The German market for energy efficiency services

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Abstract

The energy service market in Germany has experienced continuous growth over the last decade. The German Federal Energy Efficiency Center (BfEE) is responsible for monitoring the energy service market and for developing proposals for its further improvement according to the German Act on Energy Services and other Energy Efficiency Measures (EDL-G).

The BfEE has published two studies on the energy service market in general: The first was published in 2013 and focused on analyzing the supply side of the market (BfEE 2013). It confirmed that there already is a relatively well-developed market for energy services in Germany. However, given the breadth and variety of market actors and products, the market can be described as very heterogeneous. Also, the understanding of the product terms differs between actors, making it difficult to define the market and to draw conclusions about market performance. The second market study was carried out between July 2015 and October 2016. It aimed to update and specify the findings of the previous study. A significantly greater focus was placed on the research of the demand for energy services of households and small and medium enterprises (SME). The results make it possible to assess the current development of the market performance and to gain insight into the expectations and motivations as well as the awareness towards energy services.

The paper discusses available data and problems of monitoring and evaluation of the energy service market in Germany. It also deals with the idea of an ongoing monitoring study that would allow evaluating the market situation in a regular and detailed way.

Introduction: idea and mission

Energy efficiency services (EES), be it simple energy checks or complex and elaborate products like energy performance contracting (EPC), can provide effective and cost-efficient energy solutions to different market actors, from large private companies of all sizes and public administrations to private households. There is a great need and large potential for the accelerated further development in volume and variety of the EES market through better policy. "While the expansion of policies has been effective in generating energy savings and reducing emissions, more is required and more is possible. Improvements in energy intensity and energy efficiency are still far from achieving our climate goals." (IEA 2016, p. 16).

A good understanding of the market is paramount in developing adequate instruments in support of its development to spur further investment in energy efficiency. Therefore, the market needs to be monitored continuously. Past research indicates that the energy services market not only hosts many different relevant products, but that there are distinct barriers for the further take-up of each product. Unlike mature markets for largely standardized products, the energy services market is fluid, dynamic and innovative. This renders continuous monitoring extremely difficult. The availability and consistency of available data in literature is very limited. Therefore, regular original research is needed.

The Federal Energy Efficiency Center (BfEE) has been charged with the observation of the energy efficiency services

market in 2010 according to the EDL-G. Since then, several projects have been conducted to assess and understand the market. In 2013, a large market study realized with the support of research institutions (Prognos AG, the Ifeu institute and the University of Applied Sciences Ruhr West) was the first study to look at the German energy efficiency services comprehensively. It proposed fundamental product categories and gave an overview of the market in general. Based on the study, the authors of the paper "Monitoring the Energy Efficiency Service Market in Germany" (Offermann et. al. 2013) identified several problems to consistent monitoring of the market for energy efficiency services.

> First, there is no category 'energy service' or 'energy efficiency service' in national statistics. Second, products and markets are heterogeneous, with services ranging from very simple energy efficiency advice by single consultants via services contributing to energy management to complex integrated performance contracting. Third, associations of EES providers themselves have problems to get full market coverage and sufficient information from their members. Fourth, only few publicly available studies on the EES market cause a problem of circular reference. (Offermann et. al. 2013.)

The paper discussed the need for clear definitions of the products that should be considered relevant (partial) energy efficiency services for the purpose of market observation to facilitate the qualitative evaluation of its development. The results presented below stem from the second large market study finalized in 2016, which built upon the first. With a view to the reliability and representativeness of the data, the study aimed at

- generating standard market indicators (e.g. market volume, product prices, number of suppliers etc.)
- understanding the market potential for different products among private households and SMEs, and
- uncovering opportunities to further develop the market.

Two key ideas have guided the research presented below. First, definitions for a class of established products were developed and second, the observation focused on the question if and how the products offered meet (potential) demand.

Methodological approach

The study differentiated between the demand side of the market and the supply side of the market and it was undertaken in several phases. The first phase included the development of product definitions, as well as guided interviews with 75 experts representing the supply side of the market and 25 experts representing the demand side. It concluded with an expert workshop. Data was gathered during the second phase. The survey and interview results were discussed at a workshop thus ending the second phase. During the final phase, a report was drawn up and the study results were published.

The BfEE, as the official federal institution for the energy service market, developed definitions for products with particular relevance for the market or particular complexity for detailed study and the determination of respective market indicators. An overview of the products is found below (Figure 1).

The guided interviews (Table 1) served several purposes. They allowed improving the overall perception of the market in preparation of the questionnaire for the standardized interviews. Furthermore, they allowed gathering insights from suppliers and customers that are too few for standardized questioning (e.g. development banks, energy agencies, consumer associations) or out of scope for standardized questioning in (e.g. large real estate companies and associations, craftsmen's organizations). Finally, the definitions were developed and refined during the interviews and again at the workshop to make sure that there was a common understanding at least among important market actors.

