Energy Efficiency Policies for Small and Medium-sized Enterprises

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The importance of small- and medium-sized enterprises (SMEs) from economic, social, and environmental point of view and the crucial role of energy efficiency (EE) are widely recognized. However, the development of effective policies and their analysis are still challenging topics, for which research is relatively scarce. The main reasons for this are the high heterogeneity of SMEs, their low energy impact compared with energy-intensive enterprises, the lack of quantitative information on the energy consumption of SMEs, and the low awareness of SMEs on energy topics. The structural paradigm change in the energy markets has underlined the importance of EE in SMEs. It is necessary to highligth the need for a good balance between economic and supportive mechanisms and the crucial role of energy audits. The analyzed contributions show that despite SMEs' efforts to use existing EE policies, there are still important barriers to be addressed. Moreover, there is an important lack of quantitative analyses, which are necessary for the development a harmonized policy evaluation approach.

energy efficiency | energy efficiency policies | SMEs

1. General Framework for the Classification of Energy Efficiency Policies of Enterprises

The potential for increasing energy efficiency in SMEs is extensive, but its full implementation is still prevented by numerous technical and economic barriers. Energy efficiency can be enhanced though the implementation of energy-efficient technologies, operational improvements, and energy-oriented maintenance. The development of policies to increase EE in SMEs is still a major challenge, to be addressed through the creation of balanced, integrated and effective policies

The classification framework is defined according to the approach developed by Tanaka [1], who conducted an extensive review of energy efficiency policies, referring to three main policy categories:

- Prescriptive policies, orienting the behavior of companies with different modulations and stringencies; this category includes regulations, mandates and agreements.
- Economic policies, adjusting price signals and influencing cost effectiveness of energy efficiency actions; they are represented by tax reliefs, direct financial support, cap and-trade systems and incentivized energy prices.
- Supportive policies, reinforcing the information basis for decision making and improving competences; these are tools for identifying energy efficiency opportunities, cooperation programs, capacity building and information and technical assistance.

Different policy categories, or different combinations of policies, may be effective in specific contexts [2][3], reflecting that energy efficiency drivers differ by country and industry. In some sectors, energy efficiency could be partly driven by high energy prices, whereas in other sectors access to capital could be a major limitation [4].

In this section, the classification of [1] is provided and updated with further contributions. Contributions available by country were updated, using the IEA [5][6], ODYSEE MURE [7], and OECD [8][9][10] databases.

Analyzing prescriptive policies, regulations on energy management do not prescribe specific energy efficiency interventions - also known as energy performance improvement actions (EPIAs) or energy efficiency measures (EEMs)- but set rules for adopting energy management systems that help companies identify the most suitable solutions to implement. The relevance of energy management systems in improving the knowledge of firms' consumption profiles and identifying EPIAs has been widely recognized; for example, Refs. [11][12] can be consulted for recent reviews. The adoption of energy management systems using ISO 50001 [13] can also be incentivized financially, for example, under the Germany Energy Tax Act, showing another case of the successful combination of different policy categories [14].

A different approach is represented by negotiated agreements, which differ for various degrees of policy-induced incentives for action, which could be absent (completely voluntary agreements) or represented, for example, by penalties, exemptions from existing measures, or threats of future regulation. Several studies have highlighted the positive effects of this policy tool [15][16][17][18]; other studies found mixed results [19] or showed such measures would need some modifications to ensure the

achievement of 2020 targets [20][21]. The great diversity in terms of motivational power and coverage affects their effectiveness, as shown in [22], comparing China, Finland, Japan, the Netherlands, and the UK, and investigating the potential of such a policy tool for ASEAN countries [23][24]. The Swedish and German experiences with voluntary agreements (for industrial SMEs) show the possibility of applying for a rebate on energy tax if companies develop an energy audit or introduce energy management systems, which proved to be successful [25][26].

