in mind that national specificities exist.

3. ANALYSIS OF GERMAN NATIONAL SURVEYS

The German BAFA carries out an annual sample survey of companies having contracted energy services (Energiedienstleistungen - EDL). The total sample size is about of 2,750 companies each year (2,500 SMEs and 250 non-SMEs). BAFA shared the survey results data from 2021 and 2022 (respectively surveying the years 2020 and 2021) with the AUDIT2MEASURE consortium. Since these companies have received support from energy service companies, they may tend to be more advanced in terms of energy management and efficiency than the national average. This bias is likely to affect the absolute prevalence of barriers; however, since the following analysis will be comparative and not in absolute terms, this aspect is not further reflected in this chapter.

The results from both years were aggregated as it is assumed that in the case of “sampling with replacement” the probability of drawing the same company twice is low given the total amount of companies. To ensure as much coherence as possible with the A2M Survey, only surveyed manufacturing companies (NACE Code C) falling under the energy audit obligation were analysed. Due to the nature of the survey, not all questions were answered by all participants, therefore sample sizes may vary slightly. Overall, over the two years, 116 manufacturing industries falling under this category reported barriers. That sample size is, however, too small for the assessment of barriers by manufacturing sub-sectors, therefore this analysis was carried out looking at all manufacturing companies with and without audit obligation.

In the light of the previous comparison of A2M project countries (see 2.2. Comparison of barriers between the 5 project countries), it is assumed that overarching findings from German national data can inform on general trends on barriers and drivers in the context of the other project countries. Further, the following analysis highlights the relevance of differentiating barriers by company and ESM types, even though results may differ between countries. More comprehensive evaluations and adequately designed surveys are needed on national level to better understand the causality and the impact of specific barriers.

3.1. Ranking of barriers from 116 manufacturing companies

Overall, the pool of obligated manufacturing companies cited economic and organisational barriers most frequently: high investment costs, other priorities, not economically viable measures, uncertain price and technology evolutions and time expenditure. Operational constraints, unprecise recommendations and lack of offers appear to play a lesser role (Figure 10).

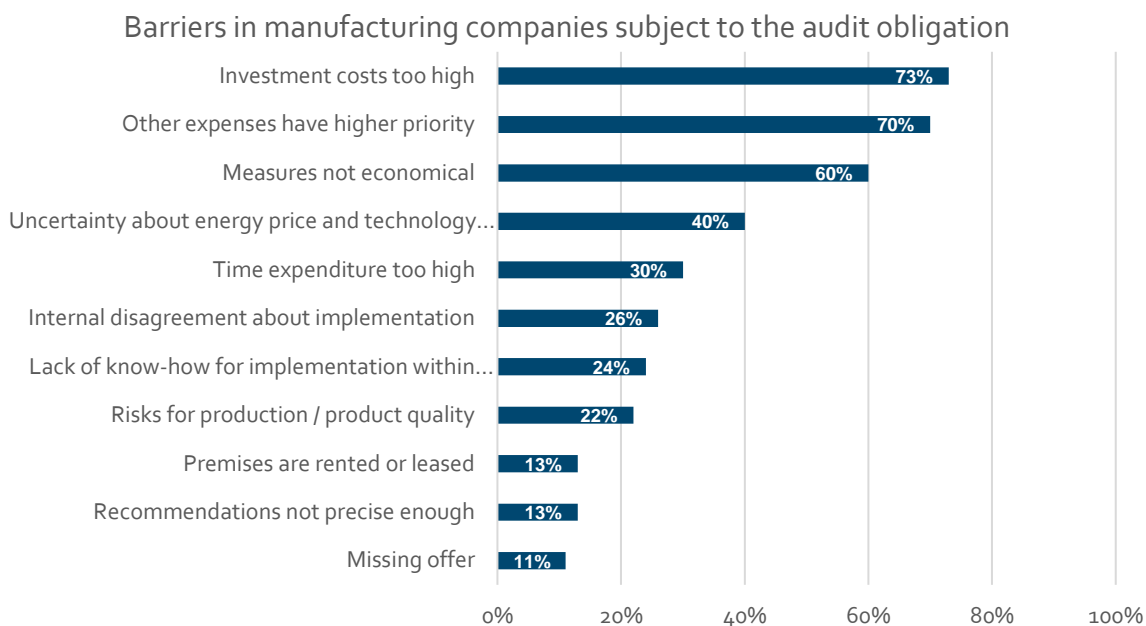


Figure 10: Prevalence of barriers among 116 German manufacturing companies subject to the audit obligation (data: BAFA EDL survey 2021 & 2022)

3.2. Differentiation by company typology

Using other quantitative data from the surveys, the 116 surveyed companies can be differentiated, for example, by number of employees, energy intensity, existence of an EMS and so on. The following sections investigate whether differences in the prevalence of specific barriers emerge between these categories.

3.2.1. Differentiation by company size

The most prevalent barriers regardless of company size are too high investment costs, other priorities and not economically viable measures. Main barriers among medium and large size companies (above 100 employees) appear to be relatively homogenous, except market uncertainties which seem to preoccupy companies above 500 employees significantly more (Figure 11).

Economically unviable measures, market uncertainties, lack of time, lack of know-how, risks for production and missing offers appear to affect smaller size companies, between 10 and 99 employees, significantly more than medium and larger size companies. Whereas internal disagreements and premises which do not belong to the company seem to play a lesser role for smaller size companies.

It is worth noting that all of the considered companies have declared falling under the energy audit obligations, whether they are SMEs or not. This includes SMEs affiliated to larger entities and companies with high energy consumptions.

