Size matters – and so does comparable performance data

Dipl.-Volksw. Stefan M. Buettner
EEP – Institute for Energy Efficiency in Production
Nobelstrasse 12
70569 Stuttgart
Germany
stefan.buettner@eep.uni-stuttgart.de

Dipl.-Wi.-Ing. Diana Wang
EEP – Institute for Energy Efficiency in Production
Nobelstrasse 12
70569 Stuttgart
Germany
diana.wang@eep.uni-stuttgart.de

Prof. Dr.-Ing. Dipl.-Kfm. Alexander Sauer
EEP – Institute for Energy Efficiency in Production
Nobelstrasse 12
70569 Stuttgart
Germany
alexander.sauer@eep.uni-stuttgart.de

Keywords

data, indicators, evaluation, barriers, behaviour, industrial energy saving, realistic baselines, energy efficiency index, barometer, values

Abstract

The *Energy Efficiency Index of the German Industry* (EEI) describes a path for evidence-based decision-making on energy efficiency for companies, policy makers and financiers. This is highly relevant: more than half the GHG reductions that need to be tackled through energy efficiency to fulfil the Paris Agreement will need to come from industry and would also considerably strengthen energy productivity and hence competitiveness (IEA 2016).

To make this possible, it is essential to switch from a 'watering can' approach to an 'understanding the demand side' one. The EEI builds the foundation for shaping policies, and business models that take account of the needs, values and realities of key industrial sectors by reflecting businesses' perception of energy efficiency opportunities and (potentially lacking) policies. It allows specific comparisons across 27 economic sectors and the 4 company sizes (as defined by EC 2003). With the *Barometer*, this systematic is currently being extended and prepares the ground to objectively assess, inform and boost to accelerate energy efficiency as a whole.

This paper gives an overview of the state of energy efficiency in industry and explores the gap between perception and action across sectors and company size, which indeed matters in many aspects. However, it is not always the biggest companies that are the driving force and some topics are just emerging. Do companies see an energy-related benefit for themselves in the flexibilisation of their energy consumption, a higher variability in supply through the integration of power sectors or through new services and business models coming with digitalisation? How can transaction costs and risks be reduced? How do implemented measures actually perform? These are all questions that the EEI is designed to find answers for, based on data from hundreds of manufacturing companies to develop tailored policies and business models that accelerate energy productivity and mitigate climate change.

Introduction

The *Energy Efficiency Index of the German Industry* (EEI) differs from other indicators as it focusses on entrepreneurs' opinions, experiences, expectations and intentions. In other words, the entrepreneurial, business focused, mind-set, awareness and way of thinking are at the centre of the indicator. Its creation in 2013 was in reaction to the lack of "targeted energy efficiency analysis, presented as an index for industry as a whole and especially the manufacturing sector" (Mandel/Sauer 2014). In terms of methodology, the EEI leans on the general approach of the German monthly economic indicator, the *ifo-Index* (ibid).

Across seven semi-annual data-collections undertaken to date in collaboration with Fraunhofer IPA, TÜV Rheinland, the Federation of German Industries and the German Energy Agency, the quality and quantity of data[1] has continuously risen, allowing an increasingly deeper analysis of the data. The

1. In this paper: 2014, n=312, 51 % micro companies, 26 % small companies, 13 % medium-sized companies 10 % large companies; 2015, n=371, 21/24/27/28 %; 2016A, n=637, 15/17/31/37 %), 2016B, n=916, 16/21/29/34 %).

data is gathered from across 27 manufacturing sectors via formal market research (making up on average around 80–90 % of the sample), complemented by online and paper questionnaires: ca. 4,000 companies have been invited to participate via email and ca. 500 paper surveys were distributed each time. In our analysis, we pay particular attention to minimum numbers of companies per sector or size (≥20) before considering them in the sectoral or size analyses. According to EC 2003, the four company sizes are defined by number of employees (1–9, 10–49, 50–249, 250 and more) and turnover (<€2 m, €2–10 m, €10–50 m, >€50 m).

In 2016, the Institute for Energy Efficiency in Production (EEP) built on the success of the EEI and initiated the *Energy Efficiency Barometer of Industry* (EEBI), aside an international version featuring a number of country-versions (Sweden, UK, USA) that are gradually expanded. As these have just launched, the focus is on the robust Germany-specific data. Future papers will include a specific focus on cross-country comparisons.

This paper focuses on issues around current discussions and policy options within the German *Energiewende* (energy transition) and the Energy Union, and sheds particular light on the 'black-box' of the manufacturing sectors' micro-, small-, and mid-sized companies (SMEs). As the Director of Energy Efficiency at the IEA stated during a session hosted by EEP at the EE Global Forum 2016 in Washington D.C., the SME segment is heterogeneous, dynamic, hard to reach, and information about SMEs is lacking (Motherway 2016). Of course, lots of common knowledge applies, such as the impact of economies of scale, and the fact that specialist staff can be found with increasing company size – but EEI's findings shed light on many not so obvious discoveries.

How important is energy efficiency really?