At the core of the study was the generation of empirical data. In addition to more than 100 guided interviews and two expert workshops, the study of 2016 employed an online questionnaire of 25 minutes answered by more than 1,400 energy con-

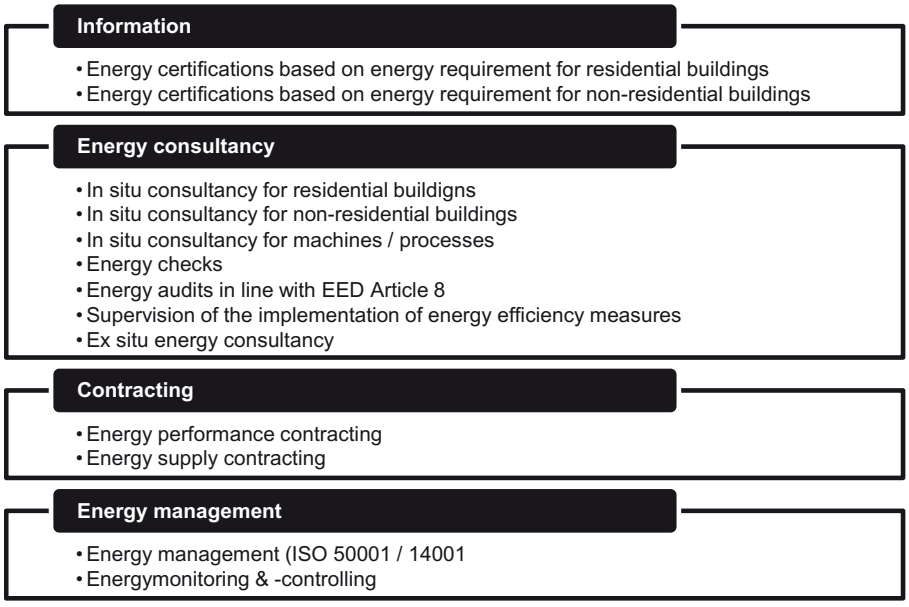

Figure 1. Overview of products defined and studied.

Table 1. Concluded expert interviews.

Demand side	Qty.	Supply side	Qty.
Tenants Association	1	Customers' associations	7
Real estate industry	10	Energy agencies	8
Carriers of asylums	4	ISO 50001 and ISO 14001 certifiers	5
Home owners' association	2	Development banks and thrift institutions	4
SMEs/SME associations	14	Software providers and metering service companies	8
		Utilities and contractors' associations	13
		ESC providers	4
		Energy consultants' associations	5
		Suppliers of building automation technology	6
		Craftsmen's organizations	10
		Other suppliers	4

Table 2. States and regional clusters.

No.	State
1	Baden-Wuerttemberg
2	Bavaria
3	Brandenburg, Saxony-Anhalt, Mecklenburg-Western Pomerania
4	Hesse
5	Lower Saxony, Schleswig-Holstein
6	North Rhine-Westphalia
7	Rhineland-Palatinate, Saarland
8	Saxony, Thuringia
9	City states (Berlin, Hamburg, Bremen)

sultants and standardized telephone interviews of 10 minutes on average. 3,000 private households and 3,000 SMEs (10 to 249 employees) were interviewed to learn about the needs and assessments of (potential) energy efficiency services customers. Representativeness was reached at a sub-national level, for households as well as SMEs. For this purpose, some German states were grouped into clusters by their size, economic and settlement pattern (Table 2).

SMEs were grouped into clusters based on their energy use profiles (Schlomann et. al. 2013) and the findings are representative for those clusters at the national level. On the supply side, 210 companies were questioned. Among them 100 utilities, 40 energy contractors, 30 suppliers of energy efficiency technology, 25 suppliers of energy management software and 15 certified auditors of energy management systems (EMS). In the assessment of the supply side, the estimation of the universe remains a major challenge that will need to be addressed further in the future.

The next chapters of this paper discuss the findings of this bundle of surveys as well as the methodological challenges that were overcome and those that remain.

The market for energy audits and energy consultancy

The term energy consultancy is not accurately defined. Therefore, the study provides definitions for seven different types of energy consulting. The focus of the study lies primarily on comprehensive and market-relevant energy consulting services. In this study, energy consultancy is defined as a process of personal communication and interaction between two parties that professionally deals with the topic energy. A consultant has to deal with the specific issues of a customer. Following this definition most internet-based services such as CO_2-calculators or online-information-systems are not regarded as energy consultancy even if they represent a substantial additional source of information. Energy audits are a special type of energy consultancy that mostly target the industry and service sector. Energy audits are defined by the EDL-G ("Gesetz über Energiedienstleistungen und andere Energieeffizienzmaßnahmen").