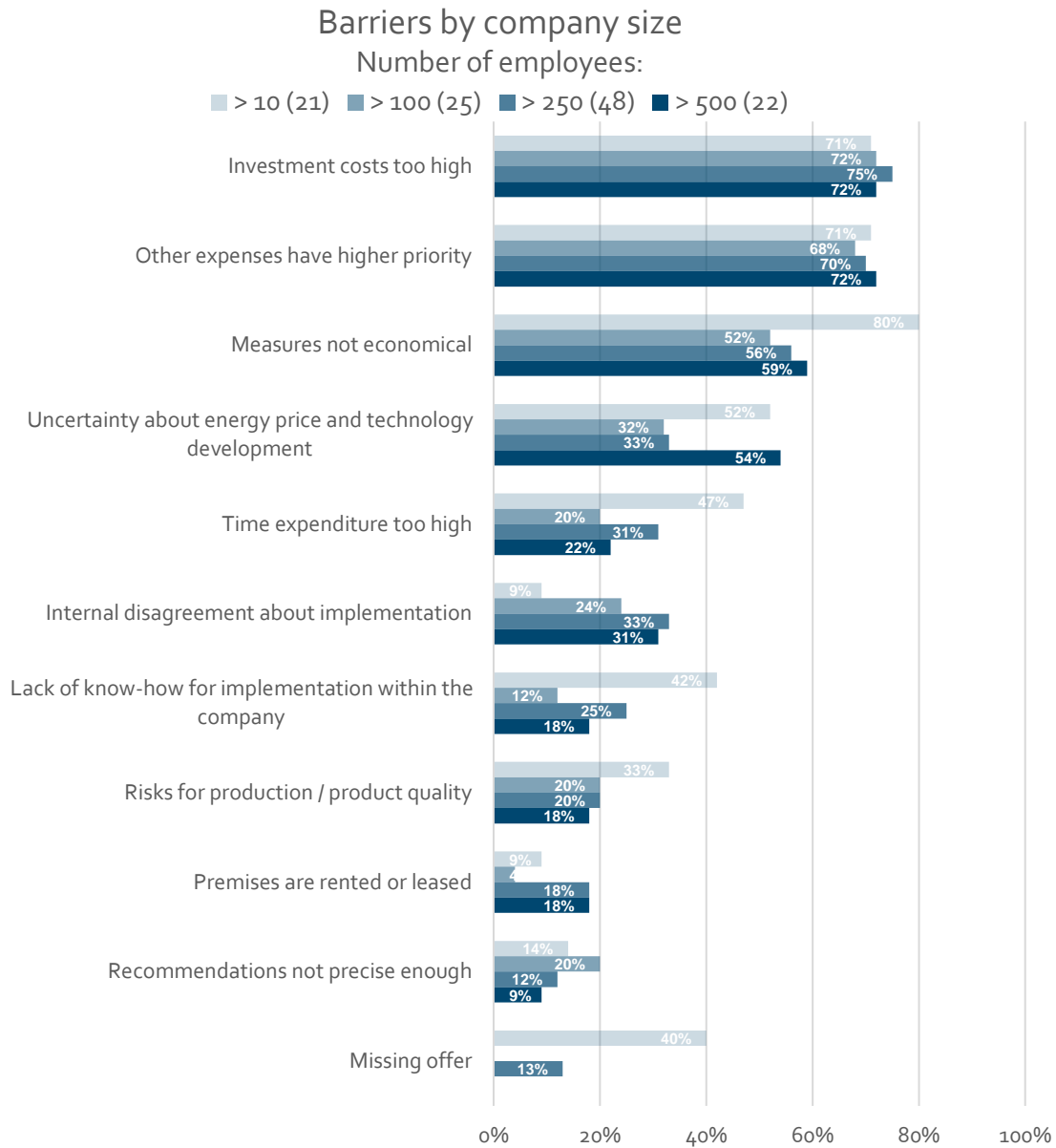


Figure 11: Prevalence of barriers according to German manufacturing companies subject to the audit obligation, sorted by number of employees (data: BAFA EDL survey 2021 & 2022)

3.2.2. Differentiation by energy intensity

The energy intensity of a company can be approached by comparing the annual energy expenses with the turnover. A meaningful categorisation was suggested in the graph below (Figure 12). It is worth noting, however, that this classification creates very heterogeneous sample groups encompassing both smaller and larger companies and is, therefore, only meaningful to assess the impact of energy expenses on perceived barriers.

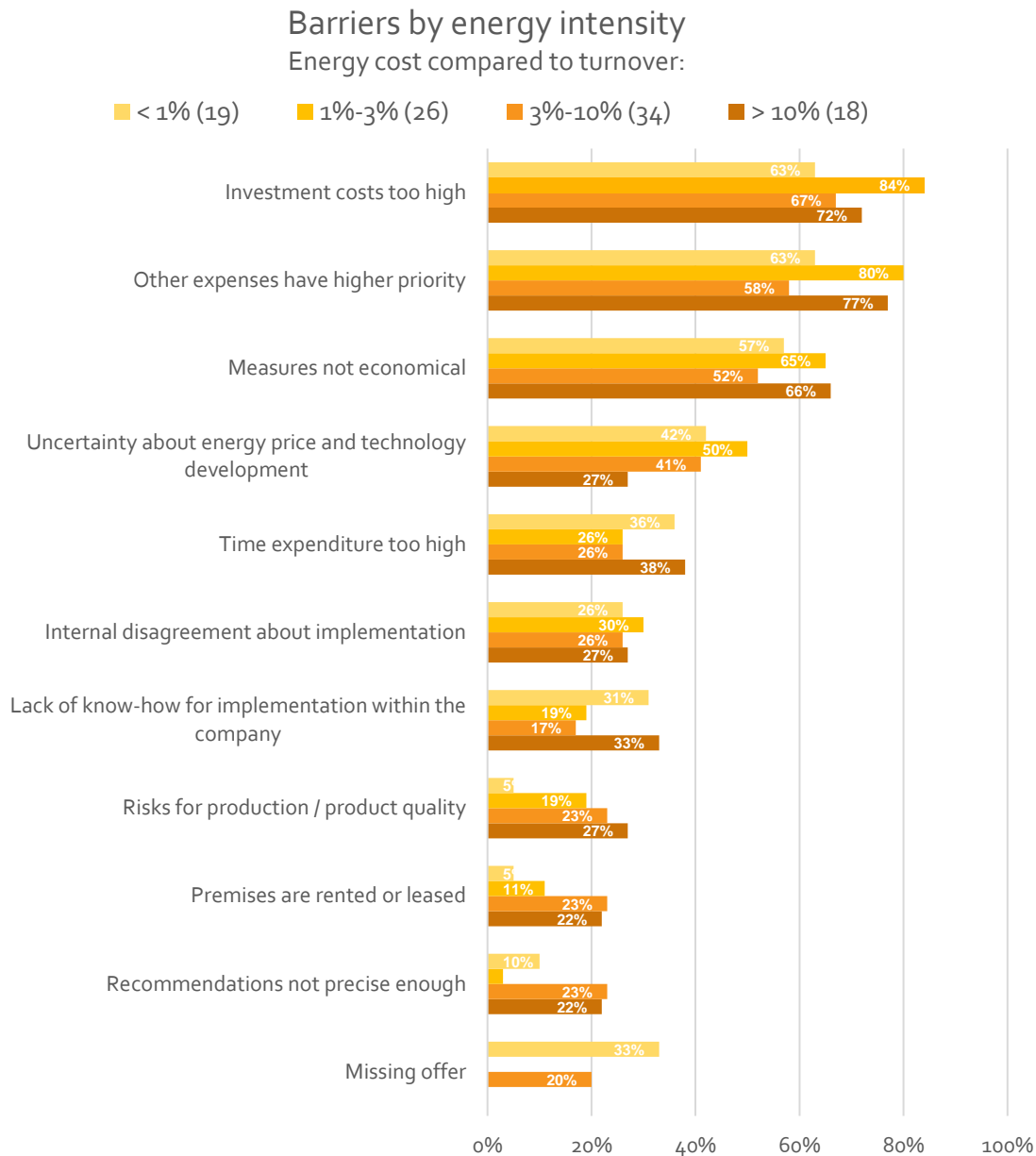


Figure 12: Prevalence of barriers according to German manufacturing companies subject to the audit obligation, sorted by energy cost compared to turnover (data: BAFA EDL survey 2021 & 2022)

Regardless of the energy intensity, main barriers are too high investment costs, other priorities and not economically viable measures. Investments cost seem to be more of a problem for companies with energy costs representing 1-3% of their turnover. Other priorities seem to slow implementation especially in companies with energy costs between 1-3% of their turnover but also very energy intensive companies, with energy expenses above 10%. Operational barriers such as rented premises and production risks seem to affect comparatively less companies with very low energy consumption (below 1% of turnover) than others.

Energy market uncertainties seem to rather affect less energy intensive companies than others. This may be due to German tax and subsidy specificities. In fact, energy-intensive companies can benefit from a number of instruments aimed at reducing the burden of high energy prices, such as reduced renewable energy levy, compensations on their electricity and energy taxes (Spitzenausgleich-Effizienzsystemverordnung - SpaEfV), on the cost of ETS and of the cost of national CO₂-certificates. Overall, it is likely that energy intensive companies have comparably lower specific energy costs.