How important is the topic of energy efficiency to entrepreneurs in Germany? The answer is: quite important. As illustrated in Figure 1, in 2016 between 75 % (micro) and 90 % (large) of companies consider energy efficiency to be at least as important as other factors. While the importance is consistently beyond 90 % in energy-intense sectors (e.g. manufacturers of machinery and equipment, chemicals and paper/paper products, rubber, plastics and motor vehicles), the importance drops to a lesser 60 % in the wood- and cork-ware sector (EEP 2016B).

Investments in energy efficiency – when are they made?

At the centre of any energy productivity increase is the willingness to invest in such measures. While the share of companies that do not plan to invest in efficiency measures in 2017 spans from a quarter (large) to nearly half (micro) of companies, the solid share of 40 % of companies across all sizes planning to invest at least 10 % of their investment budget into efficiency measures is promising, with medium-sized companies upfront (Figure 2). Sectoral champion is the paper manufacturing sector (n'=26) with over a third of companies planning to spend 20% or more of their investment budget on efficiency (EEP 2016B).

Asked whether improvements of energy efficiency are a collateral benefit of 'other' investments or result of a purposely made decision, around one third of companies consider energy efficiency as the main reason for their investment decision. However, as seen in Figure 3, there are large differences across company sizes. It appears that the bigger the company, the more likely is energy efficiency the main reason for investment. This is particularly the case for large companies, where more than half of them invest purposely into efficiency rather than through a co-benefit. This could be due to a number of reasons, e.g. tougher cost competition or projects reach required size for dedicated investments easier (cf. transactions costs) in large companies (EEP 2014).

When asked what kind of incentives would encourage them to invest in energy efficiency, companies of all sizes agreed that investment grants would make a difference (see Figure 4). This makes sense, as it directly reduces payback time. Although the direct reduction of investment volume is the largest share for all company sizes, the share size rises with the company size. This means that large companies having more capital/assets prefer investment grants even more than micro companies with less capital. Looking at the attractiveness of the deduction of special expenses, the interest of companies appears to be limited (EEP 2015).

It seems that investment volume is a crucial factor for decision makers. This led us to the assumption that during times of low oil prices and therefore falling energy costs, energy efficiency investments are stopped or postponed. Surprisingly, and as shown in Figure 5, despite the low price of energy and the resulting longer payback times, only few companies postpone energy efficiency projects (between 8 % and 15 %, except micro businesses increasing by size). To the contrary,

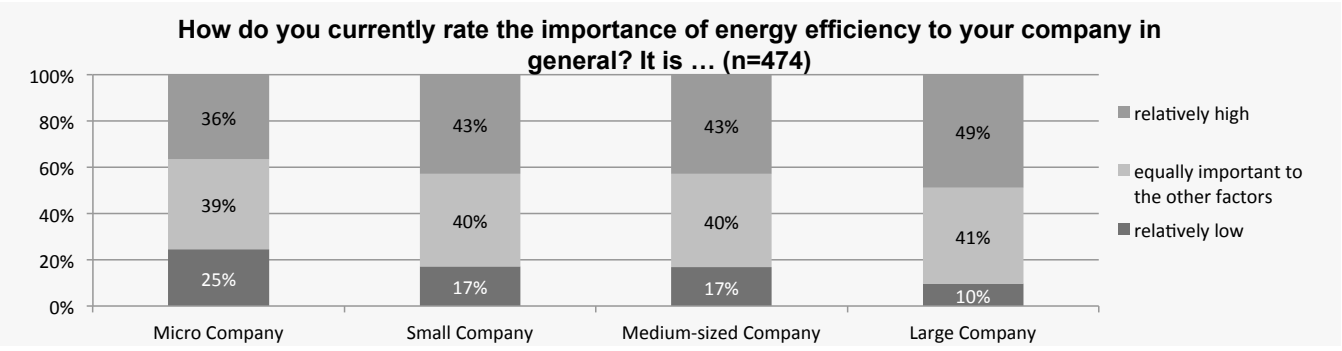

Figure 1. Importance of Energy Efficiency (EEP 2016B).

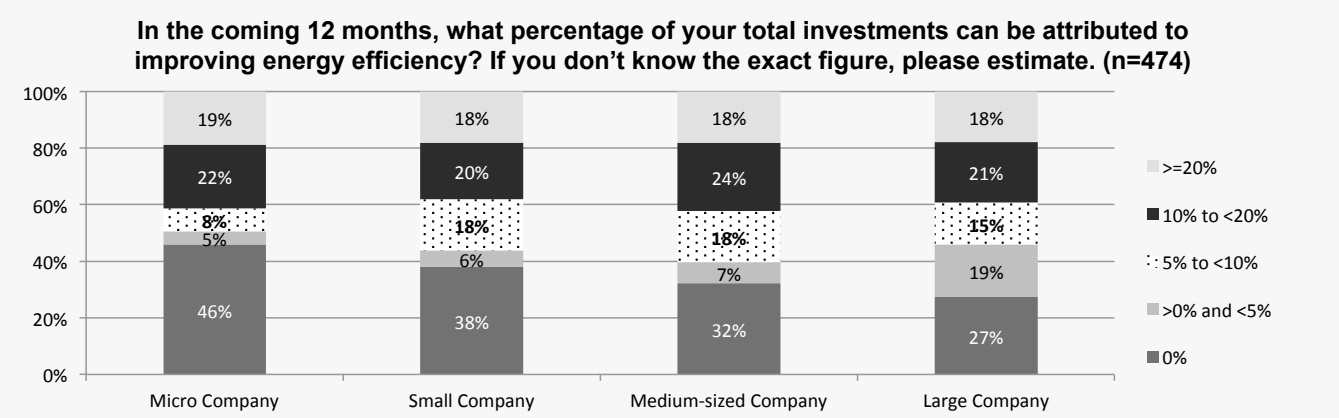

Figure 2. Planned Future Investments (EEP 2016B).

