How can energy audits and energy management be promoted amongst SMEs? A review of policy instruments in the EU-28 and beyond

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Abstract

There is a large un-tapped potential for cost effective energy savings in the industrial sector due to barriers to the uptake of energy efficiency. The need to overcome these barriers has widely been stressed in literature. Amongst others, information barriers appear to be very relevant for small- and medium-sized enterprises (SMEs). Energy audits and energy management systems are important concepts to overcome these barriers and to help companies in achieving cost-effective energy savings. Instruments to promote both concepts have been established in many countries. Through Article 8 of the Energy Efficiency Directive (EED), the European Commission has further strengthened their relevance by requiring the European Member States (EU-28) to develop instruments that encourage SMEs to undergo energy audits and to implement their recommendations. In addition, various Member States have also established instruments that target energy management systems in SMEs. Instruments addressing these areas are diverse in nature, but there is no up-to-date review of them. The aim of this paper is to provide a structured and comprehensive review of existing policy instruments targeting energy audits and energy management systems in SMEs including regulatory, voluntary, financial and information-based elements. Results indicate 50 instruments are in place in the EU-28. Another 15 instruments have been identified across Brazil, Canada, China, India, Japan, Norway, Switzerland and the USA. Within our analysis, we provide an overview of the different instruments by clustering them, and discuss the major design features of their implementation. Through our analysis, we intend to increase the transparency of the current implementation of policy instruments dealing with energy audits and energy management systems for SMEs in the EU-28 and beyond. This shall enable researchers and policy makers to further enhance policy making on industrial energy efficiency.

Introduction

Improving energy efficiency is a key concept in increasing the profitability and competitiveness of SMEs (IEA 2015). Yet there appears to remain a considerable un-tapped potential for cost effective energy savings in the industrial sector due to barriers to energy efficiency (e.g. Boßmann et al. 2012). Energy audits and energy management systems are important concepts for partially overcoming such barriers. Policy-making therefore strives to enhance the implementation of energy audits and energy management systems in SMEs. As a consequence, many countries have established different national policy instruments to address them.

In Europe, the European Commission decided to enhance the implementation of energy audits and energy management systems through Article 8 of its Energy Efficiency Directive issued in 2012. This article requires the EU-28 Member States to develop national instruments that encourage SMEs to undergo energy audits and to implement their recommendations. In addition, various Member States have also introduced instruments that aim at promoting energy management systems in SMEs. The promotion of energy audits and/or energy management systems in SMEs is also an essential element in other national policy mixes including *Australia*, *Brazil*, *Canada*, *China*, *India*, *Japan*, *Norway*, *South Africa*, *Switzerland*, *Turkey* and the

USA. The instruments addressing these concepts are diverse in terms of design and implementation. Understanding their commonalities and differences can help to further enhance the policy making process and the implementation of audit and management systems by companies. However, there is no up-to-date review of these instruments.

The aim of this paper is to provide a structured and comprehensive review of existing policy instruments targeting energy audits and energy management systems in SMEs analysing advantages and challenges related to different aspects of implementation for regulatory, voluntary, financial and information-based instruments in the EU-28 Member States and beyond.

The paper is organised as follows: First we outline the specific situation for SMEs and provide a definition of energy audits and energy management systems including a brief description of their major differences. Thereafter, we introduce our methodological approach to analyse the current implementation of national policy instruments. Next, we present the main results of this national review and we briefly discuss major differences and commonalities as well as key features and challenges of these instruments clustered by different policy types. This is followed by an overarching discussion of the instruments before we finally conclude our paper.

Background

SPECIFIC SITUATION FOR SMES

In the EU-28, more than 99 % of the companies in Europe's non-financial business economy can be considered as SMEs when using the number of employees as the decisive criterion. This translates into some 22 million companies (EC 2015). The relevance of SMEs in Europe is also underlined by an estimated consumption of approximately 13 % of total energy demand (IEA 2015). Policy interventions for improving energy efficiency are usually justified by a need to remove market barriers/failures which prevent the realisation of socially optimal investments in energy efficiency (e.g. Brown 2004).

Given an abundant body of scientific literature on barriers to energy efficiency (see for example Cagno et al. 2013; Thollander et al. 2013; Sorrell et al. 2011) we briefly outline four key aspects that appear to be particularly relevant for SMEs in the context of discussing policy instruments for energy audits and energy management systems. These key aspects can be summarised as follows: First, the energy demand and thus the energy costs of SMEs are lower than in large companies with similar products. As a consequence, energy saving potentials both in terms of energy and money saved tend to be less important for SMEs. Second, SMEs are operating on less rigorous innovation processes (Terziovski 2010) and often have limited expertise on energy-related matters (IEA 2015). As a consequence, information-related barriers are generally more prevalent in smaller organisations. Third, centralised decision-making processes by fewer individuals allow the quicker implementation of energy efficiency measures in SMEs than in large organisations where split-incentives and sophisticated organisational structures may slow down implementation processes. And fourth, SMEs often have stronger restrictions on the availability of budget for energy-related activities, or may have other investment priorities (de Groot et al. 2001, IEA 2015).

ENERGY AUDITS AND MANAGEMENT SYSTEMS

Energy audits and energy management systems are two important organisational concepts for the improvement of energy efficiency. According to the EED, an energy audit can be defined as "a systematic procedure with the purpose of obtaining adequate knowledge of the existing energy consumption profile […], identifying and quantifying cost-effective energy savings opportunities, and reporting the findings". This procedure can be considered as a type of indirect energy service as it does not directly improve energy efficiency but paves the way for later implementing energy efficiency measures (Backlund & Thollander 2015). Though empirical results indicate that only part of the audit recommendations are usually realised (see for example Table 6 in Fleiter et al. 2012), it has been demonstrated that energy audits can have a significant effect on the adoption of energy efficiency measures (Schleich et al. 2015).

Energy management systems can help to improve the adoption of energy efficiency measures, as well. According to the EED, an energy management system is a "set of interrelated or interacting elements of a plan which sets an energy efficiency objective and a strategy to achieve that objective". There appears to be a wide range of estimates on achievable energy savings from energy management; this might partially be attributed to a lack of consistent definitions of energy management in academic literature (Schulze et al. 2016).