The disparities in Figure 12 raise the question of the statistical significance of the energy expense compared to turnover for the prevalence of barriers. A quick assessment of the significance can be carried out by looking at the Pearson correlation coefficient (R) and its significance (p-value) for this metric in relation with the prevalence of each barrier (Table 3). An R coefficient tending to 1 indicates a strong positive correlation between energy intensity and a given barrier, an R close to zero indicates there is no correlation, an R close to -1 indicates a strong negative correlation. The respective p-value shows the significance of the energy intensity for the given barrier, i.e. the probability that another data point will have a similar R coefficient. A p-value close to zero indicates a high significance, a p-value close to 1 indicates a low significance.

Table 3: Correlation and significance of energy cost compared to turnover for the prevalence of barriers among audit-obligated and among all surveyed manufacturing companies (data: BAFA survey 2021 & 2022)

	Audit-obligated NACE C (218 companies)		All NACE C (1621 companies)	
	R	p-value	R	p-value
Investment costs too high	0.03	0.724	-0.0	0.924
Measures not economical	0.02	0.825	-0.03	0.480
Other expenses have higher priority	0.06	0.538	0.05	0.168
Recommendations not precise enough	0.06	0.527	-0.0	0.934
Time expenditure too high	-0.02	0.840	-0.0	0.957
Lack of know-how for implementation within the company	0.02	0.867	-0.0	0.905
Risks for production / product quality	0.22	0.019	0.11	0.005
Uncertainty about energy price and technology development	-0.1	0.300	0.01	0.766
Internal disagreement about implementation	-0.04	0.654	-0.02	0.629
Premises are rented or leased	0.02	0.835	-0.08	0.040
Missing offer	-0.04	0.820	-0.01	0.923

Table 3 presents the results of this assessment, carried out both for the energy intensity of manufacturing companies under the audit obligation and for the energy intensity of all surveyed manufacturing companies. For most considered barriers, the energy intensity does not appear to have a significant impact. Only risks for production and product quality were found to be positively correlated to higher energy intensity with a high significance. Difficulties due to third-party owned premises appear to be negatively correlated to higher energy intensity, but only among non-obligated companies. This can be explained by the fact that this tends to be more of a challenge for SMEs with lower energy intensity.

This assessment confirms that a direct link between energy intensity and the prevalence of barriers is difficult to establish in general. As mentioned previously, this may be due to the multiplicity of parameters behind a company's energy profile.

3.2.3. Differentiation by EMS

Surveyed companies also had indicated whether they had implemented a certified EMS. Companies with an EMS are likely better aware of their energy costs and the technical opportunities to increase energy efficiency and are also more likely to have already implemented measures previously². Due to the scope of the national survey, a high proportion of surveyed companies already have a certified EMS. Nevertheless, it is possible to compare them with companies which did not implement an EMS.

Overall, the barriers for the implementation of energy saving measures were ranked in similar order both among companies with and without EMS (Figure 13). Only few divergences are significant: companies with EMS cited "measures not economical" and "uncertainties about energy price and technology evolutions" twice more often than companies without an EMS. "Lack of offer" although ranked low, seems to play a bigger role for them too. This may indicate a better level of knowledge on the real cost of energy saving measures and the state of the art of energy efficiency technology among companies with EMS. It is also likely that companies with EMS have already implemented most economically viable measures and are now facing economic barriers, including market uncertainties, to take more ambitious measures.

² The median energy efficiency investment of companies with EMS is twice as high as the median energy efficiency investment of companies without EMS in the considered sample.

Most prevalent barriers between companies with and without EMS

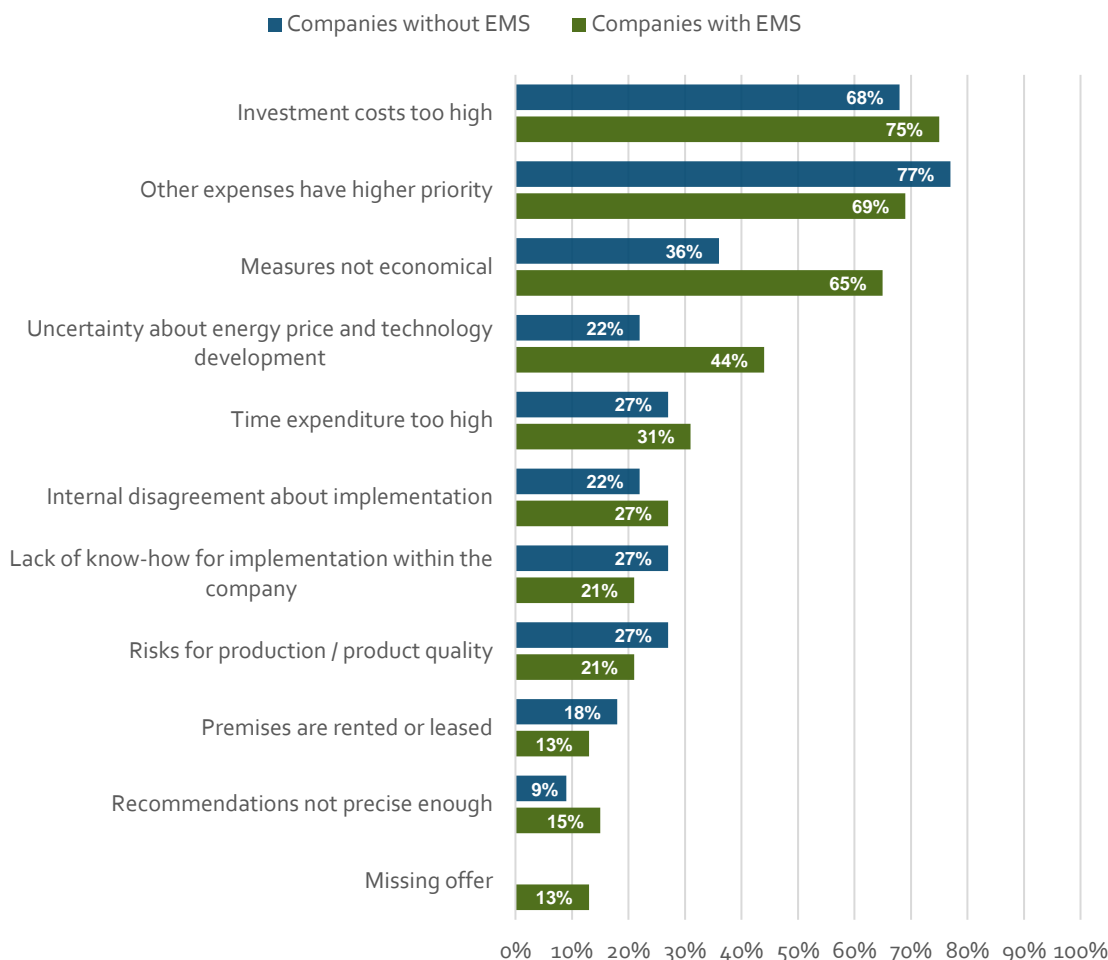


Figure 13: Prevalence of barriers according to German manufacturing companies subject to the audit obligation, sorted based on the existence of an EMS (data: BAFA EDL survey 2021 & 2022)

Companies without EMS, rather coherently, appear to prioritise other expenses rather more often than companies with EMS, indicating that an EMS may increase awareness on the importance of energy efficiency. They also appear to see operational and informational barriers as rather more important than companies with an EMS, although these factors rank low in both categories.