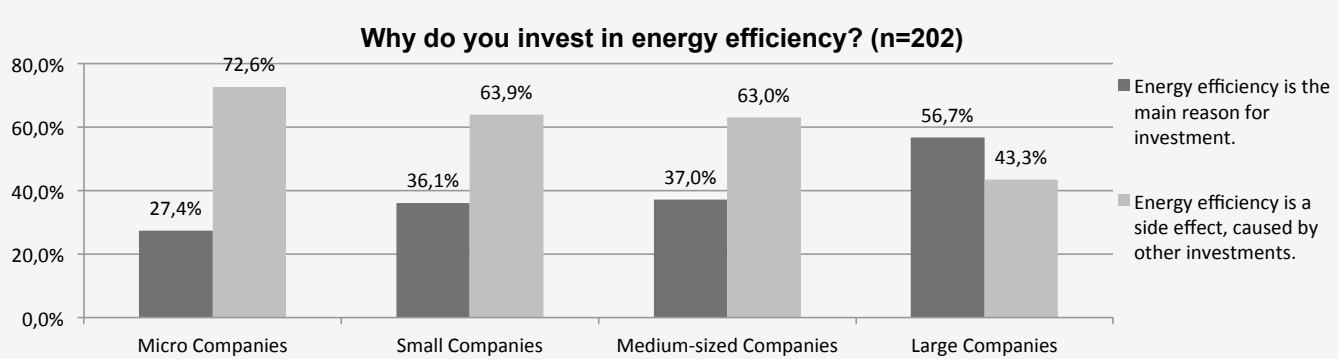

Figure 3. Reason for Investment (EEP 2014).

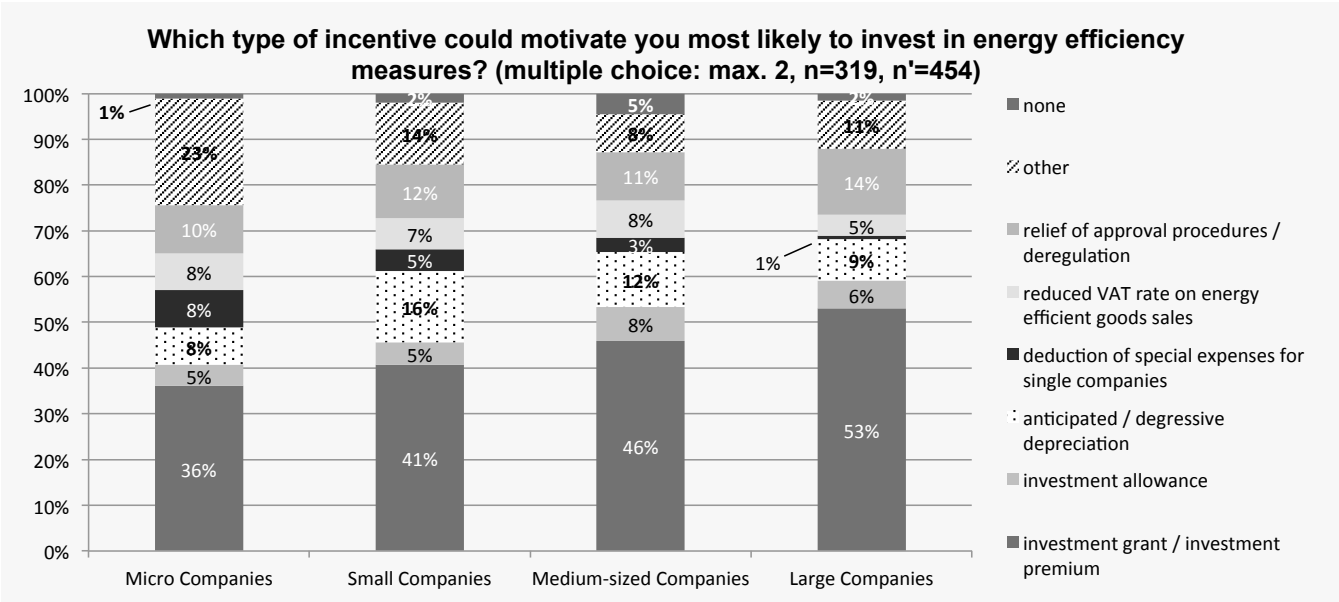

Figure 4. Incentivising Energy Efficiency (EEP 2015).

