Energy efficiency networks: latest developments in Germany and in the world

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Abstract

Energy efficiency networks (EENs) have established themselves as a firm fixture in the global energy efficiency landscape. At least 21 countries and all continents except Australia have experience with energy efficiency networks to this point. The authors count 1,333 EENs worldwide, with Germany and China far ahead of other countries in terms of absolute numbers. Next, this paper offers insights from the monitoring of the German Initiative Energy Efficiency Networks, set up as a voluntary measure within the framework of the National Action Plan for Energy Efficiency in 2014. To date, 272 EENs have registered under this programme. The results of the accompanying monitoring are represented separately for different levels: that of networks, that of participating companies and that of individual energy efficiency measures implemented. Across these different levels, a large heterogeneity in terms of the main parameters such as energy and CO_2 savings can be observed, highlighting the diversity of participating companies and the contexts they operate in. Also presented are the factors which seem to contribute to the successful or less successful operation of the networks. Finally, the paper offers a short discussion on the operational and political choices faced by the potential future initiators of an energy efficiency networks initiative.

Introduction

The network idea dates back to the 1980s, when a number of companies in Switzerland joined forces to implement energy efficiency measures. With the implementation of 30 Learning Energy Efficiency Networks (LEEN) as part of a pilot programme of the German Federal Government between 2009 and 2013, the approach of using moderated networks as a platform for the development of operational energy efficiency measures finally found its way into Germany. Since the implementation of the Initiative Energy Efficiency Networks (IEEN) in 2014, the global landscape with regard to energy efficiency networks (EENs) has undergone major changes.

First, the interest of countries across all continents in this approach is growing rapidly, and at least 21 countries have now implemented EENs, half of which have done so in the last five years. An up-to-date overview of the situation is provided in this paper. Secondly, some countries are far beyond a pilot phase and have already implemented large-scale programs. This paper presents an overview of the programmes implemented in China, Germany, Switzerland, the USA and Sweden. China and Germany – with around 500 and 400 implemented EENs respectively – are clearly the leading economies and together account for 70 % of the estimated number of EENs in the world. Very little information is available on the energy efficiency networks in China. Information on the energy efficiency networks in Germany has only been published in German. To fill this gap, this paper will present a more detailed insight into the EEN programmes in both countries, including the impact of the programmes.

One specific characteristic of the German networks is the voluntary character of the underlying initiative. This leads to several challenges in the evaluation and monitoring of such a programme, which are discussed in this paper.

What is an energy efficiency network?

An energy efficiency network can be described as a structured, moderated and temporally limited (e.g. 2–4 years for the German IEEN) exchange of knowledge and experience between companies, with the aim of facilitating the implementation of energy efficiency measures (Figure 1). The first step typically is to identify the energy saving potentials in the companies which comprise the energy efficiency network. Individual energy efficiency measures are used to set an individual, non-binding saving target. Next, internal and external energy professionals meet at regular intervals to discuss energy efficiency and possible measures and, if necessary, involve external experts with specific areas of expertise. This gives the participating companies access to knowledge, good practices and first-hand experience and helps them justify the necessary investments within the company. Different types of EENs have established themselves, e.g. regional, sector-internal and for large companies with many sites, company-internal EENs. The evaluation of previous pilot projects indicates that networks can significantly accelerate the implementation of effective energy efficiency measures in the participating companies.

Energy efficiency networks worldwide

Due to the successful demonstration and implementation of the EEN concept in Switzerland and Germany (Durand et al. 2018), many countries in and outside of the European Union (EU) have shown interest in this innovative approach. However, there exists no single global monitoring or database of the EENs implemented across the world. Previous work was carried out to provide an overview (Durand and Damian 2019). The data presented in Figure 2 includes the latest available data from Germany and also Algeria, where the first EEN was launched in November 2019.