3.2.4. Differentiation by manufacturing sub-sector

A larger sample size is needed to compare the prevalence of barriers by manufacturing sub-sector clusters. Therefore, all surveyed NACE Code C companies were considered in this analysis which focuses on the most represented sub-clusters in the German survey (Figure 14 to 19).

Food, beverage and tobacco (110)

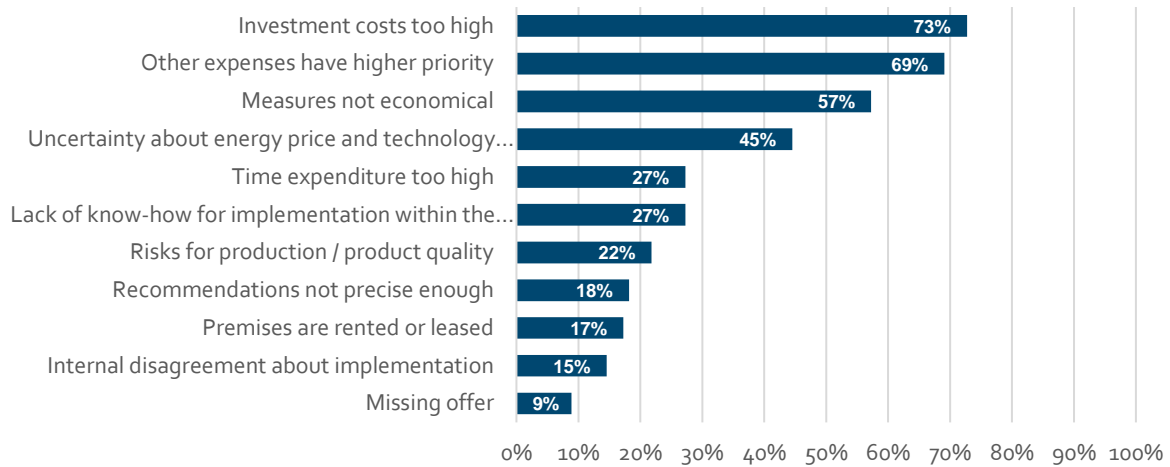


Figure 14: Prevalence of barriers among surveyed companies from NACE C10, C11, C12 (data: BAFA EDL survey 2021 & 2022)

Wood, cork, pulp, paper and print (60)

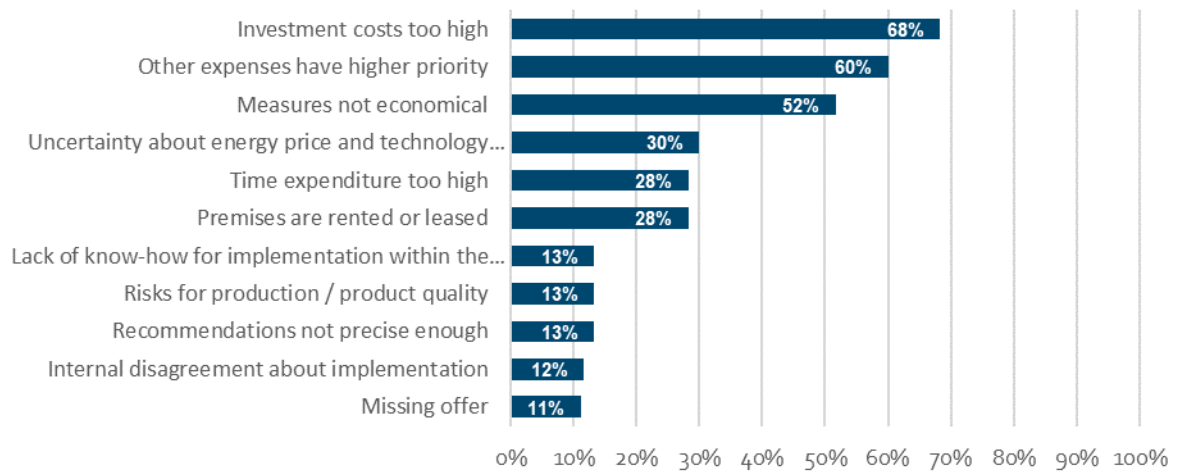


Figure 15: Prevalence of barriers among surveyed companies from NACE C16, C17, C18 (data: BAFA EDL survey 2021 & 2022)

Rubber, plastic and non-metallic minerals (63)

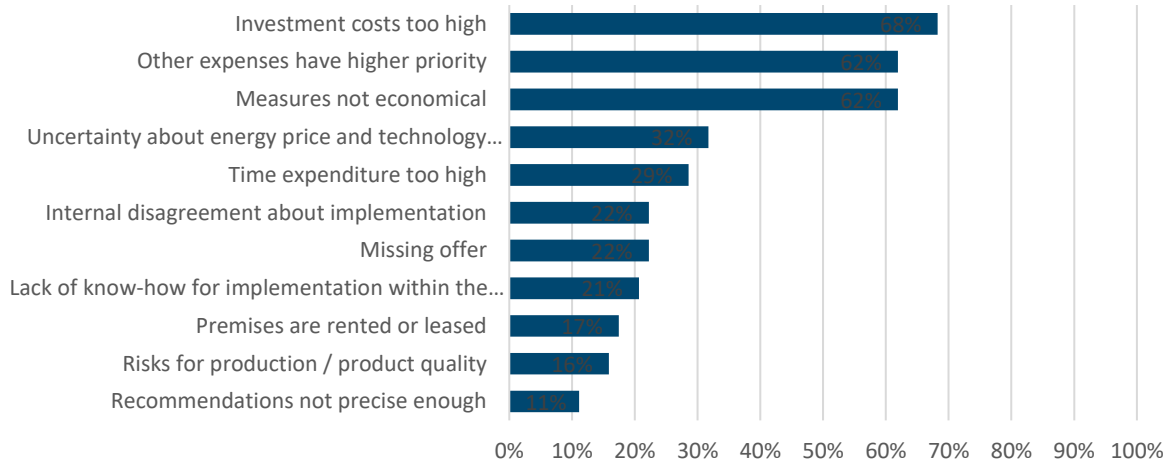


Figure 16: Prevalence of barriers among surveyed companies from NACE-sectors C22, C23 (data: BAFA EDL survey 2021 & 2022)

Metal (156)

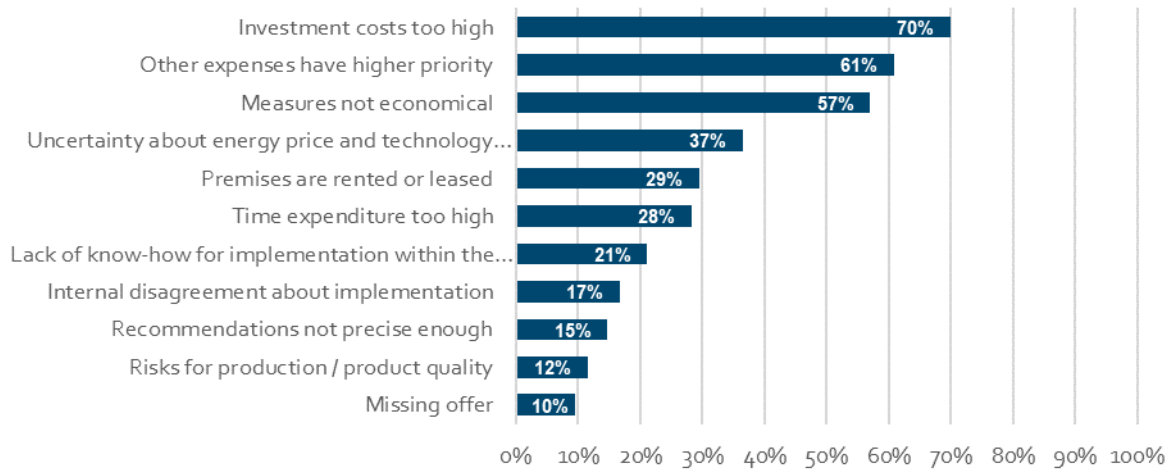


Figure 17: Prevalence of barriers among surveyed companies from NACE-sectors C24, C25 (data: BAFA EDL survey 2021 & 2022)