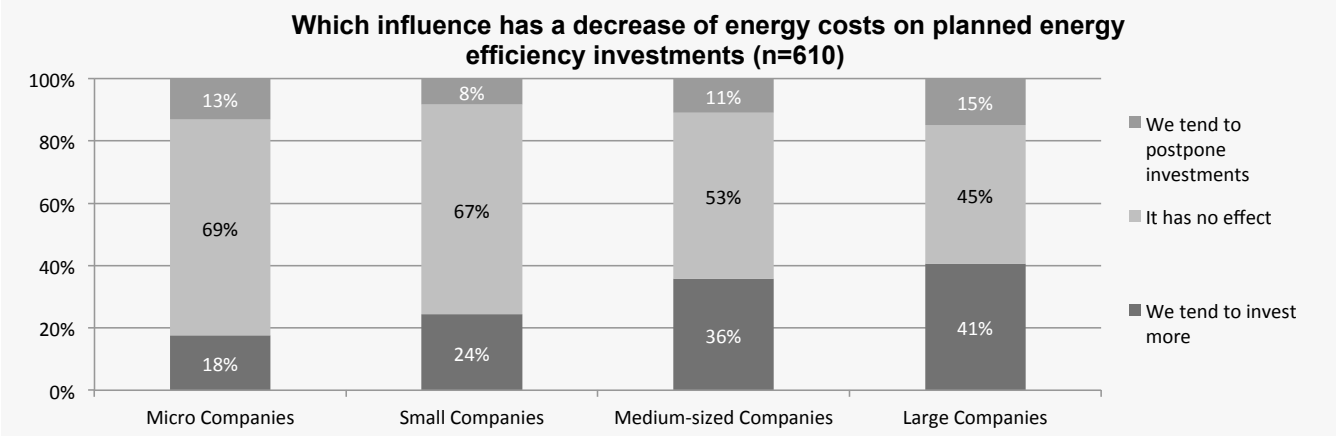

Figure 5. Effect of Decreasing Energy Costs (EEP 2016A).

many even invest more, increasing by company size (18 % to 41 %). Another surprise is the 55 % of companies overall that state that planned energy efficiency investments are not affected: the smaller the company, the larger is the share of those saying falling energy costs have no effects on planned energy efficiency investments. Maybe the share of energy costs of smaller companies is so small that the effect of changing prices is so little that it leads to 69 % (micro companies) or 67 % (small companies) of them sticking to the planned energy efficiency measures. Consequently, only 12 % agreed with our first assumption to postpone planned energy efficiency measures. This means that the assumption that there is a proportional relationship between company size and cost sensitivity is correct. All in all, the results are unexpectedly positive: irrespective of company size at least 85 % state that falling energy prices/costs have no negative or even positive effects on planned energy efficiency measures. Should this be a one-off effect, a possible explanation might be allotted energy budgets that were not required due to low prices, particularly in conservatively planning stock market listed businesses (EEP 2016A).

Practice and engagement drive success

The key to increasing energy productivity in the industrial context is to know what interventions would be beneficial for this ambition. A fair majority across all company sizes knows at least some energy efficiency measures. With decreasing company size however, the share of companies that know of hardly any possible measure increases from one in five (large) to one in three (micro) companies (EEP 2016B).

Whilst most people are probably aware that most home appliances consume stand-by power in order to become operational within short-notice, one often is not aware how much this stand-by consumption adds-up to. This is also the case in industry, where on average 75 % of companies do not know their stand-by consumption – a bit more amongst micro- and small-, a bit less amongst medium and large companies. In a sectoral view this uniformity disappears: whilst only 9 % in the printing and reproduction of recorded media sectors are aware of their production plant's stand-by power consumption, nearly 50 % of the 'other mining and quarrying' sector know – possibly due to different variety in the set-up and diversity of their production machinery (EEP 2016B).

Approaching implementation, around **1 in 5 of all the companies, state their most recent efficiency measure overshot expectations**. Whilst the share of projects that perform as calculated is around 45–48 % in medium and large companies, it is just 36–40 % in micro and small companies (see Figure 6). The share of projects that underperformed due to use and handling is significantly higher in the medium (9 %) and large companies (5 %).

This may arise from the difficulty to get 'the whole team' on board which peaks in medium size companies that are stuck between small and large management structures. This assumption is backed by the fact that technical reasons hit all company sizes equally (8–10 %).

Lacking data is not only an issue for policy makers but also within companies: the rate of micro and small companies that do not assess the impact of implemented measures is twice as high (~22 %) as the one of the larger companies (~10 %).

From a sectoral viewpoint, every third project in the beverages industry over-performs, and technical issues most often concern the printing (17 %) and chemical industry (15 %). Whilst only 2 % of projects in the rubber and plastics industry were not assessed, this is the case for every third project in the wood- and cork ware sector (EEP 2016B).

Analysing the performance of past measures in conjunction with the question whether feasible measures are implemented leads to promising results: **the likelihood to have over-performing projects increases with experience**. Only 45 % of companies that rarely implement known measures have a satisfying outcome, those however that partially or mostly implement known measures reach much better outcomes with 72 % and 84 %, respectively (EEP 2016B).

WHO INITIATES WHO DECIDES?