When discussing policy instruments for energy audits and energy management systems, some major differences between these concepts need to be noted: An energy audit can be considered as a spotlight intervention by an external or internal auditor, i.e. it is carried out during a relatively short period of time and with limitations in terms of coverage and/or level of detail. Based on the reported results, a company may decide whether to subsequently implement the recommendations by the auditor. Energy management systems, on the contrary, aim at changing the organisational setup of a company in the long term. For this purpose, they require defining an energy policy including energy goals and setting up a continuous improvement process addressing energy efficiency. Thus energy management systems have a higher impact on the organisational structure and they anchor energy efficiency into the routine of the company. Energy audits can become part of this routine. Evidently, establishing and maintaining energy management systems requires more time and resources than conducting an audit. This additional effort has to be taken into consideration and it needs to be analysed in view of the specific situation of a company.

Methodological approach

DATA COLLECTION

The data presented in this paper was obtained by a two-step approach which was carried out between May and September 2015; the results in this paper therefore show the situation as of late summer 2015. The aim of the first step was to develop a preliminary description of currently implemented policy instruments in the EU-28 and other countries. Therefore we carried out a structured review of existing data regarding policy instruments pertaining at energy audits and energy management systems at national level. This included a literature study as well

as a review of institutional websites, documents, databases and other material such as legal documents (e.g. EED, Guidance Notes addressing Article 8 EED, national laws transposing Article 8 EED, etc.) and other official documents (e.g. the National Energy Efficiency Action Plans (NEEAPs), national guidance documents, etc.).

To close information gaps and to verify our findings after the review of documents, we conducted 30 semi-structured interviews with stakeholders from different institutions, thereof 15 interviews with national ministries, five interviews with national public authorities, four with energy agencies and six with other institutions (e.g. research institutes). The interview partners were familiar with the implementation of Article 8 of the EED. For each country, the semi-structured interview followed a questionnaire containing general as well as specific questions tailored to the national situation. This approach allowed us on the one hand to obtain comparable results in each country, and on the other hand left us flexibility to capture particularities in each country.

DATA ANALYSIS

For the purpose of analysing and discussing policy instruments to address energy audits and energy management systems, a classification of the different national instruments is helpful. Policy instruments to address barriers to energy efficiency can be classified in different ways (e.g. Sterner 2003; Gupta et al. 2007; IEA 2010). For our purpose, we chose to distinguish four categories: regulatory, financial and information instruments as well as voluntary agreements.[1] We perceive *regulatory instruments* as organisational and technological requirements and standards with the aim of improving energy efficiency in organisations. Thus, it is based on prescribed or prohibited activities that are based on harmonised definitions, e.g. standards for performing these activities (Gupta et al. 2007). *Voluntary agreements* (VAs) are interpreted as basically voluntary contracts between two parties – e.g. either between companies and governments or between a business association and the government (Croci 2005). These agreements are signed with the aim of achieving energy-related objectives or improving energy efficiency beyond compliance to regulation. VAs are sometimes on the cusp of a regulatory instrument as these are not entirely voluntary and non-compliance may result in fines or the loss of rewards (Bertoldi & Rezessy 2007). VAs are occasionally also combined with financial incentives to motivate companies for participation (OECD 2006). *Financial instruments* can be divided into direct and indirect subsidies. Incentives or taxes and charges either impose a fee on each unit of undesirable activity, i.e. on energy demand and/or direct related emissions, or are based on direct payments, tax reductions, price supports or equivalent mechanisms (e.g. Sprenger 2000). *Information instruments* are intended to provide information on the energy demand of organisations and on opportunities to improve their energy efficiency. As awareness raising campaigns, for example, they are designed to support companies in making 'better informed choices' and at the same time may be used to increase the effectiveness of other instruments (Gupta et al. 2007). Furthermore, this type of instrument reduces transaction costs for firms in their search for profitable energy efficiency measures.

Results

The majority of the EU-28 Member States have established instruments for addressing energy audits and energy management systems in SMEs.[2] In some cases, these instruments are also open to large companies. Similar instruments targeting SMEs can also be found in *Australia*, *Brazil*, *Canada*, *China, India, Japan, Norway, South Africa, Switzerland, Turkey* and the *USA*. In sum a total of 65 instruments have been identified, thereof 50 in the EU-28 (see Table 1) and 15 instruments across a selected group of non-EU countries (see Table A1 in the Annex).[3] The individual countries rely on different types, as well as numbers, of instruments to address energy audits and energy management systems in SMEs.[4] The majority of them focus on financial instruments whereas some countries also rely on voluntary agreements, as well as on information and regulatory instruments. In the following sections, we will discuss each category in turn.

REGULATORY INSTRUMENTS

Regulatory instruments, sometimes referred to the governments' 'stick' (Lemaire 2003) or 'command-and-control-instruments' (Howlett & Ramesh 2003), are generally deemed as well suited to specify, with a certain degree of precision and certainty, the actions that SMEs must undertake to achieve energy savings and thereby energy policy objectives (Gupta et al. 2007).

Regulatory instruments in the EU-28 that address SMEs are often related to the requirements of Article 8 of the EED for large companies which has been recently introduced. According to Article 8 of the EED, non-SMEs are obliged to conduct mandatory energy by 5th December 2015 and every four years thereafter. The 'SME status' is essentially based on threshold values for three criteria: (1) number of employees, (2) turnover and (3) balance sheet total (EC 2003). Accordingly a non-SME is defined as one which has at least 250 employees. If the company has fewer than 250 employees, but a turnover in excess of EUR 50 m and a balance sheet total greater than EUR 43 m, it will also be considered as a non-SME company (for further details, also on groups of companies, see EC 2003). In addition, especially relevant for SMEs, is the fact that if a company belongs to a group of companies and is classified as a large enterprise due to a linked or partner enterprise status, the respective company is also obliged to conduct an energy audit.

1. Other instruments, such as tradable permits, are conceivable to enhance the diffusion of energy audits and energy management systems in SMEs. However, the analysis in this paper refers to the current state of implementation of the instruments. Note that our notion of 'instrument' requires that the there is a concerted type of concept or action related to energy audits or energy management in place by policy makers and/or institutional stakeholders to improve the energy-efficiency in SMEs. Research and development projects, general information platforms and general development programmes for SMEs are not considered as instruments in this sense unless they have an explicit setup for energy efficiency.