Electric and electronic equipment (64)

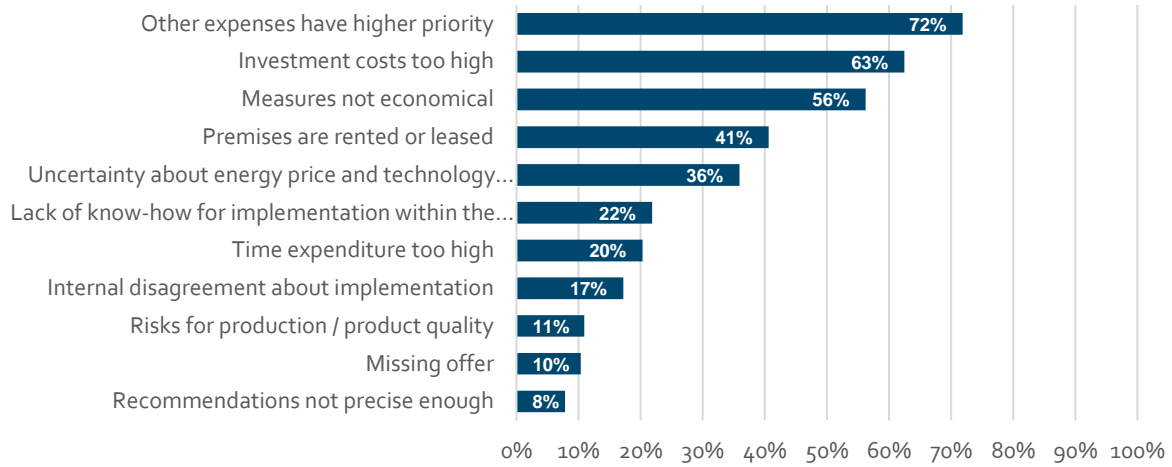


Figure 18: Prevalence of barriers among surveyed companies from NACE-sectors C26, C27 (data: BAFA EDL survey 2021 & 2022)

Machinery (78)

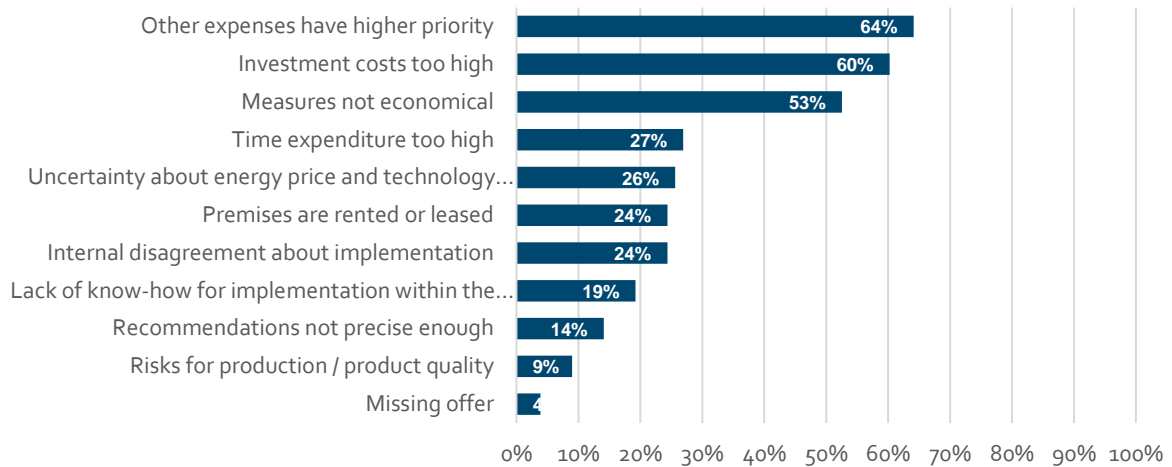


Figure 19: Prevalence of barriers among surveyed companies from NACE-sectors C28 (data: BAFA EDL survey 2021 & 2022)

Overall, economic and organisational barriers are the strongest across all sub-sector clusters with high investment costs, while not economically viable measures and other priorities top the barriers ranking for all sub-sector clusters. However, some first distinctions emerge:

- The machinery manufacturing sector appears to be confronted comparatively less frequently with barriers than other sub-sectors and only internal disagreements about implementation are a comparatively higher barrier than elsewhere. Possibly, this sub-sector has already been implementing simple ESM due to its high energy intensity;
- The food, beverage and tobacco cluster appear to be comparatively more frequently confronted with barriers than other sub-sectors. Especially, uncertainties about energy market evolutions and lack of internal know-how for implementation, but also production risks and unprecise recommendations are comparatively stronger barriers than in other industries. This may be due to the structure of this sub-sector cluster which, beside big players, is also composed of smaller and less energy intensive production sites;
- Missing offer appears to be comparatively a more common concern in the rubber, plastic and non-metallic minerals cluster than other considered manufacturing sectors. Difficulties related to third party-owned premises is a comparatively more prevalent barrier in the electric and electronic equipment manufacturing cluster.

This indicative analysis suggests that a sector specific assessment of barriers is relevant; however, larger samples or sub-sector specific evaluations are needed to pinpoint the particular challenges to ESM implementation of each sub-sector.

3.3. Differentiation by company “lifestyle”

The 160 surveyed companies can be sorted into the four “lifestyle” categories from the framework developed by Palm (2009) (see 1.3.3. Classification of companies by “lifestyle”) based on certain qualitative questions from the national BAFA EDL survey, which assess their intrinsic motivations. Criteria were set such as to make the lifestyle categories mutually exclusive:

- Companies were put in the “**Ignorant**” category when they answered below 5 on a scale from 1 “not relevant at all” to 10 “very relevant” to the question: “What is the relevance of energy efficiency for your company?”;
- Companies were put in the “**Implementer of Simple Measures**” category when they did implemented measures but assessed their energy efficiency investments as low compared to their turnover;
- Companies were categorised as “**Economically Interested**” if they indicated that their main motivation behind carrying out an energy audit or implementing an EMS are: meeting legal requirements for energy tax breaks³, creating a basis for the use of subsidies, gain control over energy costs; and are not: planning investments or strategic decision for climate protection;

³ Since 2013, German companies in the manufacturing sector can receive a so-called peak compensation on their electricity and energy taxes if they introduce a certified energy or environmental management system. SMEs can carry out an energy audit instead. (Spitzenausgleich-Effizienzsystemverordnung - SpaEfV)

- Companies were put in the **“Innovative Environmentalist”** category if they answered 9 or 10 on a scale from 1 “not relevant at all” to 10 “very relevant” to the question: “What is the relevance of energy efficiency for your company?” and said strategic decision for climate protection was a reason behind carrying out an energy audit or implementing an EMS.