A key element for any success is initially to get the ball rolling. Whilst this understandably often is the executive management in micro companies, this changes the larger the company is (from 58 % down to 31 %) and in line with a steady-increase of the role of Energy- and Environment Managers (from 11 % up to 38 %). Other roles, such as controlling, production line managers and chief engineers tip off projects in rather similar

figures across company sizes. There are indications of a parallel relationship between micro and small (22:18), as well as medium and large companies (23:15) (EEP 2016B).

From a sectoral viewpoint, there is a large variance of the role of executive management, which is nearly two thirds in the 'wood and cork product'- and only a third in the 'paper manufacture and products' sector. In the latter, employees take by far the most relevant role in initiating energy efficiency projects (17 %), followed by the beverage industry and the manufacturers of fabricated metal products (14 %). Importantly, **employee involvement appears to pay off big time**: the outcome of energy efficiency measures in companies where projects are usually initiated by employees, is better than envisaged nearly twice as often (41 %) than if tipped off by others (between 11 and 24 %). When it comes to decision making, efficiency measures are in majority an executive level task: in 68/69 % of cases with medium and large, and even 81/82 % with micro and small companies. Whilst the decision powers of energy-/environment managers increase with size (from 6 to 14 %), the role of chief engineers and production managers peaks in medium sized companies (18%) (EEP 2016B).

No matter who drives efficiency where and in what manner, the bottom line is that energy efficiency together with renewables serve a greater goal – the transition of the energy system. The question is – how ready are we?

Energiewende – Are companies ready for flexibility, digitalisation and integration of power sectors?

When asking whether flexible energy demand will become relevant in the future, it seemed to split the answering companies: 51 % said yes and 49 % no. As illustrated in Figure 8, the share of those saying yes increases size by size by roughly 10 % points each. In other words the bigger the company the more likely that it sees potentials – however we are still at the beginning of the process and future research into the reasons is needed (EEP 2016A).

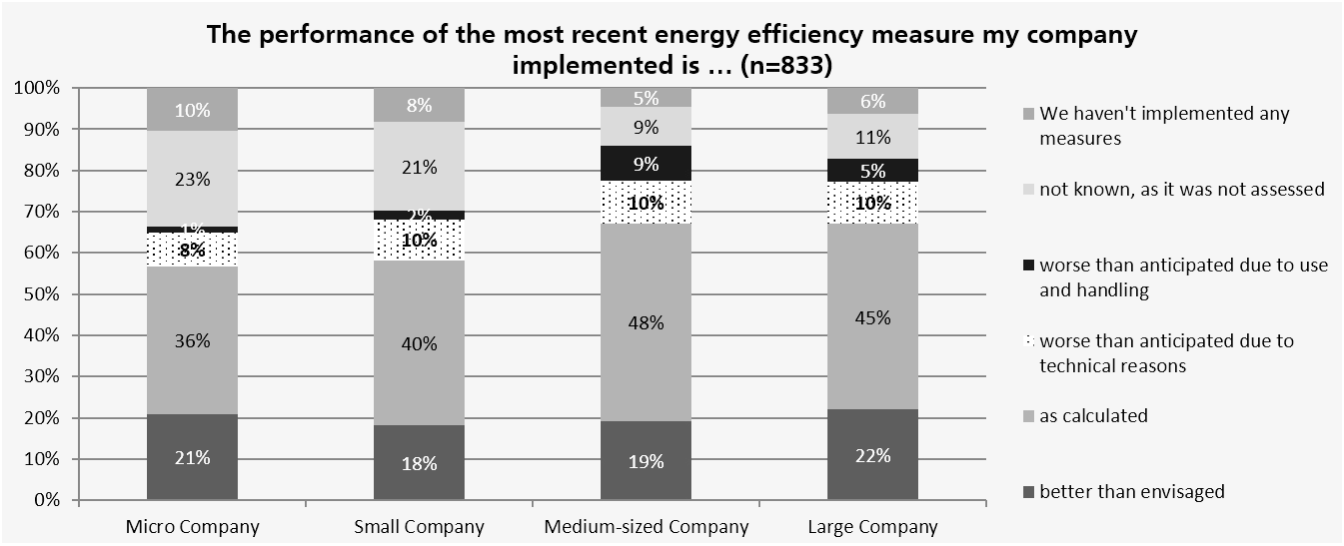

Figure 6. Performance of Recent Measures (EEP 2016B).