SUPPLIERS OF ENERGY AUDITS AND ENERGY CONSULTING

Energy consultant is not a protected professional designation in Germany, therefore there is not a single directory of all suppliers and the number of energy consultants can only be estimated between 12,500 and 13,500 among them 3,800 energy auditors (in accordance with the article 8 of the Energy Efficiency Directive of 2012).

Concerning the nature of the businesses of the interviewed energy consultants, around 39 % are running energy consultant offices, while 36 % are architectural or construction engineering offices and 16 % are other engineering offices (Figure 2). Additionally, there are around 500 utility companies offering energy consulting and/or energy audits. Due to the absence of a single directory the study lacks especially the group of craftsmen, who offer energy consulting services additionally to their craftsmanship, notably for residential buildings.

Most of the energy consultants are highly specialized and work alone (50 %) or in micro-companies with up to 5 employees (34 %). Three out of four consultants offer either solely Energy Consultancy or combine it with services in the areas of civil engineering or architecture. A large number of energy consultants offer further services in addition to energy consulting, most often energy certification of buildings. Also, counselling for financial aid programs, measuring services and implementation assistance are significant additional services. Two explanations might be possible: Either customers expect "carefree packages", so energy consultants i.e. also look after the implementation of the recommendations or and this could be the second explanation energy consulting generates only small sales.

The latter is supported by the relatively low prices achieved for some energy consultancy services (Figure 3). Especially energy consultancy services for residential buildings are comparatively cheap and therefore generate low income. At the same time, the majority of energy consultants offer energy consultancy services for residential buildings, sometimes this even being the only type of energy consulting offered. Although hourly wages have risen throughout the last years, costumers of residential building consultancy seem to be very price-sensitive and competition is high so prices for consultancy for residential buildings remain low.

As a consequence of the company size and the focus of a majority of consultants on residential building consultancy, the turnover of those single person or small sized enterprises is not high. Half of the companies have an annual turnover of less than €80,000 (Figure 4). However, there are some enterprises of substantially larger size and influence sometimes offering services at an international level.

DEMAND SIDE

The study distinguished between SMEs as well as tenants and owners on the part of households. In each group, around one third had already taken advantage of energy consultancy. SMEs and house owners prefer on-side consultation, while tenants seem to be in favor of personal consultation outside their apartment. Satisfaction with the received consultation is generally high, 91 % of the owners being very satisfied or partly satisfied, 84 % of the tenants and 80 % of SMEs answering accordingly. In interviews, some 40 % of all households claimed that they were not interested in taking part in Energy Consultancy regardless of the costs. Out of those there are households that feel they do not need such services. Reasons are for instance that the buildings are new or because owners feel they are too old to make the effort. Reaching those households is one of the keys to achieving possible energy savings.

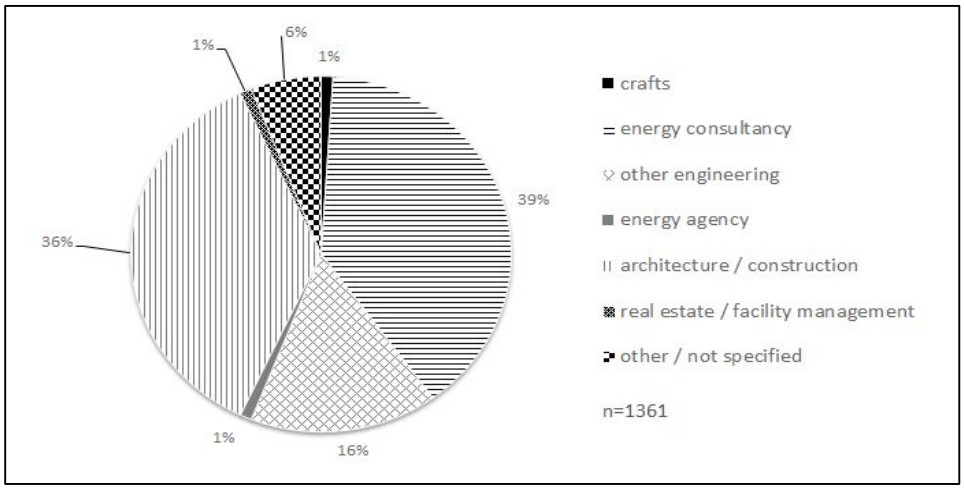

Figure 2. Companies' line of business.