Economic policies can adjust price signals in two ways: applying energy and CO_2 taxes or emissions cap-and-trade programs and introducing direct tax reduction or other financial incentives. Examining the first group of policies, energy use is taxed in many countries [8][9][10], and this could be an incentive to use energy in an efficient way, according to the share of energy cost and the energy saving potential for each industrial sector [27]. Cap-and-trade mechanisms, more often applied to CO_2 emissions than energy efficiency [28], have generally more limited coverage and provide more volatile price signals, which are influenced by the quota allocation method and level of the target. According to [1], when taxes and cap and trade are applied to energy efficiency, the effectiveness can be considered high, while the quantifiability of results is medium–low, as is the acceleration effect on R&D. For example, the Italian White Certificates mechanism is an obligation scheme that creates a market to trade certificates associated with energy saving projects: it has been considered a best practice in energy efficiency policies [2], and it has promoted investments in many industrial sectors [29].

A different approach is represented by two policy categories: favorable tax treatment under specific conditions and non-tax financial incentives, such as subsidies, preferential loans, and R&D funds. Tax reductions are included in the first category as stand-alone measures or in the context of negotiated agreements; also, tax deductions for energy efficiency investments, which can be deducted from the company taxable amount as in the Italian Ecobonus scheme, are included here. In terms of non-tax financial incentives, accelerated depreciation schedules for energy efficiency investments are another example of this category; for example, they proved to be effective in Ireland [30].

To promote energy efficiency in industry, subsidies are used in a wide range of countries. They stimulate investments by reducing the financial risk and easing barriers such as access to credit and long pay-back periods. Subsidies could be targeted not only to fund EPIAs but also to provide a contribution toward the realization of an energy audit and the achievement of an EnMS certification, as in the Program for Improving Energy Efficiency in Energy Intensive Industries, operating between 2005 and 2014 in Sweden [31]. Energy audits (EAs) can be supported as stand-alone schemes, as in Sweden, or as part of a more comprehensive program, e.g., in the form of voluntary agreements or the implementation of energy management systems, such as in Germany [32]. Ref. [20] examined the energy efficiency policies in Sweden and Japan and found that, from a governmental point of view, subsidies for energy audit programs prove to be the most cost-effective policy. Green loans for retrofit residential building are relatively common, whereas examples of loans for industrial sectors can be found in fewer countries, for example, the UK [1], China [33], and France [34].

Supportive policies, in the classification adopted by [1], refer to the identification of energy-saving opportunities; capacity building through counselling, training, and information sharing; public dissemination of energy efficiency; and cooperative measures in which the government works with industry to promote their energy-saving efforts. Providing sectoral guidelines, such as for example the Energy Star methodology in the USA [35] or the Italian guidelines to conduct energy audits [36][37][38][39], is an example of capacity-building measures. Another example is the Italian information campaign to promote energy efficiency focused on the benefits of energy audits [40]. In this campaign, the Italian Energy Agency worked together with business associations to provide companies with guidelines and targeted technical advice [40]. This could prove to be effective in increasing the implementation rate of EPIAs identified in the audit, as shown by [41] for the Dutch-negotiated agreement, in general by [42], and in spreading the use of the energy audit tool by not-obliged companies. Ref. [43] highlights how the Korean government provided technical support to companies, particularly SMEs, to improve their ability to comply with mandatory regulations on industrial energy efficiency. Few studies have quantified the energy savings of this policy type: a recent attempt is represented by the Italian EED Annual Report [44].

2. Policies for Energy Efficiency in SMEs

The IEA investigated the adoption of EPIAs in SMEs, identifying key critical factors for providing policy support and improving SME competitiveness and national energy security [45]. The characterization of the importance of SMEs in energy terms was followed by suggestions for implementing EE policies specifically for SMEs through a plan–implement–monitor–evaluate pathway. The planning phase should be tailored to meet specific contexts and requirements for specific SME sectors, including an analysis of barriers, coordinating different programs, and involving the main stakeholders. A successful implementation step should include the targeting of SME groups, the identification of all benefits, the combination of schemes to provide information, expertise, and financing, and the exploitation of existing policies and programs. The monitoring phase consists of developing specific indicators useful to both policy makers and SMES. The evaluation step must focus on program results, impacts, and success factors, as well as on the assessment of cost effectiveness and the overall effectiveness of instruments used. Several good case studies are presented in [45] at the worldwide level.