2. For *Brussels and Wallonia Regions in Belgium*, *Cyprus*, *Estonia*, *Greece*, *Latvia* and *Lithuania*, no relevant instruments could be identified.

3. Note that some of the instrument do not necessarily cover the entire groups of SMEs but only part of it.

4. There is a large variance across countries regarding the number of instruments. One has to note that the absolute number of instruments per country presented in this chapter does not assess the effectiveness of the approaches taken by the countries.

Several Member States have modified the EU definition to additionally include some SMEs into the requirement for regulatory energy audits. There are seven Member States which implicitly require SMEs to conduct an energy audit by adding an additional energy or financial threshold in their national transposition of the SME definition which are highlighted in Table 1 in dark blue. *Bulgaria, Czech Republic, Ireland, Italy, Portugal* and *Romania* decided to do so by an additional energy threshold. In *Luxembourg* energy-intensive companies which have an overall annual energy demand exceeding 3 GWh are required to establish an energy balance and to regularly check on energy saving potential which may also cover SMEs. *Croatia* and *Slovenia* have lowered the financial thresholds (turnover and balance sheet total) in their national legislation as compared to the EU requirement. This potentially requires some SMEs to conduct mandatory audits.

Beyond the EU-28, *Australia, China*, and *India* have put regulatory instruments in place which are specifically targeted at encouraging SMEs to conduct energy audits. Energy audits are partially related to the Emission Trading System in *Australia* if, and only if, the regulator has reasonable grounds to suspect that a company has contravened, is contravening, or is proposing to contravene the rules to purchase 'carbon units' according to GHG emissions. In this case the regulator is allowed to require the company to conduct an energy audit (Australian Government 2007). The Chinese government addresses with its Top-10,000 programme the largest 10,000 energy-intensive companies consuming each more than 293 TJ per year which together consume about 85 % of China's industrial energy demand. Companies covered by the programme have to conduct an energy assessment (Lu et al. 2014). *India* has also established mandatory energy audits for energy-intensive companies (Energy Conservation Act 2010). The obligation refers to nine energy-intensive sectors, resulting in a total of about 700 companies that must carry out an audit.

With regard to energy management systems, there seem to be very few regulatory approaches for SMEs. *Romania* appears to be the only exception in the EU-28. According to the national Energy Efficiency Law no. 121/2014, companies with an energy consumption of above 1,000 toe are required to employ a certified energy manager (see Table 1). Outside the European Union, only *Japan* and *Turkey* have been identified as having implemented regulatory instruments for energy management systems in SMEs. The Japanese national Energy Conservation Law makes energy management mandatory for companies with an annual energy consumption of 1,500 kilolitres or more (crude oil equivalent) (Dahlgren et al. 2014). *Turkey* obliges companies with energy consumption above 1,000 toe to nominate an energy manager (Art. 7.a.1 of the Turkish Energy Efficiency Law). Industrial plants with energy consumption above 50 ktoe per year are also required to set up an energy management unit.

The results imply that regulatory instruments for energy audits of SMEs are generally only used in a relatively low number of countries. With regard to energy management systems, there are even fewer examples for the utilisation of such instruments. From a policy-making perspective, regulatory instruments for energy audits and energy management systems seem to provide several advantages for overcoming barriers to energy efficiency, but they also present some challenges. In terms of advantages, the mandatory requirements raise awareness and shift priorities in SMEs in general as these are effective instruments in changing behaviour in the target group (Lemaire 2003). This directly contributes to the reduction of the above mentioned barriers for the implementation of energy efficiency measures in SMEs. Furthermore, in some cases the regulation also may help to raise awareness of companies' management which may result in different behaviour with regard to investment decisions. Additionally, the direct connection between the regulatory requirement and the environmental outcome may provide some degree of certainty for policy makers to predict the contribution of industrial companies to the achievement of climate policy targets. However, there are also some disadvantages to regulatory instruments for SMEs in this context. It may sometimes be challenging for SMEs to be compliant with the regulation given the restricted capacities in the company. In addition, there is a risk that SMEs may primarily focus on compliance rather than seeking a reduction in their energy consumption. This is often the reason why this instrument lacks acceptance from companies. This approach also revokes flexibility from companies and decreases the incentive to search for better approaches to reducing their energy consumption (see Gupta et al. 2007 for environmental instruments).