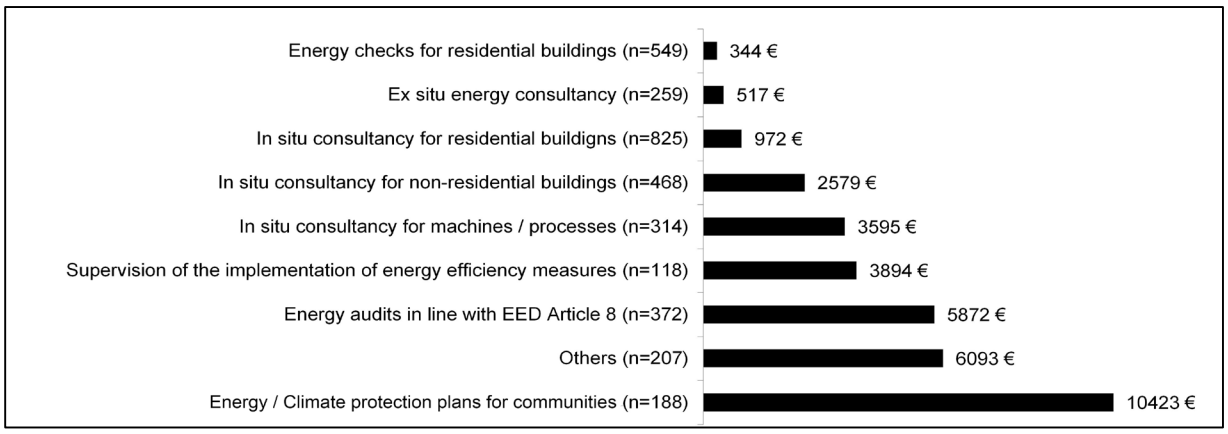

Figure 3. Average market prices for energy consultancy services in 2015.

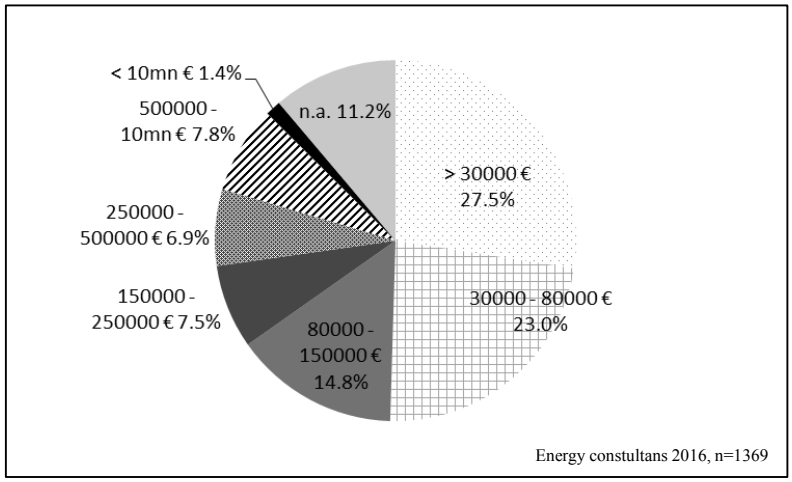

Figure 4. Turnover of companies providing energy consulting.

MARKET DEVELOPMENT

In 2015, an estimated number of between 420,000 und 460,000 energy consultancies and audits were performed. Based on the estimated cases and net costs the market volume for energy consultant services in 2015 was between €450 mn and €486 mn. If further energy consulting services are added, the annual market volume in 2015 is estimated between €1 bn and €1,125 bn.

In December 2015 energy audits for non-SMEs were made mandatory. Although this measure stimulated the market, the market slightly decreased compared to 2012 especially in the sector of residential buildings. In nearly every governmental funding program application numbers declined despite a raise of funding rates. In interviews the market was described as "driven by supply". Still, governmental funding programs remain crucial for the energy consulting market as every second on-site consultation for residential buildings and implementation assistance is state funded. To date, only one third of all private households have already received energy consultancy, therefore demand is expected to remain rather stable.

The suppliers therefore have a rather positive outlook on the market perspectives. Three out of four expect a small (48 %) or even strong (26 %) market growth.

The market for energy management

The German market for energy management services has been developing quite dynamically over the last few years as it experienced great impetus from technological innovations as well as regulatory developments. The market is predominantly fueled by companies, while energy management has met little interest from households. Smart metering and remote steering services, in liaison with improved opportunities derived from demand side management (DSM) and the use or sale of renewable energy have been drivers of the adoption of computer-based steering-solutions. The rising cost of energy for companies and public support schemes for energy intense companies using an EMS have led to growth of the market for the set-up and certification of EMS.

The study focused on selected services around energy management to capture key aspects of the market. Energy management pertains to the identification, control and optimization of energy flows. Energy management systems are defined through respective ISO norms.

In addition to the implementation and certification of energy management systems in line with ISO 50001, energy management related services pertain to energy monitoring, energy controlling, relevant metering and measurement services as well as the provision and maintenance of energy management software.

The certification of EMS in line with ISO 50001 by accredited certifiers and the set-up of those systems (which must be done by an entity different from the respective certifier) were studied. The proliferation of technical (software) and administrative (controlling) solutions to lower energy consumption and/or the cost of energy supply warranted the study of connected services.