The works on energy policies primarily put the focus on energy audit programs and show that the major energy efficiency measures from industrial SMEs are found in auxiliary and general processes (more than in production processes). The review reveals that the most-used method has been quantitative (based on questionnaires or interviews). Two methods can be applied to design public energy efficiency policy programs for industrial SMEs: to assess national governmental reports and findings, and to analyze the available scientific literature in the field. According to the second option, the major steps for designing policies for SMEs should be: 1. deciding the primary target sector group; 2. mapping the annual energy consumption; 3. reviewing the current energy policies; 4. making an energy efficiency potential estimation; 5. reviewing the barriers to and drivers of energy efficiency; 6. suggesting appropriate policy; 7. evaluating the impact of the policy program.

According to [46], the main recommendations include supplying easily accessible information to companies, increasing the activities on non-energy benefits, and ensuring regular information between countries with the concluded national transpositions. The main recommendations to SMEs are divided into three groups: energy audits (EAs), energy management systems (EnMSs). and exchange of information mechanisms.

- Energy audits (EAs) focus on energy-intensive companies; development of support schemes for the implementation of EE measures included in EAs; availability of low-interest capital for investments in EPIAs; creation of one-stop shops also with the cooperation of key institutions.
- Energy management systems (EnMSs) involve step-by-step implementation support; advice and first certification support; specific sectoral guidance.
- Exchange of information mechanisms involves the creation of regular structures for common exchange and follow-up for SMEs; increasing institutional support; using a mix of approaches to cover a broad range of SMEs.

Many studies have focused on energy audits, highlighting that they can be considered as the first step in implementing energy efficiency in enterprises. They are a useful tool for overcoming information barriers and promoting EE investments by SMEs [47]. A comprehensive guide for EA program developers was developed in [48], where twelve basic elements for developing effective EA programs were identified, represented by the definition of legislative frameworks, the identification of key players, and the training of auditors. Moreover, Ref. [48] highlights that the progress and results of a program should be continuously controlled and periodically evaluated, providing quantitative information about the pioneer Finnish program of EAs (not focused on SMEs). Moreover, energy management systems have also demonstrated considerable potential to unlock energy-efficiency investments [49]). Article 8 establishes the obligation for non-SMEs to carry out high-quality, cost-effective energy audits every four years and, moreover, states that “Member States shall develop programs to encourage SMEs to undergo energy audits and the subsequent implementation of the recommendations from these audits”. Hence, specific schemes and voluntary agreements to support the development of energy audits in SMEs have been developed in several EU countries, for example, the Swedish Energy Audit Program [50]. Firstly, the implementation of these policy programs is heterogeneous among countries, and their harmonization, in terms of EPIAs and energy use, would be useful [51]. Secondly, the SMEs present limited financial and human resources for investing in energy audits (and in EPIAs) [52]. Therefore, national schemes usually co-finance the development of energy audits for SMEs [53]. Thirdly, several efforts have been focused on identifying no-cost EE interventions and low risk investments [54] also by means of self-assessment tools [55]. Lastly, due to the voluntary nature of energy auditing in SMEs, the enterprises involved are generally self-motivated; if all the supply chain companies are involved in the auditing process, voluntary practices could become the norm [56]. The effective implementation of the energy audit programs for SMEs usually is most effective when local authority consultants, regional energy agencies, and business associations are engaged [57][58]. One successful strategy for increasing the energy services for SMEs could be the creation of public ESCOs [59].

Energy management systems are not yet widespread among EU SMEs [60]. Some reviews cover the implementation of EnMS in SMEs at the global level [12][61][62], highlighting that energy management standards (mainly ISO 50001) are often too complex for a cost-effective implementation at the SME level (for non-energy-intensive companies [63]) and alternative tools for energy management should be tailored to SMEs (i.e., networks [64], in-house tools [65], plan–do–check–act cycle tools [66], integrated decision support systems tools [67], or external support [68]). Hence, their implementation in SMEs in simplified forms should be taken into consideration by policymakers.

Energy efficiency is generally analyzed through the direct benefits associated with the reduction in costs, end-use consumption, and energy price volatility. However, in recent years, the attention paid to the non-energy (or multiple) benefits of energy efficiency has growth [69]. The full range of multiple benefits include job creation, increased productivity, health and wellbeing, air quality, energy access for all, increase in assets value, etc. [70]. Many studies have examined the wide range of multiple energy efficiency benefits in general terms [69][71][72][73][74] or relative to specific countries and measures [41][75][76][77]. Analyses and the quantification of the multiple benefits of energy efficiency in SMEs are still scarce [71] but a broad introduction can be found in [78].