VOLUNTARY AGREEMENTS

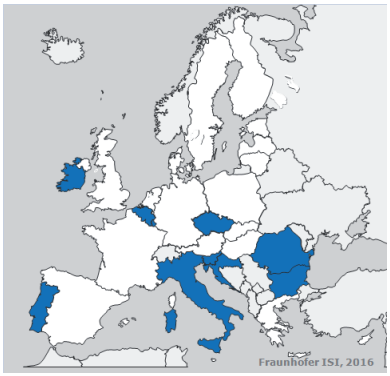
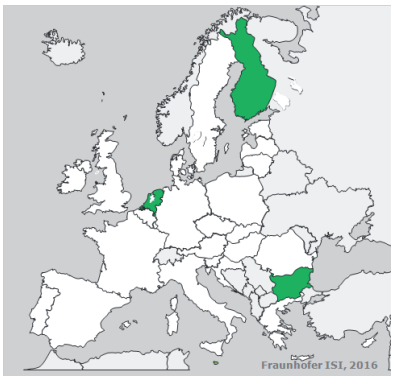
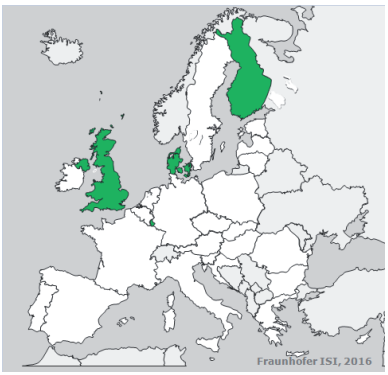
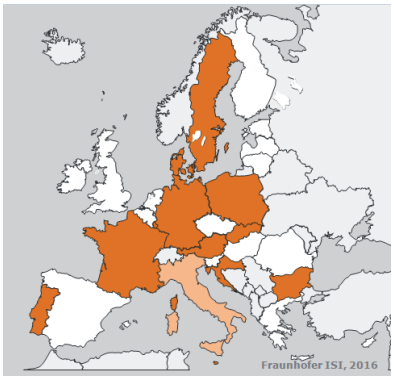
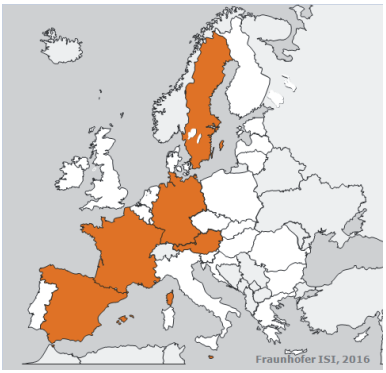
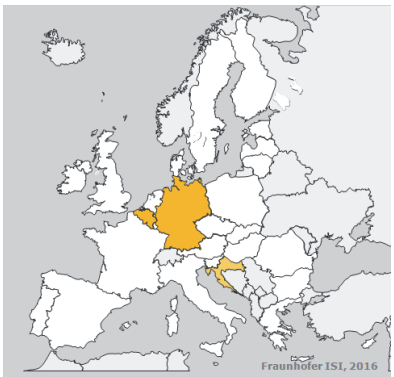
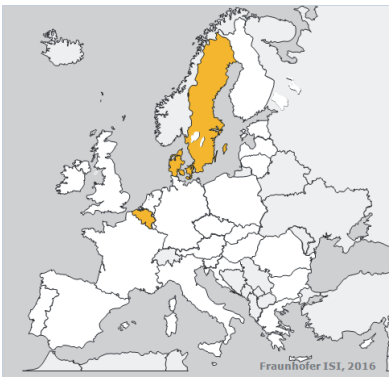
As a means to achieve energy savings, VAs as cooperative policies, sometimes also referred to 'delegated regulation' or 'self-regulation' (Hawlett & Ramesh 2003), have in some cases proven to be a suitable instrument to overcome barriers in energy efficiency (e.g. Blok et al. 2004; Price 2005; Bertoldi & Rezessy 2007). Usually the agreement is negotiated between companies and federal institutions. Basically three different alignments of VAs exist: (1) VAs which are completely voluntary, (2) VAs in connection with tax redemptions or direct financial incentives (to motivate companies to participate in VAs) and (3) VAs where participation is driven by the threat of future regulations or energy/GHG emissions taxes (for an overview about the different types of voluntary agreements and their characteristics see e.g. Croci 2005).

Our results indicate that the majority of countries using VAs with regard to energy audits and energy management systems makes use of the above mentioned case (2) and provide tax redemptions while requiring companies to implement an energy audit or energy management system as a quid pro quo (see Table 2)[5]. However, VAs leave companies a certain degree of freedom on how to achieve the objectives. This is the main advantage as a policy instrument. Depending on the level of stringency of the instrument the achieved energy savings may vary considerably. When combined with specific preconditions, voluntary agreements help to motivate companies to undertake energy efficiency measures.

Table 1 and Table 2 indicate that only relatively few countries address energy audits and energy management systems in SMEs through voluntary agreements in their energy efficiency policy. These include *Bulgaria*, *Finland*, *Netherlands* and *Switzerland* in terms of energy audits and *Denmark, Luxembourg,*

5. For an overview about programs worldwide focused on voluntary agreements targeted at energy efficiency in general see Price 2005 and Price & Lu 2011.

Table 1. Overview of instruments promoting energy audits and energy management systems in the EU-28.

	Energy audits		Energy management systems	
Regulatory instruments		Bulgaria Croatia Czech Republic Ireland Italy Luxembourg Portugal Romania Slovenia		none (except Romania: mandatory energy manager)
Voluntary Agreements		Bulgaria Finland Malta Netherlands		Denmark Finland Luxembourg United Kingdom
Financial instruments		Austria Bulgaria Croatia Denmark France Germany Italy Luxembourg Malta Poland Portugal Slovakia Sweden		Austria France Germany Malta Spain Sweden
Information instruments		Flanders (BE) Germany		Flanders (BE) Denmark Sweden

United Kingdom as well as *South Africa* in terms of energy management systems. When analysing the different forms of VAs used in the different countries, several differences concerning the level of stringency become evident. Some countries such as e.g. *Bulgaria*, *Denmark or Luxembourg* oblige participating companies to establish energy efficiency action plans or to implement profitable energy efficiency measures. Whereas other VAs such as in the *Netherlands, United Kingdom* or *South Africa* are less rigorous and are based on energy efficiency targets and voluntary implementation of energy efficiency measures. In *Denmark*, for example, companies are obliged to implement all energy efficiency projects (related to the energy included in the agreement) with a simple payback time of five years or less alongside the implementation of an energy management system, if they request a tax reimbursement (Danish Energy Agency 2015). In the *United Kingdom* participating companies are not obliged to implement energy efficiency measures. However, they are obliged to reduce their energy consumption in line with the targets agreed when signing the VA (UK Environmental Agency 2014).

In summary, it can be stated that VAs are very seldom used as a "stand-alone" instrument, but are often flanked by other policy instruments in the policy mix. VAs are often tailored to specific conditions and aims and leave companies a considerable flexibility to take the framework conditions of their company, such as branch particularities, into account (Bertoldi & Rezessy 2007). In addition, VAs enhance trust between the negotiating parties as these may contribute to a consensus on the adopted decisions (e.g. targets) (Croci 2005). Furthermore, VAs may help industrial companies to avoid future regulation and/or additional taxation by increasing their energy efficiency as an early action (Bertoldi & Rezessy 2007). In some cases companies may also gain access to subsidies or tax rebates (as shown in Table 2), develop a green image as demanded by customers or investors, obtain strategic advantages, save insurance costs and increase their capital market value (Bertoldi & Rezessy 2007). However, VAs involve some disadvantages. Administration and monitoring activities may be a difficult task for federal institutions which lead to high transaction costs. Furthermore, fee rider effects might arise: If VAs are combined with financial incentives, these possibly weaken industries' incentives to undertake energy efficiency measures under their own initiative (Croci 2005). In addition, to guarantee equality for participating companies between the different VAs is a challenge for policy makers.

Empirical evidence on the effectiveness of VAs, especially in SMEs, appears to be scarce. Regarding energy audits and energy management systems VAs seem to be very well suited to promote these approaches as a quid pro quo. In general, the main target for policy makers could be to maintain sufficient and adequate incentives for companies to increase their energy efficiency which may also be supported by VAs as one policy element in the entire policy mix.