SUPPLY SIDE

While not the largest share in market volume at about 29 %, consulting around the certification of EMS creates by far the most jobs in the market for energy management related services. We estimate that there are about 3,300 professional consultants providing guidance on energy management in Germany. In addition, 500 utilities offer services connected to energy management.

In particular, the amount of companies providing energy management software has been growing. Between 2013 and 2016, this number has nearly doubled to 220 companies. The introduction of energy management software accounts for two thirds of the market in terms of volume. The number of companies certified to audit EMS has remained largely stable at around 50 over recent years. Finally, about 120 companies that can be considered energy contractors also offer energy management services.

DEMAND SIDE

Among energy intense SMEs, 16.5 % claimed to have a certified EMS according to ISO 50001 (Figure 5), while companies predominantly operating buildings (accommodation and food services) put emphasis on energy controlling defined as the application of controlling instruments to energy flows built on energy monitoring as proposed by (GEFMA 2009). Typical services in conjunction with energy controlling are the sale,

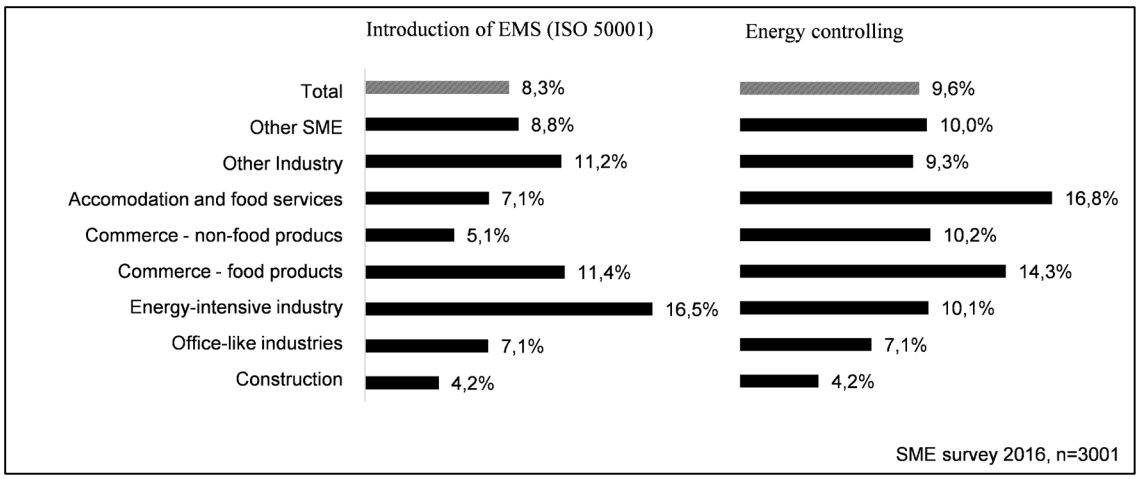

Figure 5. Usage of selected energy management services.

installation and operation/monitoring of energy management software, building automation systems and metering systems.

While larger companies are comparatively likely to adopt a certified EMS, smaller companies tend to select partial energy management related services, e.g. to achieve automated energy control. Only 5.4 % of companies with 10 to 49 employees have certified EMS and they make up a far larger share in Germany than companies with 50 to 249 employees.

MARKET DEVELOPMENT

Based on our survey, we estimate the total market volume of energy management related services reached €210 mn in 2016 (Table 3). About two thirds of the market pertains to the acquisition and operation of EMS software including the installation of appropriate sensors / meters. Almost one third of the market is consulting and assistance in setting up EMS. Around €8,5 mn were spent for the certification or re-certification of EMS, including certifications by energy consultants in addition to those carried out by certified auditors.

The market for energy management services, software and technology has been growing significantly over recent years. Almost one third of energy management services providers expect very strong further growth over the next three years and another 35 % expect some growth. Building automation leads to immediate energy savings while the management cycle helps identify measures that if implemented lower energy consumption. In sum, energy management services are expected to further contribute significantly to the improvement of energy efficiency of companies in Germany.

The market for energy contracting

Energy Contracting (EC), also labelled as Energy Efficiency Services is a "comprehensive energy service product to improve energy performance and cost efficiency of buildings or production facilities sustainably. An Energy Service Company (ESCo) implements a customized efficiency package (consisting of planning, building, operation and maintenance, optimization, fuel purchase, (co-)financing, user behaviour), takes over technical as well as commercial implementation and operation risks and provides guarantees for it's all inclusive cost and results" (Bleyl & Seefeldt 2008).