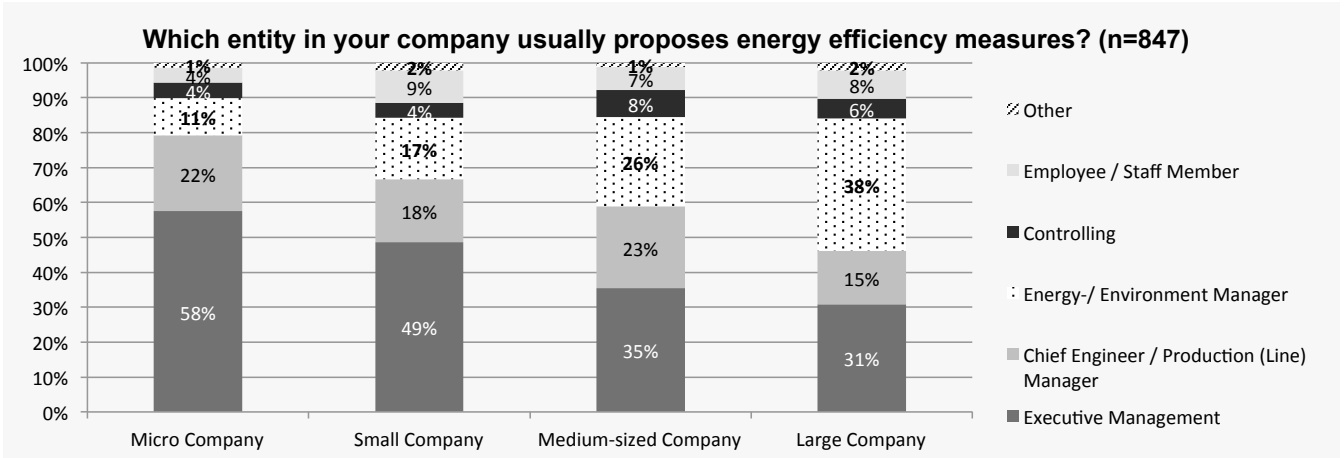

Figure 7. Initiators of EE Measures (EEP 2016B).

Similar views unfold regarding digitalisation (Figure 9): The majority of micro companies doubt digitalisation will help them to become more energy efficient. Amongst small companies, one third shares this opinion while at the same time another third thinks it will become relevant in the future; nearly half (44 %) of the medium and large companies also believe in bigger potentials in the future, only 20 % (medium-sized companies) or 10 % (large companies) are certain that there is no potential for this at all – we are still at the beginning (EEP 2016A).

There is good news for the energy transition: over one third of companies (medium-sized companies even 40%) can imagine to fully replace fossil fuels in their energy demand by (renewable) electricity.

If cost factors were accounted for, this figure could raise beyond 50 %. Particularly large companies raise process-related concerns to reject this option (37 %), and medium sized-companies are most concerned regarding security of supply (14 %) (see Figure 10).

Sectors differ a lot over this question: whilst every second company in the 'rubber and plastics', 'machinery and equipment' and pharmaceutical sector is ready for such a transition, it is less than every fifth one in the furniture sector and the chemical industry. This is typically due to the different specifics of the production process (cost and technical reasons). Power-flexible (bivalent) machinery and support measures could potentially increase the uptake (EEP 2016B).

Discussion

Other surveys or indices addressing the topic energy efficiency for the German manufacturing sectors are rare. Therefore, it is difficult to compare results of the EEI. As already discussed in Mandel and Sauer (2013), there are a few surveys/indices about energy efficiency in Germany, but they often either do not focus on energy efficiency (i.e. KfW *Unternehmensbefragung*, 2014) and are rather from the viewpoint of companies in the energy sector (i.e. *Branchenmonitor* of DENEFF) or have the goal to assess the energy transition process in Germany in general, like the *Energiewende-Index* of McKinsey or the BDI-*Energiewende-Navigator*. Upcoming topical issues referring to effect of low prices, digitalisation, and integration of power sectors (sectoral coupling) presented in Figures 5,

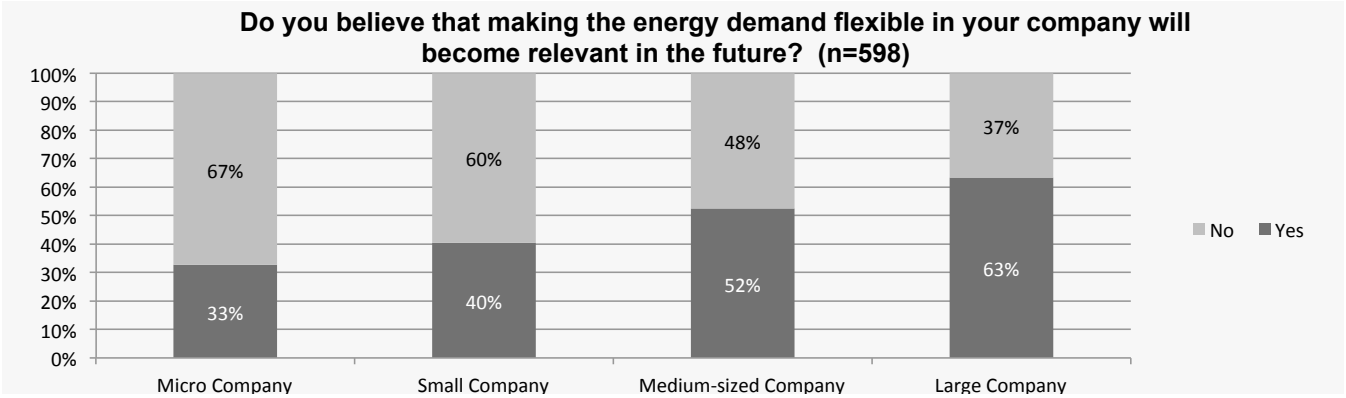

Figure 8. Flexibilisation (EEP 2016A).