The Ignorant (21)



Figure 20: Prevalence of barriers according to 21 German “Ignorant” manufacturing companies subject to the audit obligation (data: BAFA EDL survey 2021 & 2022)

The Implementer of Simple Measures (17)

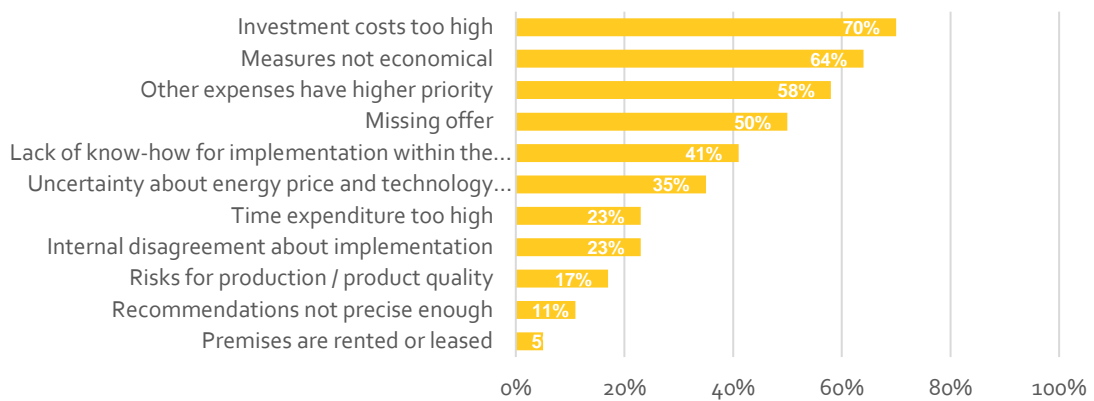


Figure 21: Prevalence of barriers according to 17 German “Simple Implementer” manufacturing companies subject to the audit obligation (data: BAFA EDL survey 2021 & 2022)

The Economically Interested (27)

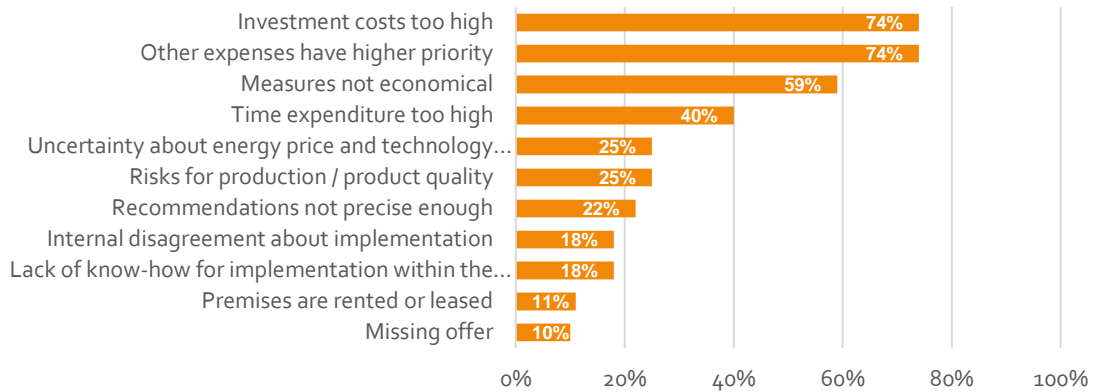


Figure 22: Prevalence of barriers according to 27 German "Economically Interested" manufacturing companies subject to the audit obligation (data: BAFA EDL survey 2021 & 2022)

The Innovative Environmentalist (50)

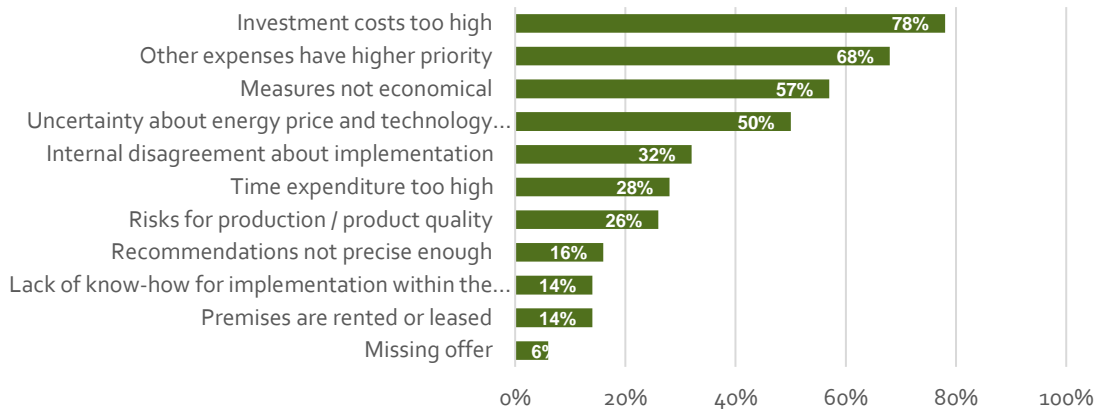


Figure 23: Prevalence of barriers according to 50 German "Innovative Environmentalist" manufacturing companies subject to the audit obligation (data: BAFA EDL survey 2021 & 2022)

Overall, all company lifestyle categories consider economic and organisational barriers as the most prevalent (too high investment, not economically viable measures and other investment priorities). Though, some specificities emerge:

- Lack of internal know-how for implementation is a much higher barrier in Ignorant and Simple Implementer companies. This can be explained by the lack of past experience and investments into energy efficiency. In comparison, in Innovative Environmentalist and Economically Interested companies, the lack of know-how is among the lesser challenges. In Ignorant companies, other investment priorities are the main reason for lagging ESM implementation. Rather coherently, this may be explained by a general lack of awareness on the benefits of energy efficiency. Simple Implementer companies perceive the missing offer in terms of ESM technologies and energy efficiency services as one of the most frequent barriers to implementation. This may be due to a relative lack of low-cost and easy-to-implement measures and services. Lack of time and other priorities play a comparatively stronger role in Economically Interested companies. This indicates that companies seeing energy efficiency through the

lens of profitability may be less willing to reevaluate their existing structures and routines to become more sustainable and rather see ESM as an add-on. Innovative Environmentalists see comparatively more plagued by market uncertainties and internal disagreements (both can be considered as behavioral barriers). These companies may have already implemented most easy ESM and are now slowed by their concerns regarding the feasibility of more ambitious and less high-yield measures;

- A categorisation by “lifestyle” or mindset categories appears to be a useful approach to better understand and address the kind of barriers each company is facing. A preliminary discussion with the top management could, therefore, be a useful step to tailor adequate capacity building and technical assistance activities for the uptake of ESM in manufacturing companies.

3.4. Differentiation by ESM types

Based on the available survey data, it is not possible to directly attribute barriers to specific implemented ESM technologies. However, it is possible to correlate what barriers are most frequently mentioned by companies which did not implement certain general types of ESM. For this approach, implemented measures were categorised into the following five general types of ESM:

- Building energy renovations;
- Cross-cutting technology improvements (motors, pumps, cooling, HVAC, lighting);
- Process-specific optimisation measures;
- Installation and improvement of energy production systems;
- Information and motivation of employees.