The German market development of Energy Contracting (EC) started in the early 1990s. Early market development activities were mainly driven by two groups of stakeholders. On the one hand, few utilities (still operating as integrated companies by then) started to implement Least-Cost-Planning (LCP) and Demand-Side Management (DSM) strategies, mainly based on the so called *Energy Supply Contracting* (ESC or 'chauffage'). While, on the other hand, a variety of manufacturers of building technologies, automation and control equipment companies, as well as a number of plant engineering and construction companies, had a strong interest to deliver efficiency services beyond the supply point, delivering energy savings based on building, lighting, automation and control technologies. They extended their value creating chains and scope of services to the so called *Energy Performance Contracting.*

WHAT ARE THE SPECIFIC PRODUCTS? DEFINITIONS

ESC

In accordance to DIN 8930-5 ESC projects are considered as a comprehensive service, including planning, financing, implementing, operating & maintaining supply equipment (for the *supply* of useful energy such as heat, cooling, lighting, compressed air and/or electricity). Customers are billed by the amount of supplied energy (MWh).

EPC

The focus of EPC is on reducing final energy consumption through DSM energy efficiency measures. The scope is extended to the entire building including measures such as building engineering, user behavior or the building envelope insulation as indicated in Figure 2. The business model is based on a savings guarantee compared to a predefined baseline, also labelled as Negawatt hours (NWh).

The ESC market developed faster than the EPC market. ESC products have been successfully established among different end-use sectors. Predominantly, these included the residential sector, industrial premises, and public facilities. Featured technologies range from standard boilers to CHP solutions (sometimes including distribution networks). The majority of projects run on natural gas but a variety of renewable heating systems and solar systems have been installed as well. (Bleyl & Seefeldt 2012).

SUPPLY SIDE: WHO ARE THE ESCOS?

To get a better overview, there was an intensive interview phase prior to the standardized query phase. For the EC Market we focused on the most important industry associations in the energy contracting sector (VfW, ESCo Forum at ZVEI, DENEFF, AGFW, BDEW, VKU & ASEW). The annual reports of the mentioned association gave also a first estimate of the market size. The results show a heterogenous supply market, with a majority of smaller ESCos (average turnover in EC: €12 mn/a), an increasing number of energy utilities ("Stadtwerke", large turnover, but similar share of EC turnover: €12 mn/a) and a small number of large 'independent' suppliers (Table 4). The database for 'independent' suppliers was compiled by individual web based research on company reports of the 20 largest ESCos in Germany. 'Independent' refers to ESCos which are *not* subsidiary of an *energy company* (regional, transregional energy supplier or municipal utility). Very often these 'independent' ESCos are subsidiaries to real estate companies, metering services, facility managers and/or building equipment and control technology manufacturers, thus having a different market and product strategy.

DEMAND SIDE: WHO ARE THE CUSTOMERS?

The standardized query among ESCos asked for the most important demand side segments for Energy Contracting. The residential sector turned out to be the most important market for EES, followed by the public sector (Figure 6).

The latter is somewhat surprising, because the public sector only stands for 50 TWh of TFED (in comparison with industry with a TFED of 700 TWh). The three segments 'Other SME', 'Accommodation and food services', and 'Commerce' represent subsectors of the tertiary sector (service sector).

PRODUCT SIDE: WHAT SELLS?

One part of the explanation can be given, when looking at different products in the EC market. The comparision betweeen market penetration of ESC and EPC in different segments

Table 3. EMS market volume.

Service	Instances	Average price	Turnover
Certification of EMS	ca. 1,740 (o/w 1,000 not by ISO standards)	€4,060	ca. €7 mn
Re-certification of EMS	ca. 790 (o/w 6,000 not by ISO standards)	€2,060	ca. €1,5 mn
Consultancy/supervision for the implementation of EMS	ca. 6,000	€9,613	ca. €60 nm
Introduction/maintenance of energy management software	ca. 70,000	ca. €2,000	ca. €140 mn

Table 4. First assessment of the EC market.

Segment	No. of companies.	Av. EC turnover per company	Total EC turnover
VfW Members	225	€12 mn	€2,5 bn
Large independent ESCos	20	€84 mn	€1,7 bn
Energy Utilities	250–350	€12 mn	€3,0–4,2 bn
Total	ca. 500–600	€14 mn	ca. €7,2–8,4 bn