Over the past 30 years, EENs have been implemented in at least 21 countries worldwide. All continents apart from Aus-

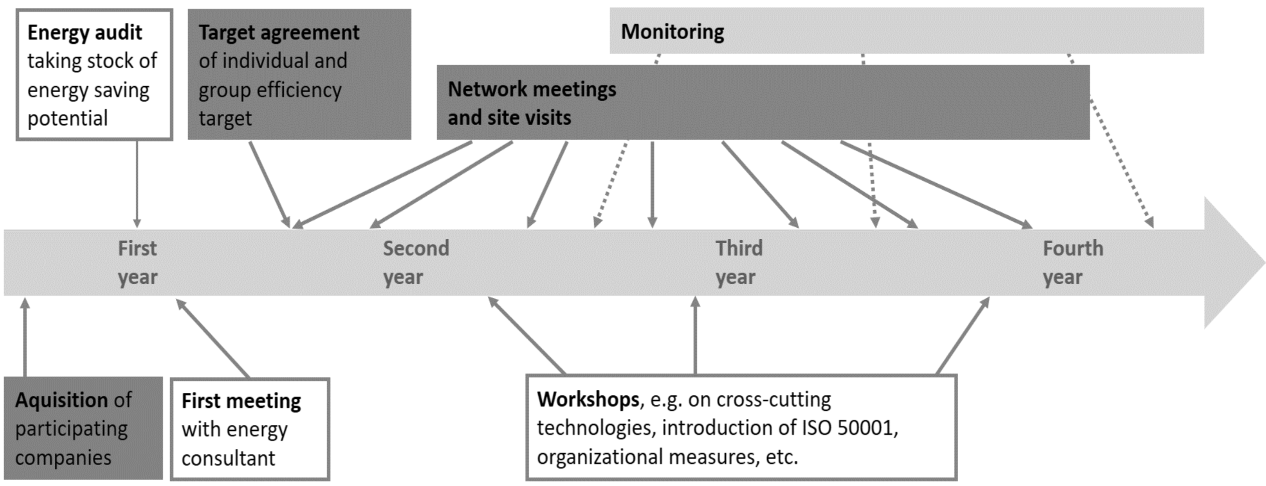

Figure 1. Typical implementation steps of an EEN. (Source: Durand and Damian 2019, based on IPEEC 2017.)

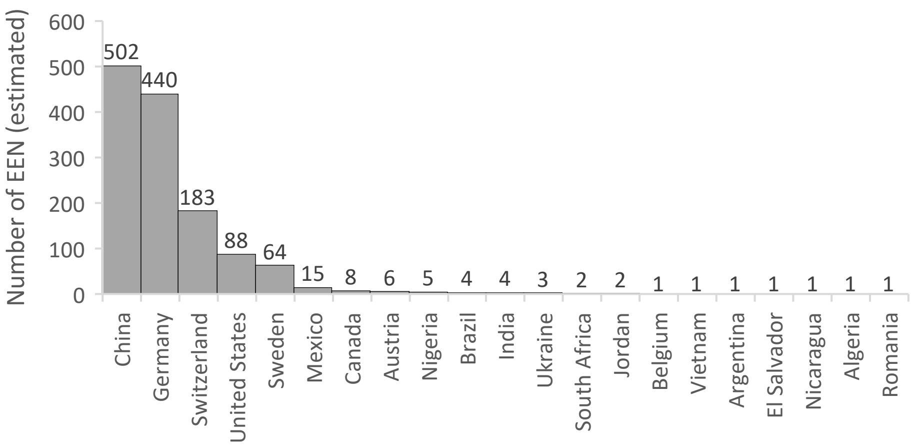

Figure 2. Estimated number of EENs in each country. (Source: Based on Durand and Damian 2019.)

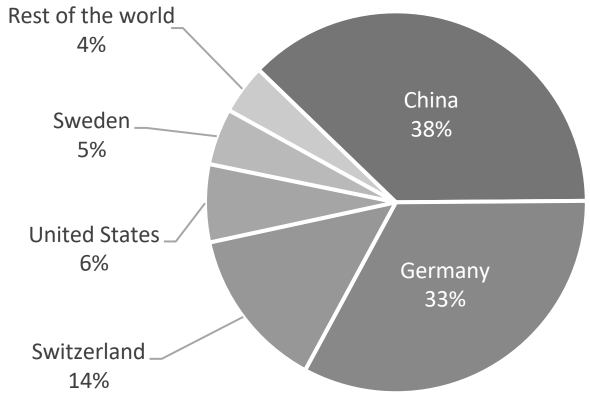

Figure 3. Share of the estimated number of EENs in each country. (Source: based on Durand and Damian 2019.)

tralia currently have EENs in operation. However, the geographic distribution is heterogeneous, as shown in Figure 3.