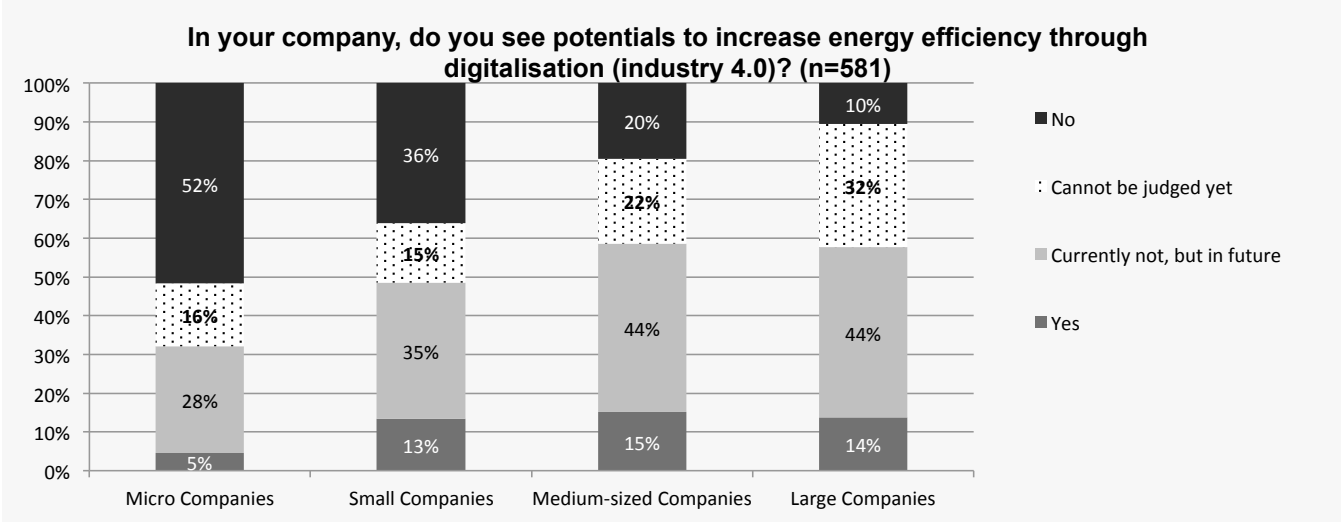

Figure 9. Digitalisation (EEP 2016A).

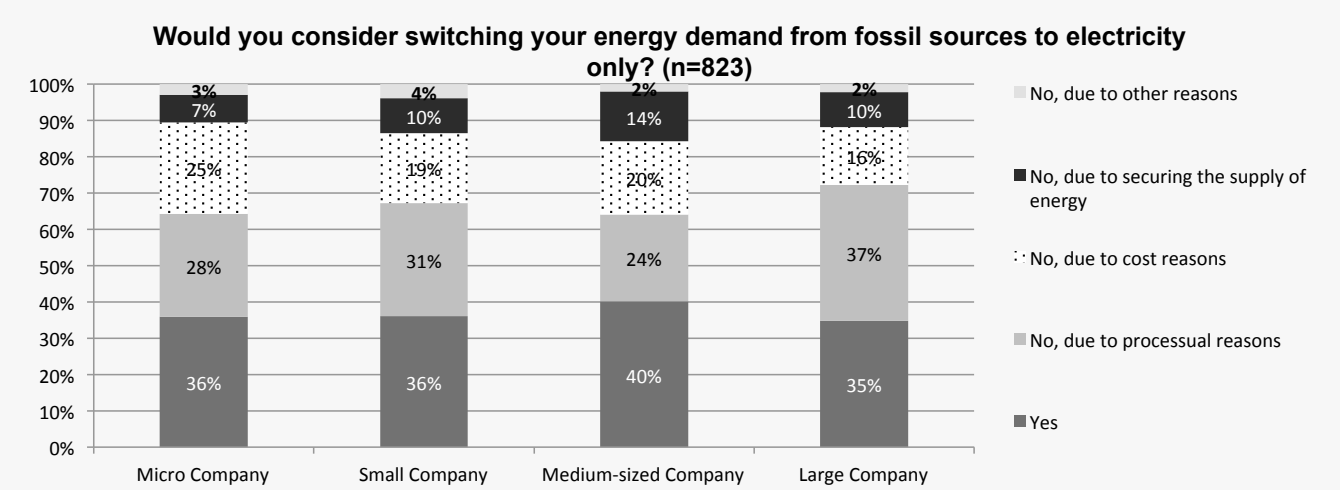

Figure 10. Integration of Power Sectors (EEP 2016B).

8–10 are not reflected from a demand-side perspective, but can at times be found in more depth from the energy sectors' point of view (e.g. Celron 2017). More general results can be found on the importance or drivers/barriers of energy efficiency, albeit with no time series. Like in Timilsina et al. (2016) for industrial companies in Ukraine, the importance of energy efficiency is very high, but more than a quarter of them do not plan to invest in the next five years. Those results seem to be similar to those of EEI although a direct comparison with EEI is not possible.