FINANCIAL INSTRUMENTS

Financial instruments contribute considerably to remove financial and information barriers. Research has shown that financial instruments are well suited to support the diffusion of organisational and technological energy efficiency measures (e.g. Fleiter et al. 2012; Schleich et al. 2015). This can among other things be explained by the fact that adoption decisions are more sensitive to cost-benefit considerations in the short term than to long-term benefits.

Financial instruments are the predominant type of instrument to encourage the implementation of energy audits and energy management systems in SMEs both in the EU-28 and beyond. This is primarily due to the fact that financial instruments are able to remove financial barriers which are especially relevant in the context of SMEs (Fleiter et al. 2012; Schleich et al. 2015). For this purpose countries currently use two different mechanisms: (1) SMEs receive a direct financial subsidy for the implementation of an energy audit or energy management system and (2) SMEs receive tax reductions if companies implement an energy audit or energy management system as a quid pro quo (some countries connect this mechanism also to voluntary agreements, see Table 2).

At present, 13 EU Member States have financial instruments in place that focus on energy audits in SMEs; regarding the other countries we analysed beyond the EU-28, *Switzerland* and *Japan* have also established mechanisms targeted at SMEs. In addition, seven Member States, i.e. *Austria*, *France*, *Germany*, *Luxembourg*, *Malta*, *Spain* and *Sweden* also have instruments established which are targeted at the introduction of energy management systems in SMEs. Outside the EU, *Canada* and *Norway* provide financial incentives for SMEs for the implementation of energy management systems, as well (see Table 1 and Table 3[6] in conjunction with Table A1 in the Annex).

Direct funding for energy audits is available in *Austria*, *Bulgaria*, *Croatia*, *Germany*, *Luxembourg*, *Malta, Poland, Portugal, Sweden* (see Table 3). *Japan,* as an exception, provides energy audits free of charge for SMEs. With regard to the eligibility criteria, some countries have decided to connect funding to certain minimum thresholds for energy consumption. In *Luxembourg* according the Regulation of Energy Audits SMEs must have an energy consumption exceeding 3 GWh per year to request funding. In *Portugal,* companies must have an annual energy consumption of less than 1,000 toe per year (Portuguese Ministry of Economy and Innovation 2008). In *Sweden*, only companies with a final energy demand exceeding 0.3 GWh per year are eligible for funding (Swedish Energy Agency 2015). *Norway* merely provides funding to companies with an energy consumption of equal or above 1 GWh per year and in addition varies the amount of funding according to the amount with energy consumption (Enova 2015).

With regard to indirect funding for energy audits based on tax redemptions Germany is the only country which makes also use of this mechanism besides direct financial subsidies. Currently, there are two different instruments in place. The first one is the Eco tax cap for manufacturing. In this context SMEs which request a tax reimbursement have to conduct an energy audit as a quid pro quo. This so-called surplus settlement is available upon request to companies from the manufacturing sector and enables the redemption of up to 90 % of electricity and/or energy taxes paid (German Federal Ministry for Econ-

6. Comment for Norway: For companies with a demand exceeding 50 GWh per year, the target is based on the energy demand for support processes.

Table 2. Characteristics of voluntary agreements promoting energy audits and energy management systems.

Country	Name of instrument	Energy Audits	EMS	Target/Action Plan	Obligatory implementation of measures	Financial benefit	Type of financial benefit	Comment
BG	Energy Efficiency and Green Economy Programme	●		Target	yes	yes	Grants: 30 %–50 % of the costs	min. of 10 % energy saved
	Industrial Energy Efficiency Targets (IEET) for industrial energy enterprise owners	●		Target	yes	yes	Tax rebate	
DK	Voluntary agreement		●	AP	yes	yes	Compensation of the PSO (public service obligation) tariff (7 øre (1 cent) per kWh)	Implementation of EMS according to ISO 50001 mandatory Target: Reduction of energy consumption
FI	Voluntary Energy Efficiency Agreement	●	●	AP	yes	yes	Up to 50% of energy audit costs and 20% subsidy for implementation projects	
LU	Voluntary agreement on industrial energy efficiency		●	AP	(yes)	yes	Relief on energy taxes (for electricity and gas)	Aim is to improve energy efficiency by 7 % as compared to the average level of 2009 and 2010
MT	(Programme from MHRA)	(●)		none	no	no	None	(●): programme currently under preparation
NL	Long Term Agreements (LTA3 or MJA)/Long Term Agreement energy efficiency ETS companies (MEE)	●		Target (soft), AP	yes	no	None	Soft non-binding target of 2 % annual energy efficiency improvement, in return, company is more likely to be granted the environmental permit that it needs to operate
UK	Climate Change Agreements		●	Target	no	yes	Tax rebate (Climate Change Levy CCL) – Reduction of 90 % on electricity bills and 65 % on other fuels	Target: Energy efficiency targets individually by sector; Agreement between Department of Energy and Climate Change and industry sectors
CH	Voluntary target agreements	●		Target	no	yes	Tax redemption of CO_2 regulatory tax	–
ZA	National Energy Efficiency Leadership Network (EELN)		●	Target, AP	no	no	None	–

omy and Energy 2013).[7] The second instrument is called Special Equalisation Scheme and is part of the Renewable Energy Sources Act (EEG). According to this Act, energy-intensive companies (possibly also refers to SMEs) may request, under certain circumstances, a reduction in the renewables surcharge (EEG surcharge). As a prerequisite, applicants have to operate a certified energy or environmental management system (in line with DIN EN ISO 50001 or EMAS); companies with an electricity consumption of less than 5 GWh can operate alternative systems (e.g. according to DIN EN 16247-1) that improve energy efficiency (German Federal Ministry of Justice and Consumer Protection 2014).

7. To gain this reduction the energy intensity has to be continuously reduced by the manufacturing industry as a whole.

Evidently, the amount of funding varies considerably across the countries ranging from EUR 5,500 (Energy vouchers) in *Sweden* to funding of EUR 50,000 for the introduction of an energy management system in *France*. However, when analysing the different amounts of funding, one has to take into account that the share of eligible costs also varies across countries ranging from a minimum of 5 % in *Slovakia* to a maximum of 70 % or 80 % in *Sweden*, *Germany* and *Poland*.