3. Barriers to and Drivers of Energy Efficiency in SMEs

A comprehensive review of energy efficiency policy programs for industrial SMEs [79] showed that the research in the field is heterogeneous in both scope and basis, but the majority of studies are related to barriers to and drivers of energy efficiency. The review revealed that the methods most used in these studies were questionnaires or interviews.

The likelihood of a company investing in energy efficiency is a function of energy intensity, the size of the company, and investment profitability. EPIA implementation is also directly linked to the effectiveness of policy-making strategies [80]. In other words, policies have an effect of the marginal cost curves of different technologies [81], affecting the marketability of each technology and the corresponding payback time.

The European Union has supported the market uptake of EPIAs in industry and services through more than 40 projects (under Intelligent Energy Europe Programme II and H2020 Energy Efficiency projects, 2007–2020) [82], addressing three main general barriers: the lack of financing, the long pay-back time for some EPIAs, and the lack of regulations on energy audits for SMEs; the lack of expertise, knowledge, practical experience, and time; and the poor recognition of the comprehensive value of energy efficiency.

Removing these barriers would help SMEs to exploit their energy efficiency potential. The first two types of barriers are typically associated with the need for public policies that support EE investments, while the last one can be seen as a perceived internal barrier in the companies that do not implement cost-effective EE investments. In the literature, this issue is called the “energy efficiency gap”, which is the gap between potential and implemented cost-effective EPIAs and has been investigated in several scientific publications [83][84][85][86][87]. This gap is due to the existence of barriers to energy efficiency dissemination. An energy efficiency barrier, as defined by Sorrell [85], is “a postulated mechanism that inhibits investments in technologies that are both energy efficient and (at least apparently) economically efficient”. Significant differences exist across industrial sectors, but many EPIAs with high potential and relatively low pay-back time are not implemented; although energy management could help with identifying these options, an extended energy efficiency gap remains [88].

A first categorization of barriers for organizations, both private and public, was proposed by Sorrell et al. [85], with further modification and application in [80][89]. In their approach, single barriers are classified according to three main theoretical backgrounds: economical, organizational, and behavioral, developing a taxonomy consisting of the following six broad categories of barriers: “imperfect information, hidden costs, risk, access to capital, split incentives, and bounded rationality” [90].

These barriers, which could be also differently classified [91][92], are likely to co-exist and they help explain the need for public intervention to boost EPIAs, as described in the previous sections. For example, clearer price signals with economic measures may help to solve imperfect information issues, whereas enhanced access to finance favoring access to capital or improved information basis and skills faces bounded rationality constraints.

Barriers to policy effectiveness may be inside the policy measures themselves [93]; a framework needs to be provided to analyze the adoption of EPIAs under different dimensions, in particular in terms of measured characteristics addressing the relative advantage, technical, and information contexts.

De Canio [83] stated that companies often set internal hurdle rates for energy efficiency investments that are higher than the cost of capital for the company due to information and control problems. A well-managed company may still have profitable opportunities available that it finds difficult to realize. In [84], the “energy efficiency” paradox was statistically investigated. In [86], different types of barriers, investigated through a series of interviews, were identified, and approaches for overcoming these barriers were examined, with the authors also proposing some criteria for evaluating them. The study focused on the identification of the right size of the energy efficiency gap, investigating market and non-market needs for the gradual diffusion of energy-efficient technologies.

Cagno et al. [92], focusing more specifically on the industrial sector, proposed a new approach that also considers the interactions between the different barriers. In the proposed novel taxonomy, barriers are classified according to the responsible actor from which they originate. This actor could be external (such as the market, politics, energy suppliers, etc.) or internal (enterprise organization, behavior, etc.) to the enterprise. In their article, they also point out that the structure of the enterprise can have an impact on actual barriers. For SMEs, the purely organizational barriers are often not relevant since decisions are often made by a single person. Trianni et al. [94] focused their analysis on SMEs’ energy efficiency barriers, conducting an empirical investigation on 48 Italian manufacturing SMEs. The decision-making process was investigated by evaluating the importance of real and particularly important perceived barriers. The major perceived barriers identified for SMEs that emerged from the study were economic and information barriers. An important aspect highlighted was the need to distinguish between small and medium enterprises in the evaluation of barriers impact, since their organizational and productive structures can be completely different [94].