These five types of ESM cover all the most commonly recommended measures and it can be assumed that every surveyed company was recommended at least one measure from each of these categories. By comparing the divergence of companies which have not implemented certain types of ESM from the overall prevalence of barriers (including among companies having implemented no measures at all), it is possible to correlate the non-implementation of certain ESM types with the prevalence of certain barriers (Figure 24 to 28). For example, in Figure 24, “lack of know-how for implementation” is 25% more prevalent in companies which did not implement energy production upgrades than among the whole pool of answers, while the barrier “measure not economical” is 10% less prevalent in companies which did not implement energy production upgrades than among the whole pool of answers.

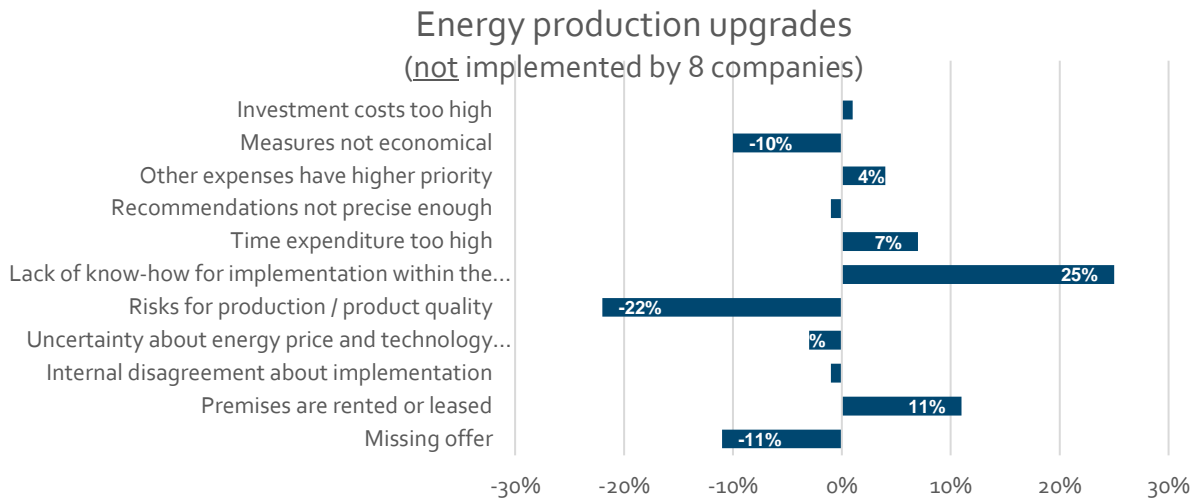


Figure 24: Prevalence of barriers in companies which did not improve or install efficient energy production systems (data: BAFA EDL Survey 2021 & 2022)

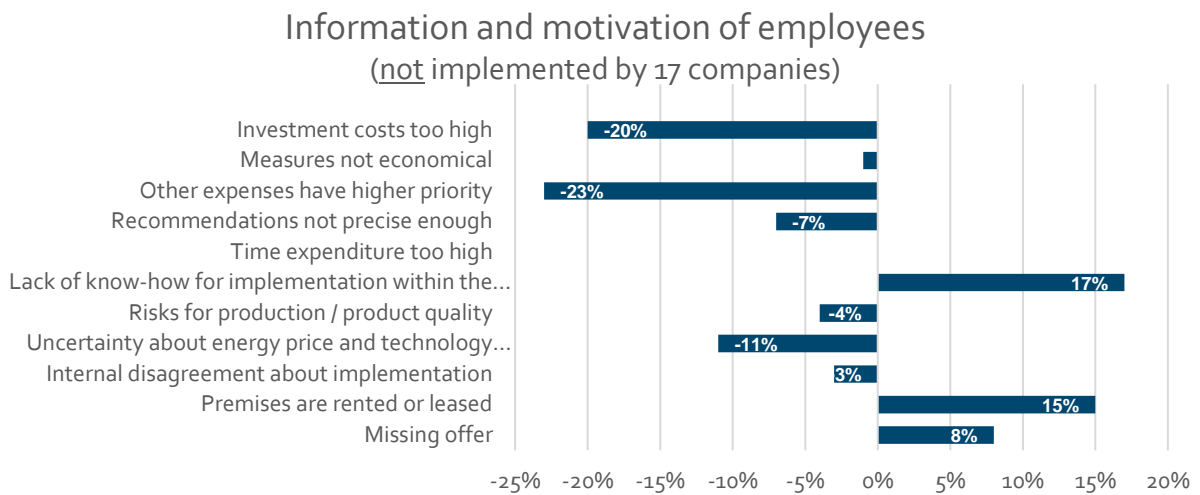


Figure 25: Prevalence of barriers in companies which did not inform and motivate employees as an ESM (data: BAFA EDL Survey 2021 & 2022)

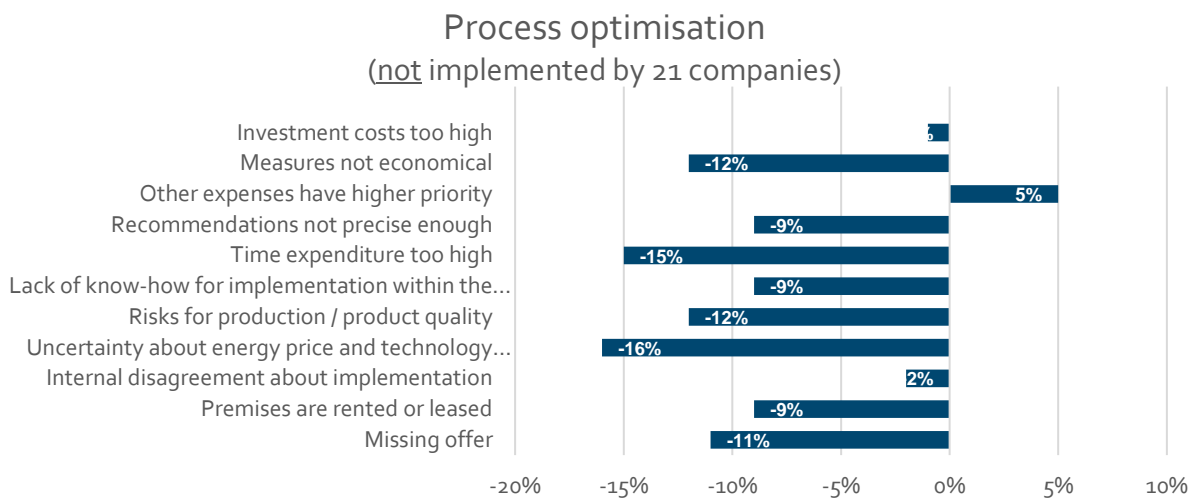


Figure 26: Prevalence of barriers in companies which did not implement process optimising ESM (data: BAFA EDL survey 2021 & 2022)

Cross-cutting technology improvements (not implemented by 31 companies)