In addition, to enforce the implementation of energy efficiency measures identified during an energy audit, some Member States such as *Austria, Denmark, France* and *Spain* provide additional funding or low interest loans for SMEs. For the implementation of energy management systems, SMEs may use direct funding in *Austria, France, Germany, Malta, Spain, Sweden, Norway* and *Canada*. With respect to indirect funding for energy management systems, as a quid pro quo

Table 3. Characteristics of financial instruments applied in the EU-28 (+Switzerland, Japan, Canada and Norway) promoting energy audits and energy management systems in SMEs.

Country	Name of instrument	Energy Audits	EMS	Level of funding	Comment
Austria	Regional programs	●	●	Depends on programme	Additional funding for implementation of energy efficiency measures sometimes available
Bulgaria	Energy Efficiency and Green Economy Programme	●	–	40 %	–
Croatia	Subsidies for energy audits in SME	●	–	EUR 6,600	–
Denmark	'VE til proces' scheme (RE for production process)	●	–	Project-dependent grants	Available funds: EUR 500 m from 2013–2021 – rates differ depending on the size of the company and project type
France	Energy checks in SMEs	●	●	Max. 70 % of expenditure, max. EUR 50,000	Additional funds of up to EUR 100,000 can be provided to support the implementation of energy efficiency measures
Germany	SME Energy Consulting Program	●	–	Up to 80 % of the consultation costs, max. EUR 8,000	–
Germany	Eco tax cap for manufacturing industry	(●)	●	Tax cap up to EUR 1,000	Prove that an energy management system has been implemented
Germany	Special equalization scheme	(●)	●	Beneficiaries pay the full EEG surcharge for the first GWh and then 15 % of the EEG surcharge for every kilowatt hour of electricity they consume above	Reduction of the renewables surcharge (EEG surcharge, also called EEG reallocation charge) for energy-intensive companies
Germany	BAFA support programme for cross-cutting technologies	●	–	Max. EUR 30,000 for cross-cutting technology	Max. EUR 150,000 for system optimization
Germany	BAFA fund for energy management systems		●	80 % of qualifying expenses up to EUR 6,000	Funding also for the purchase of metering technology and/or software for an energy management system, external energy consultation, training costs of employees
Italy	(Call for co-funding of Regional programs)	(●)	–	–	(●) programme currently under development
Luxembourg	Funding scheme for energy audits in energy-intensive companies	●	–	50 %; approx. EUR 23,000	Funding for energy audits provided to industrial, craft, agricultural and commercial enterprises exceeding an energy consumption of 3 GWh per year
Luxembourg	Voluntary agreement on industrial energy efficiency	●	●	Partial release from taxes	–
Malta	Malta Enterprise Scheme	●	●	Funding for audits available	–
Poland	Energy/electricity supply audit of an enterprise	●	–	70 % of eligible costs (de minimis)	–
Portugal	Refund of energy audit costs	●	–	50% of energy audit costs, max. EUR 750	Organisations with an annual energy consumption of less than 1,000 toe/year are entitled to apply for a refund of half the costs of an energy audit
Slovakia	SlovSEFF III program	●	–	5 %–20 % of a disbursed loan	–
Sweden	Energy audit vouchers	●	–	50 % of energy audit costs, max. EUR 5,500	Programme has been revised in 2014, companies with a final energy demand exceeding 0.3 GWh/year (formerly 0.5 GWh/year)
Sweden	Support scheme for energy efficiency investments	●	●	70 % of the costs (>50 employees), medium-sized companies 60 %	Prior to receiving funding, companies have to have carried out an energy audit
Switzerland	Canton de Vaud audit program	●	–	30 % of tax	–
Japan	Fee energy audits for SMEs	●	–	Total costs	Free of charge, audits are conducted by governmental organisations, such as ECCJ (Energy Conservation Center Japan) and NEDO (New Energy and Industrial Technology Development Organisation)
Canada	ecoENERGY Efficiency for Industry program	–	●	50 % of the costs, up to a maximum amount of $25,000	–
Norway	Funding for introducing energy management	–	●	1–10 GWh: EUR 22,000; >10 GWh: EUR 110,000	Eligible companies have to have an annual energy consumption equal to or above 1 GWh, maximum share of funding is 50 % of eligible costs and companies have to set a target of achieving energy savings of 10 % within five years

for tax reimbursements there is currently no country using this concept.

From a political perspective, direct subsidies are much easier to implement with regard to acceptance of the affected group than e.g. regulatory instruments or taxes. With respect to SMEs these are suitable to overcome financial barriers and thereby to contribute to an adoption of energy efficiency measures (e.g. Schleich et al. 2015). Blok et al. (2004) argue that some empirical evidence exists which states that funding programmes for the adoption of technologies are a factor three to eight more effective than 'equivalent' energy taxes. Furthermore, this type of instruments leaves flexibility and allows companies themselves to decide upon the best way to reduce their energy consumption (Sprenger 2000). However, subsidies present some disadvantages which may result in market distortions. In the context of the cost-effectiveness, direct financial subsidies are disputed for a variety of reasons. Firstly, free-rider effects[8] related to this instrument are likely to arise. Policy-makers are responsible to avoid these effects with an effective design of the policy instrument, including suitable requirements for eligibility of funding. Secondly, subsidies cause administration costs that tend to be larger than those for tax-based mechanisms (Blok et al. 2004). Thirdly, as stated above, subsidies have strong market implications as they may expand e.g. the subsidised industry (Gupta et al. 2007). However, one has to note that this may also be the case for regulatory instruments, such as it is currently the case for mandatory energy audits (Article 8 of the EED) which results in peaks demanding energy audits every four years. Fourthly, to achieve the correct and economically effective amount of subsidy may be a long-lasting process of 'trial' and 'error' (Howlett & Ramesh 2003).

When discussing implications of taxation on the diffusion of energy audits and energy management systems in SMEs, one has to note that all countries which focus on this mechanism connect the implementation of an energy audit (in some cases also energy management system) as a quid pro quo for the tax redemption. Academic literature discussing the relevance of taxes in this regard does usually not focus on this mechanism because taxes generally have to be paid by all actors and thereby generate revenues that can be used to further decrease environmental pollution in other areas. In the case of energy audits and energy management systems, the opposite is the case as companies get tax redemptions. One might argue that, due to economic considerations, it is disadvantageous for the adoption of energy-efficient technologies that these companies do not receive the full price signal anymore. However, the evidence of barriers as described in the introductory section suggests that the design of these instruments is suitable to enhance the adoption decisions by companies. As for subsidies, free-rider effects are also relevant for instruments based on tax redemptions in the context of the implementation of energy audits and energy management systems. In addition, various types of administration costs arise. However, with respect to the diffusion of energy audits and energy management systems in Germany for example this has proven to be a suitable approach.