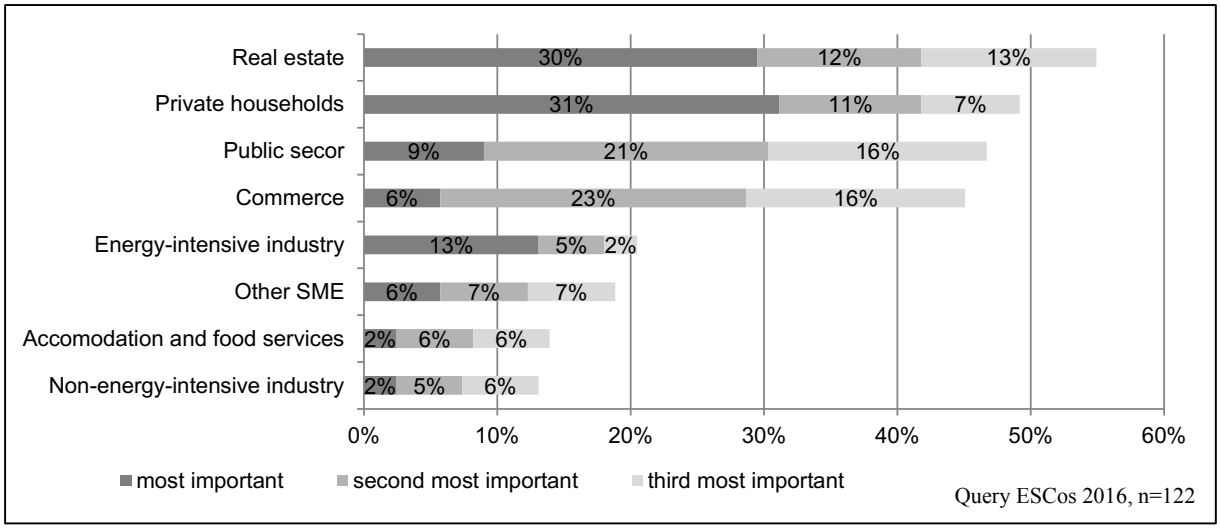

Figure 6. Importance of different target groups (from ESCO's perspective). Question: "Please name the three most important target groups for Energy Contracting".

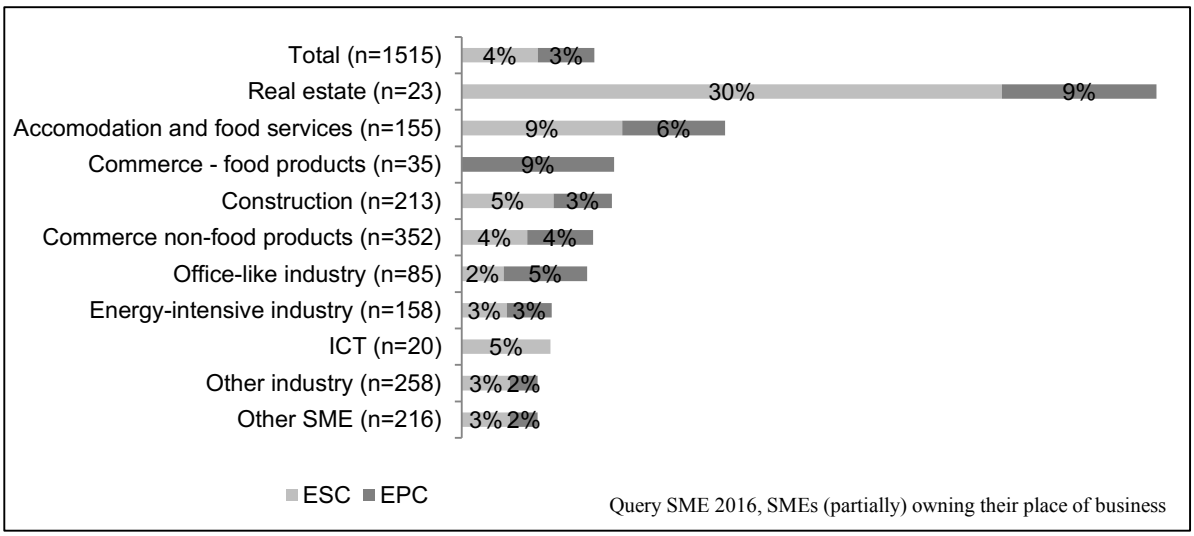

Figure 7. Usage of contracting products by SMEs by sector in the last three years.

shows a relatively low level of penetration in both cases. However, martket penetration of ESC stood at 4.3 % (Figure 7).

In a mature market with contract durations around 10 years a stable market penetration rate should show values around or above 10 %. There is a high demand for ESC in the real estate sector relative to other segments and compared to EPC as a product. ESC is not only used quite often, but it is particularly used by professional buildings owners, who are operating many objects. This is typcial for the German housing sector with a relatively high number of public housing companies, which typically own several thousands of appartements in several buildings. They frequently use ESC to strategically outsource the energy equipment to ESCos. The penetration rate of EPC is generally better in the tertiary sector, where the technical infrastructure for lighting, HVAC and control techniques plays a more important role. Yet the penetration rate is on a comparatively low level, because EPC is still a quite complex product, with quite high requirements especially in the project development phase (e.g. assessment of energy data, energy baseline, typical utilisation and occupancy scheme and a detailed definition of the EPC contract).