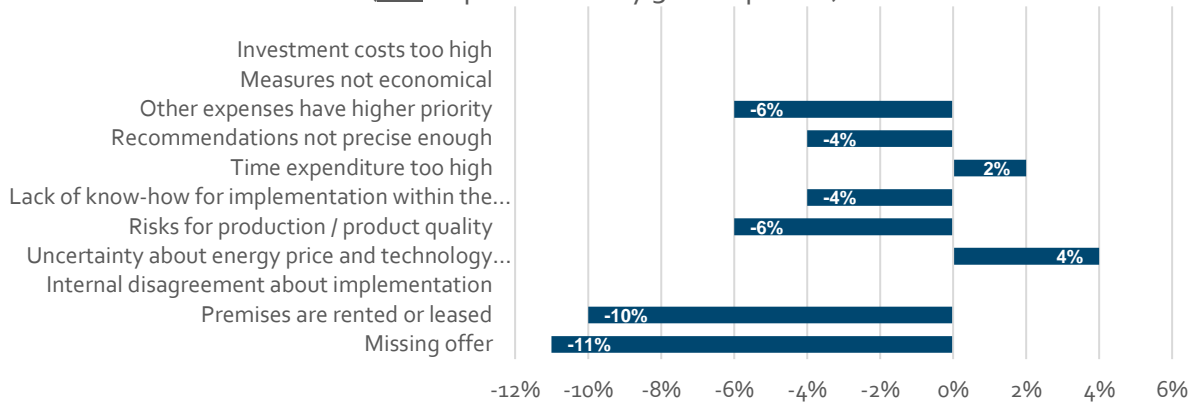


Figure 27: Prevalence of barriers in companies which did not implement ESM on cross-cutting equipment such as motors, drives, pumps, cooling, HVAC, lighting (data: BAFA EDL survey 2021 & 2022)

Building energy renovations (not implemented by 21 companies)

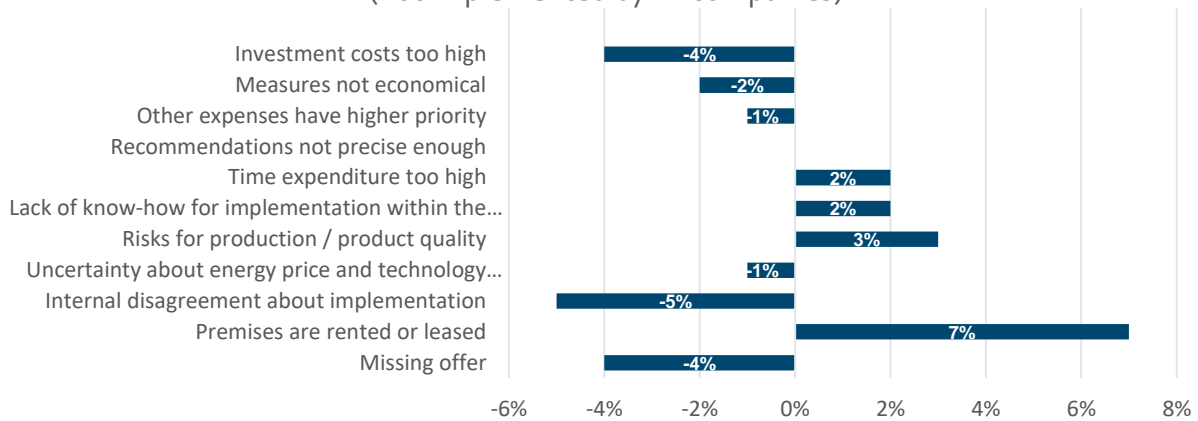


Figure 28: Prevalence of barriers in companies which did not carry out energy renovations of their facilities (data: BAFA EDL survey 2021 & 2022)

Some interested results are listed below:

- Non-implemented energy production upgrades are comparatively often linked to a lack of internal implementation know-how as well as third-party owned premises and rather less associated with production risks (Figure 24);
- Non-implemented informational and motivational measures are comparatively frequently linked to a lack of internal know-how and to third-party owned premises and rather less related to high economic barriers (Figure 25);
- Non-implemented process optimisation measures are comparatively often associated with other investments taking the priority (Figure 26);
- Non-implemented cross-cutting technology improvements are comparatively often linked to uncertainties regarding the evolution of energy costs and technologies, while they are rather less associated to the challenge of third-party owned premises and a lack of technology and service offer (Figure 27);
- Non-implemented building renovation measures are comparatively frequently associated to the challenge of third-party owned premises and negative impacts on

production and rather less linked to internal disagreements, lack of offer and too high investment costs (Figure 28).

This basic analysis indicates that links can be found between the prevalence of certain barriers and the types of ESM considered by companies. However, larger data sets from adequately designed surveys is necessary to ascertain the links between ESM types and specific barriers.

CONCLUSION AND KEY FINDINGS

Overall barriers and drivers to ESM implementation in the manufacturing industry are well known and documented. However, due to the lack of comprehensive and homogenous data, differentiations by countries, company types and ESM technologies are missing. This report aims at refining existing analyses by looking at potential differences in the relevance of the most common barriers in the manufacturing industries of the five project countries. This “patchwork” approach drawing on literature and surveys of different nature can only provide indicative results and primarily seeks to highlight the relevance of a differentiated approaches in order to better target and address barriers. Such results are listed below:

- **Economic barriers** are the most frequently cited factors hindering ESM implementation, this includes internal barriers such too high investments costs and too long pay-back periods, but also market related and regulatory barriers which discourage implementation, for example uncertain energy price and technology evolutions and lack of funding. In this regard, regulatory drivers such as adequate subsidies and other financial incentives, minimum energy efficiency requirements and encouraging long-term energy strategies in companies should be considered by policy makers;
- **Organisational barriers** also count among the most common difficulties for ESM implementation. These barriers include lack of time and other investment priorities, which can be interpreted as a difficulty to change existing routines. In this regard, informative measures and vocational trainings should be scale up in order to lift ambitions, shift company mindsets, build up internal know-how and improve access to technical support;
- **Informational and competence barriers** are perceived as rather less prevalent, with unprecise recommendations, missing know-how, as well as planning and implementation mistakes rather generally cited less frequently;
- **Differences between countries:** Based on the AUDIT2MEASURE survey results, no structural differences could be identified between the project countries. In Czech Republic and in the Netherlands, the lack of personnel resources plays a primary a role. Difficulties to change existing routines seem more prevalent in Spain, Italy and Greece. Companies in Italy and the Netherlands, which may have more experience with ESM implementation, ranked mistakes slightly higher than in other countries;
- **Barriers by company typology:** Some distinctions in the relevance of barriers can be found when discerning certain company types. Nevertheless, in all categories, companies cited economic and organisational barriers the most frequently. Smaller companies (below 100 employees) seem to stand out, as organisational barriers and lack of know-how seem more present. Companies with EMS appear to have a generally better understanding of energy expenses and technical aspects. Energy intensity regardless of the size does not appear to significantly influence the prevalence of barriers. Some distinctions can be found between certain manufacturing sub-sectors: the food, beverage and tobacco cluster is comparatively

more affected by operational and informational barriers, while the machinery sector seems comparatively less affected by most common barriers;

- **Barriers by company “lifestyle”:** Meaningful trends emerge in the prevalence of barriers when distinguishing companies according to their “lifestyle” or mindset. Ignorant companies and companies only implementing simple measures are characterized by a lack of internal implementation know-how. Economically interested companies are characterised by greater organisational barriers, while innovative environmentalist companies struggle more with uncertainties and internal disagreements. This categorisation appears to be a useful approach to better understand and target the barriers companies are facing and can be a useful step to tailor adequate capacity building and technical assistance activities to support the uptake of ESM;
- **Barriers by ESM types:** The analysis of the data at our disposal highlights that some links can be found between the prevalence of specific barriers and the non-implementation of certain common ESM types. For example, third-party owned premises are a frequent barrier among companies which do not carry out building renovations and energy production upgrades, while uncertainties regarding energy price and technology evolutions are more common in companies which decided not to implement cross-cutting equipment upgrades. However, larger data sets and adequately designed surveys are necessary to ascertain the links between ESM types and specific barriers.

More comprehensive evaluations and adequately designed surveys on national levels would significantly contribute to a better understanding of the barriers facing ESM implementation in the European manufacturing industry

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