8. Free-riders are defined as agents who make use of the subsidy, but would have undertaken the subsidised action anyway – and without any delay (Blok et al. 2004).

INFORMATION INSTRUMENTS

As a lack of information is a significant barrier to the adoption of energy efficiency measures in SMEs (IEA 2015), some countries have also established information instruments particularly focused on this target group. For energy audits these are *Belgium* (Flanders region), *Germany*, *United States* and for energy management systems *Belgium*, *Denmark* and *Sweden*.

Germany, for example, established energy efficiency networks which consist of 10 to 15 regionally based companies with energy costs above EUR 500,000 from different sectors which come together aiming to enhance their energy efficiency performance (Dütschke et al. 2016). The companies set non-binding energy efficiency goals; they conduct energy audits, monitor their energy performance on a regular basis and regularly share their experiences with regard to energy efficiency improvements. This approach is very well suited for SMEs to overcome barriers for the improvement of their energy efficiency. Besides, *Belgium* uses 'energy scans' for SMEs, which are free of charge energy audits for companies. In the *United States* information instruments for energy audits and energy management systems are widely used. For energy audits the Industrial Assessment Center provides free of charge energy assessments for SMEs. For this purpose teams of engineering students located at 24 universities conduct energy audits of SMEs and typically discover savings opportunities of more than $130,000 at each company during the first year following the audit (Office of Energy Efficiency & Renewable Energy 2015). In terms of energy management systems in SMEs, *Denmark* and *Sweden* provide an Energy Management System Light which is tailored to SMEs and aims to demonstrate how to implement an energy management system.

Information instruments help to transfer knowledge and to reduce transaction costs, as well as support companies to increase their energy efficiency which is particularly useful for SMEs as they do not have as much internal capacity as large enterprises. Sometimes these instruments are referred to as 'moral suasion' due to the fact that these instruments aim at achieving a particular behaviour in the target group (e.g. Vedung 2003). However, these instruments are soft in their nature and thus, do not necessarily lead to energy savings in the end. Nonetheless, these instruments are suitable as one element in the policy mix to increase knowledge about possible energy efficiency measures in SMEs.

Discussion

It has been shown that there are a wide range of different instruments and policies that address energy audits and energy management in companies. Though we can only provide a brief glance into national instruments in this paper, it becomes evident that designing corresponding policy instruments can be challenging for policy makers.

For each group of instruments, we have highlighted some typical advantages and challenges. It should be noted that policy instruments in the individual countries are in constant evolution. Thus, our analysis only provides a spotlight on the situation in 2015. Nevertheless, we want to highlight some overarching recommendations that are supported by our findings. Given the fact that overcoming information barriers is particularly important for improving energy efficiency in

SMEs, informing SMEs about possibilities to request and receive support for the implementation of energy audits and energy management systems is crucial. For this purpose there is also a need for policy makers to provide information material such as guidelines (e.g. McLaughlin 2015) or other information material. This material should also highlight non-energy benefits of energy audits and energy management systems. One main goal should be to raise SMEs' awareness of potential policy instruments providing a low threshold access for the different programmes which minimises the administrative burden regarding both the application for permit as well as the actual implementation. Time and employee capacity are limited resources for SMEs, and the information is often spread across various public institutions. Therefore one-stop-shops, which bundle the relevant information regarding possible policy instruments for these companies, are useful to minimise the transaction costs for the research on information as well as the interpretation. Furthermore, political institutions might suggest 'light-weight' energy management systems for SMEs which principally are based on energy management systems, but with a reduced set of formal requirements. Thereby the accessibility for SMEs could be enhanced and simplified (e.g. also Rohde & Eichhammer 2016). Financial capital may be a bottleneck for SMEs after completing the energy audit or implementation of an energy management system. Therefore, the provision of subsequent implementation support, such as low-interest capital or partial funding for the implementation of the recommendation, may accelerate energy efficiency progress in SMEs. As our results show, various countries already pursue this approach successfully. Finally, regular information exchange between institutions involved in policy making process, both inside the national territory as well as across borders, enhances the exchange of best-practices as well as reducing transaction costs for the parties involved.

Looking at the entire set of existing policy instruments targeting energy audits and energy management systems in SMEs and having in mind the different advantages and challenges discussed above, the results indicate that no single instrument alone is able to incentivise implementation under the guiding principles of economic and environmental effectiveness as well as distributional aspects regarding equal treatment of the target group (for the discussion of multiple policy instruments see e.g. Bennear & Savins 2007). As the empirical results show, a policy mix consisting of different types of policy instruments which are designed coherently and synchronized considering their interlinkages at the same time is necessary. Especially for SMEs, further support for the implementation of energy efficiency measures identified during the implementation of an energy audit or energy management system seems crucial.

Conclusion

In this paper we presented a structured and comprehensive review of existing policy instruments targeting energy audits and energy management systems in SMEs. We have analysed advantages and challenges related to different aspects of implementation for regulatory, voluntary, financial and information-based elements both in the EU-28 Member States and beyond. Results show 50 instruments in place in the EU-28. Another 15 instruments can be found across *Brazil*, *Canada*, *China*, *India*, *Japan*, *Norway*, *Switzerland* and the *USA*.

The SME segment represents 99 % of Europe's non-financial business economy and, with 13 % of total energy demand, is also highly relevant in terms of energy consumption. Our paper highlights the importance of this target group which has special requirements in terms of policy support compared to those of large companies. The most important challenges are improving their knowledge on energy efficiency measures, strengthening their internal capacity both in terms of financial capital as well as employee capacity focusing on energy topics and raising the priority of energy efficiency topics at management level.