Summary and conclusions

The latest market study commissioned by the BfEE showed that the German market for energy efficiency services hosts a large variety of service packages (products) and is developing dynamically, but trends are not uniform across product classes. Demand for energy consultancy and energy performance contracting seems to be stagnating, while interest in energy management services as well as energy supply contracting is rather large. The methodological challenges encountered pertain to each market segment and will need to be addressed further in future projects.

The Market for Energy Audits and Energy Consultancy slightly decreased compared to 2012. But energy consultancy remains the EES product with the highest demand in the German market for energy efficiency services, coming both from SMEs and public households. Still it is driven more by supply than by demand and therefore characterized by a high level of competition. Governmental funding programs remain crucial for the energy consulting market. In total in 2015 an estimated number of between 420,000 and 460,000 energy consultancies and audits were performed. The market volume for energy consultant services in 2015 was between €450 and 486 mn. If further energy consulting services are added, the market volume is estimated between €1 and 1.2 bn. Although hourly rates for consultants have risen throughout the last years, costumers of residential building consultancy seem to be very price-sensitive and competition is high so prices for consultancy for residential buildings remain low.

The market for energy management services, software and technology has been growing significantly over recent years and service suppliers expect further dynamic growth. The market volume of around €0,2 bn is driven by the expansion of smart metering and remote services, in liaison with improved opportunities derived from DSM and the use or sale of renewable energy. While regulation motivates especially larger companies to systematically tap their energy efficiency potential through the adoption of EMS, smaller companies tend to opt for solutions that are tailored to their specific needs and interests.

With a total volume of 7 to €8 bn of annual turnover (of a total market of around €9,8 bn), Energy Contracting is the largest market segment of all EES products. It has the longest tradition of all EES markets, which started in the early 1990s. Early market development activities were mainly driven by the so called 'Energy Supply Contracting'. On the other hand, a variety of manufacturers of building technologies, automation and control equipment companies have extended the scope of services to the so called 'Energy Performance Contracting' (EPC). After a decade of two-digit growth, the growth rate recently slowed to the one-digit rates. The future market prospects are generally positive, while EPC is still remaining in a market niche, probably due to the complex product and the comparatively high preparation effort. This is why the BfEE has recently established a support scheme for EPC project identification and project development.

METHODOLOGY

The methodological mix has proven appropriate for the study of the complex energy efficiency services market. Several challenges to the observation and evaluation of the energy services

market remain regarding the appropriate scope and the level of formalization.

The most significant issue is the clear determination of actual (and potential) branches of EES providers. While the reliability of the estimates regarding the total number of suppliers of the various EES products was improved, it is still not sufficient. Significant brain power will have to flow into the enhancement of the concept to capture the supply side of the EES market and to generate even more reliable figures regarding the market volume.

Scope

One fundamental challenge is to balance consistency and adequacy of the monitoring, considering budget restraints and the lack of alternative data (i.e. energy efficiency services are not specified in the nomenclature of economic activities and companies do not have to give statistical information about energy efficiency services). Therefore, several aspects, such as the needs of the public sector or larger companies (demand side) and the realities of craftsmen on the supply side were not included. Effort was put into establishing the universe of the providers of energy efficiency services through interviews and determining relevant codes in the nomenclature of economic activities. Still, several groups of suppliers are underrepresented.

Going forward, a consideration of larger companies is envisaged. Larger companies present a relatively huge potential market as research has shown that company size matters immensely for energy efficiency service take-up. The use of online queries could be elaborated to better capture groups that are too large to be covered through standardized interviews (e.g. craftsmen). The telephone interviews on the demand of SMEs showed that indeed large differences exist between different branches, while few regional disparities were discovered. The interest and openness for energy efficiency services among households, however, varied considerably between regions in Germany. The next study will therefore not strive to reach representativeness at subnational regional level for SMEs.

Standardization vs. accuracy

While the study built upon product definitions established in a process that ensured extensive input from stakeholders on the supply and on the demand side of the market, they are not (and cannot) cover the reality of everything that is being offered on the market. The lack of standardization of what certain energy services actually entail remains an issue. Given the observed dynamism of the market, it could be argued that definitions are futile and academic in the bad sense. However, the definitions helped as they provided orientation and created common ground for discussions and interviews. If experts identify major trends in products that are not adequately covered by definitions, the definitions could be further developed.

Continuous improvement of the methodology through learning will, of course, generate better results. Given the complexity of the task, however, some insights regarding the development of the market can only be gained if data is collected regularly.

The authors would like to express special thanks to Ruth Offermann.

Ruth Offermann was an expert for energy services and the project manager for the Prognos and Ifeu project team.

It was Ruth's initiative to hand in the abstract for the paper for the eceee Summer Study 2017. In October 2016 Ruth was run over by a truck at the age of 32 years.

We'll all miss her dearly.

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