Conclusion

The analysis described in this paper shows that opinions, intentions and actions around energy efficiency differ a lot across company sizes, but often increasing or decreasing by size. The topics of flexibilisation, digitalisation and sectoral coupling are gradually emerging, but it is too early for many companies to determine prospects pursuing these: whilst flexibilisation is an option the larger a company is, not much can be said yet for efficiency potentials of digitalisation, and despite a third of companies being open to a fuel-switch towards electricity-only, particularly large companies are hindered to consider this due to processual reasons.

We have found that decreasing cost of energy rarely negatively affect planned investments and that efficiency gains are the investment motivation for in majority large companies; whilst all sizes of companies are most appealed by incentives in the format of investment grants, the larger a firm, the more this applies.

Practice and engagement drive the success of measures – the likelihood to have over-performing projects increases with experience and implemented measures proposed by staff appear to over-perform twice as often as measures initiated by any other group. In smaller companies the share of projects not assessed for their impact is twice as high as in the larger ones. Underperformance due to use and handling is practically only an issue for larger companies. What potentials lie in the reduction of stand-by consumption is, however, an unknown for most companies – irrespective of size.

Even though energy efficiency plays an equal role in many companies, there is the need to find out about the reasons why not more measures are undertaken and why businesses do not take the paths that do accelerate action. This would inform what is possible and how.

This paper has just scratched the surface of what is possible when looking closely at the industrial demand-side. Keeping this in mind, future work will be looking at structural relationships and a deeper reading of the data to inform decision making on the one hand. On the other hand, a further expansion of the data set, both within Germany and across the globe is needed to allow deeper analysis and cross-border sectoral comparisons.

References

BDI (2014) (Hg.) *BDI-Energiewende-Navigator 2014*, Berlin. 2014.

Celron (2017) *„Marktstudie Power-to-X" Expertenbefragung zu Chancen und Risiken der Sektorenkopplung für den Energiesektor*, Berlin 2017.

DENEFF (2016) Deutsche Unternehmensinitiative Energieeffizienz e. V. (DENEFF) (Hg.) *Branchenmonitor Energieeffizienz 2016*. Berlin, 2016.

EEP (2014) Institut für Energieeffizienz in der Produktion, Universität Stuttgart (Hg.): *Der Energieeffizienz-Index der deutschen Industrie. Umfrageergebnisse 2. Halbjahr*, Stuttgart, DE, 2014.

EEP (2015) Institut für Energieeffizienz in der Produktion, Universität Stuttgart (Hg.): *Der Energieeffizienz-Index der deutschen Industrie. Umfrageergebnisse 1. Halbjahr*, Stuttgart, DE, 2015.

EEP (2016A) Institut für Energieeffizienz in der Produktion, Universität Stuttgart (Hg.): *Der Energieeffizienz-Index der deutschen Industrie. Umfrageergebnisse 1. Halbjahr*, Stuttgart, DE, 2016.

EEP (2016B) Institut für Energieeffizienz in der Produktion, Universität Stuttgart (Hg.): *Der Energieeffizienz-Index der deutschen Industrie. Umfrageergebnisse 2. Halbjahr*, Stuttgart, DE, 2016.

EC (2003) European Commission, *Annex: Definition of Micro, Small and Medium-Sized Enterprises Adopted By The Commission*, in: Official Journal of the European Union, Brussels, 20.05.2003, L 124/39

IEA (2016) International Energy Agency (Hg.): *World Energy Outlook 2016*. Paris: OECD, 2016.

KfW (2014) (Hg.) *Unternehmensbefragung 2014*, Frankfurt/Main, 2014.

Mandel, J., Sauer, A. (2014). *A New Energy Efficiency Index for the German Manufacturing Sector*, In: International Symposium on Green Manufacturing and Applications (ISGMA 2014), pp. 123–130.

McKinsey (2017) *Energiewende-Index.* https://www.mckinsey.de/energiewendeindex, last checked 14/03/2017

Motherway, B. (2016): *Accelerating Energy Efficiency in Small and Medium-sized Companies* In: Energy Efficiency Global Forum 2016, Washington D.C., 2016.

Timilsina, G.R., Hochman, G., Fedets, I. (2016) *Understanding energy efficiency barriers in Ukraine: Insights from a survey of commercial and industrial firms*. In: Energy, 2016, Volume 106, pp. 203–211.

Acknowledgements

Establishing the *Energy Efficiency Index of the German Industry* would not have been possible without the continuous support of the Heinz und Heide Dürr and the Karl Schlecht Foundations. Aside the companies that participated, we further thank our founding partners, as well as our regional partners. This thank also extends our reviewers and to Energy Efficiency in Production (EEIP), the Edinburgh Centre for Carbon Innovation (ECCI), the Alliance to Save Energy (ASE) and the University of Linköping, who are founding partners of the *Energy Efficiency Barometer of Industry*. We also very much welcome the support of our increasing number of regional and country partners (16 to date), helping us to increase numbers and extending the Barometer to more and more countries in their native languages.

The **data collection** for the German **EEI** runs in **April** and **October** each year (www.eep.uni-stuttgart.de/index), the **Barometer** from **April – June** and **October – December** (www.eep.uni-stuttgart.de/eeei/). More information, as well as previous results of both, the Index and Barometer can be found on our website (http://www.eep.uni-stuttgart.de/eei/index.en.html).