The analysis shows that countries rely on different types of policy instruments ranging from regulatory to voluntary, financial or information approaches aim to overcome barriers in SMEs. Most of them focus on providing financial incentives. Under the guiding principles of economic and environmental effectiveness as well as distributional aspects it seems that no single instrument is appropriate as a stand-alone approach, but rather the specific type of instrument, its design and implementation strongly depend on the individual framework conditions in the respective country. This includes the characteristics of the existing general energy and climate policy design, or the relevance of certain SME segments. For this purpose it seems reasonable that EU-28 Member States have the liberty to decide on the alignment of their policy instruments according to the specific national situation. Generally, we conclude that suitable instruments should continuously raise awareness in SMEs, ensure sufficient and easy access to information on national programmes and the organisation of energy audits and energy management systems, and they should also meet the expectations of participating companies. Further research is needed evaluating the impact of the currently applied mix of instruments on industrial companies, considering also hybrid instruments as well as interdependencies between the different instruments.

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Appendix

Table A1. Overview about instruments addressing energy audits and energy management systems in SMEs.

	Country	Name of the instrument	SME	Non-SME	Comment
Regulatory Instruments	Energy Audits				
	Bulgaria	Mandatory energy audit	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Croatia	Mandatory energy audit (sec. legislation not yet in force)	(●)	●	(●): Possible inclusion of SMEs due to lower financial threshold
	Czech Republic	Mandatory energy audit	(●)	●	(●): Possibly inclusion of SMEs due to energy threshold
	Ireland	Mandatory energy audit	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Italy	Mandatory energy audit	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Luxembourg	Mandatory energy audits for energy-intensive companies	●	●	Non-EED regulation
	Portugal	Mandatory energy audit	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Romania	Mandatory energy audit	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Slovenia	Mandatory energy audit (sec. legislation not yet in force)	(●)	●	(●): Possible inclusion of SMEs due to lower financial threshold
	China	Top-10,000 programme	●	●	Inclusion based on energy demand
	Australia	Energy audits (as part of Emission Trading System)	●	●	–
	India	Mandatory energy audits for energy-intensive companies	●	●	Obligation for nine energy-intensive sectors to conduct audits
	Energy Management Systems				
	Romania	Mandatory energy manager	●	●	–
	China	Top-10,000 programme	●	●	Inclusion based on energy demand
	Japan	Mandatory energy management	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Turkey	Mandatory energy manager and energy management unit	●	●	Energy consumption above 1,000 toe (companies) respectively 50 ktoe per year (industrial plants)
Voluntary Agreements	Energy Audits				
	Bulgaria	Industrial Energy Efficiency Targets (IEET)	●	●	–
	Finland	Voluntary Energy Efficiency Agreement	●	●	–
	Malta	(Programme from MHRA)	(●)	(●)	(●): Programme currently under preparation
	Netherlands	Long Term Agreements (LTA3 or MJA)/Long Term Agreement energy efficiency ETS companies (MEE)	●	●	–
	Switzerland	Voluntary target agreements	●	●	–
	Energy Management Systems				
	Denmark	Voluntary agreement	●	●	–
	Finland	Voluntary Energy Efficiency Agreement	●	●	–
	Luxembourg	Voluntary agreement on industrial energy efficiency	●	●	–
	United Kingdom	Climate Change Agreements	●	●	–
	South Africa	Voluntary agreements	●	●	–

The table continues on the next page . . . →

	Country	Name of the instrument	SME	Non-SME	Comment
Financial Instruments	Energy Audits				
	Austria	Regional programs	●	●	–
	Bulgaria	Energy Efficiency and Green Economy Programme	●	–	–
	Croatia	Subsidies for energy audits in SME	●	–	–
	Denmark	Energy saving obligation targeted at energy companies	●	●	–
	Denmark	'VE til proces' scheme (RE for production process)	●	–	–
	France	Energy efficiency support for SMEs	●	–	–
	Germany	SME Energy Consulting Program	●	–	–
	Germany	Eco tax cap for manufacturing industry	●	●	–
	Germany	Special equalization scheme	●	●	–
	Germany	BAFA support programme for cross-cutting technologies	●	●	–
	Italy	(Call for co-funding of Regional programs)	(●)		(●): Call for selecting and co-funding of programs open
	Luxembourg	Funding scheme for energy audits in energy-intensive companies	●	●	–
	Malta	Malta Enterprise Scheme	●	–	–
	Malta	ERDF Scheme	(●)	(●)	(●): Currently suspended, new scheme under preparation
	Poland	Energy/electricity supply audit of an enterprise	(●)	●	(●): Companies with an energy consumption > 20 GWh/year
	Portugal	Refund of energy audit costs	●	●	–
	Slovakia	SlovSEFF III program	●	●	–
	Sweden	Energy audit vouchers	●	–	–
	Switzerland	Canton de Vaud audit program	●	●	–
	Japan	Free Energy Audit	●	–	–
	Energy Management Systems				
	Austria	Regional programs	●	●	–
	France	Energy efficiency support for SMEs	●	–	–
	Germany	Eco tax cap for manufacturing industry	●	●	
	Germany	Special equalization scheme	●	●	
	Germany	BAFA support programme for energy management systems	●	●	–
	Malta	Malta Enterprise Scheme	●	–	–
	Malta	ERDF Scheme	(●)	(●)	(●): Currently suspended, new scheme under preparation
	Spain	Program for Energy Efficiency in SMEs and Large Companies in the Industrial Sector	●	●	–
	Sweden	Support scheme for energy efficiency investments	●	–	–
	Sweden	(Program for energy efficiency in energy intensive industries)	(●)	(●)	(●): Programme discontinued; last companies still in the cycle
	Sweden	Support scheme for energy efficiency investments	●	–	–
	Norway	Funding for introducing energy management	(●)	●	(●): Possible inclusion of SMEs due to energy threshold
	Canada	ecoENERGY Efficiency for Industry program	●	●	

The table continues on the next page . . . →

	Country	Name of the instrument	SME	Non-SME	Comment
Information instruments	Energy Audits				
	BE: Flanders	Self-scan for SME	●	–	–
	Germany	Energy efficiency networks	●	●	–
	United States	Industrial Assessment Centers (IACs)	●	–	–
	Energy Management Systems				
	BE: Flanders	SME portfolio	●	–	–
	Denmark	Energy management light	●	–	–
	Sweden	Energy management system light	●	–	–
	Switzerland	KMU Model	●	–	–
	United States	Better buildings, better plants programme	●	●	–
	United States	Energy Star for Industry Program	●	●	–
	United States	Superior Energy Performance	●	●	–