A systematic identification of the relevant perceived barriers and drivers to EPIAs implementation in manufacturing SMEs is presented in [95]. 220 Slovenian manufacturing SMEs have been investigated to examinate the relevance of barriers and drivers for implemented and planned EPIAs. Empirical results of the study show that economic incentives are the key drivers and the lack of economic resources, experienced staff and low management priority given to energy efficiency represent the main barriers [95].

The study in [96] is based on a 2010 survey of SMEs participating in the German energy audit program. High initial investment costs were identified by the authors as a main barrier to the implementation of EPIAs [96]. The low quality of energy audits is a further obstacle to the adoption of EPIAs.

In [57], a case study of Swedish non-energy-intensive manufacturing companies is presented, identifying “cost of production disruption/hassle/inconvenience and lack of time” as major barriers to energy efficiency. In [97], the Irish mechanical engineering industry was analyzed, identifying “access to capital” has the most pervasive barrier.

In [98], a literature review and an exploration of the connection between energy efficiency opportunities offered by industry and the factors influencing the adoption of energy efficiency and industry-focused business models in the UK are presented. Other interesting insights for specific sectors can be found in [99] for the Swedish pulp and paper industry; in [100] for the Swedish foundry industry; for the Belgian ceramic, cement, and lime sectors in [101]; and for the Italian metals manufacturing SMEs in [102]. Other pertinent studies on energy efficiency drivers and barriers focused on SMEs are presented in [103][104][105][106].

4. Recommendations to develop effective policies

An extensive review of the scientific and technical literature on the energy efficiency policies in SMEs, provides detailed qualitative and quantitative information for developing and analyzing effective policies and programs [45]. Starting from a broad literature review on the topics of energy efficiency policies and programs for enterprises, a deeper analysis was carried out from quantitative and qualitative points of view on SMEs.

The energy efficiency taxonomy shows that the policy support for EE in SMEs is usually based on voluntary agreements, which limit the economic and administrative burden. Hence, SMEs are generally excluded from prescriptive policies, which are based on binding measures. Recent studies demonstrate that the most successful approaches are (1) the development of energy audits, (2) balancing of economic and supportive policies, (3) the implementation of energy efficiency networks as cost-effective actions for industrial SMEs, and (4) targeting interventions through strategic segmentation (usually focusing on Energy Intensive Industrial SMEs).

The main recommendations extracted from the extensive literature review are:

- To allow for a better understanding of policy performance and to compare different policy mechanisms, a harmonized approach for the evaluation of EE policies for SMEs is needed, including specific methodologies and indicators.
- Quantitative studies on the topic are still scarce and should be promoted, relative to policies and countries analyzed, as well as to the number of SMEs covered; moreover, more harmonization in adopted methodologies is needed, since studies effective comparison has been limited due to the high heterogeneity of the adopted approaches and/or the lack of information about them.
- All evaluation studies reporting quantitative information have focused on policies including the adoption of EA. In this sense, EA seems to be a pre-condition for performing quantitative evaluations of the savings and cost effectiveness of a program.
- According to some policy schemes, energy audit certification is mandatory. However, due to the complexity of the implementation of certified energy audits and energy management systems in non-energy-intensive SMEs, the implementation of simplified forms should be taken into consideration by policymakers.
- Targeted policies and tools, tailored as function of the size, sector and energy intensity of the company, appear to be a successful approach to overcome the barriers for EE in SMEs
- A more integrated approach combining different economic and supportive instruments may help SMEs to improve the EPIA implementation rate, starting from no-cost EE and low-risk interventions.
- The most successful strategies include the engagement of local or regional associations instead of national governments, due to the high relevance of territorial context on SME activities.
- Capacity-building programs and learning networks (which are well received by SMEs), as part of a broader range of support, can help to ensure the longevity of the policy, as SMEs can develop their own skills neede to undertake energy audits and implement EPIAs.

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