In total, an estimated number of 1,333 EENs has been implemented worldwide. The figures include all EENs launched at any time until this point and therefore include EENs that have concluded and are not in operation any longer. Assuming that on average, 10–15 companies participate in each EEN, the total number of companies that have been a part of an EEN ranges between 13,000 and 20,000. The presented figures do not take into account the EEN concept applied to municipalities, which is popular in some countries, including Germany.

China is the country with the highest number of implemented EENs (38 % of the worldwide total), followed by Germany (33 %) and Switzerland (14 %). The other 18 countries combined account for only 15 % of the total global number of EENs. The reason for the dominance of the aforementioned three countries is that a national or at least regional strategy to facilitate the deployment of EENs has been elaborated and implemented. However, the approaches in different countries vary substantially:

- Switzerland has implemented a "target agreement" policy (Zuberi et al. 2020) and exempts EEN participants from the carbon tax (EnAW 2016);
- In Germany, the Government signed a voluntary agreement with 22 industry associations to implement 500 EENs (BMWi 2014). More information on results of the Initiative Energy Efficiency Networks is given later in this paper;
- In China, the State Grid Corporation of China (SGCC) initiated the implementation of EENs in three economic regions (Changzhou, Chengdu and Kunshan), since EENs were considered an effective instrument for Demand Side Management (IPEEC 2017).

Sweden also has a fair number of EENs, thanks to its National Energy Efficiency Network Program for SMEs (Strömvall 2018). In North America, utilities have supported the deployment of Strategic Energy Management Programs and have recently enhanced the concept with a cohort approach, which was then assimilated to the EEN concept. In other countries, the concept of EEN is typically in a pilot phase, often with support of development aid agencies such as the German Society for International Cooperation (GIZ). Some countries – like India – seem to have experimented with the concept early (2002–2003) but without a follow-up. In Mexico, where more than 15 EENs have been launched to date, a national rollout with a target of 90 to 150 EENs is in the pipeline, as a concept similar to the German IEEN is being considered (Quezada 2019).

Insights from the monitoring of the German Initiative Energy Efficiency Networks

INITIATIVE ENERGY EFFICIENCY NETWORKS

Within the framework of the Integrated Energy and Climate Programme (IEKP) and the Energy Concept adopted in 2010, the German government has set itself ambitious long-term energy and climate policy goals. By 2050, for example, greenhouse gas emissions are to be reduced by 80 % to 95 % compared with 1990. Energy productivity is to be increased by an average of at least 2.1 % per year. In addition to further expansion of renewable energies, increasing energy efficiency will play a central role in achieving these long-term goals. With the adoption of the National Energy Efficiency Action Plan (NAPE) in 2014, the German government has put together a comprehensive package of measures and declared energy efficiency to be the second main pillar of the energy system transformation.

With a target contribution of 75 PJ primary energy consumption and emission reductions of 5 Mt CO_2-eqv. per year by 2020, the IEEN is one of the key measures of the NAPE. Designed as a voluntary instrument that relies on participating companies implementing economically viable energy efficiency measures, the German Federal Government and the 22 leading trade and industry associations agreed on the goal of establishing a total of 500 EEN by 2020. 272 networks have been registered as of the reporting date of this report (IEEN 2020).

The joint agreement between the Federal Government and the associations stipulates that the EENs operated within the framework of the IEEN will undergo an independent monitoring, including random checks to verify whether the reported energy efficiency measures have indeed been implemented by the companies. Each EEN is monitored only once.

While in general, different formats of EENs (e.g. regional, sector-internal, company-internal) exist with regard to the number of participating companies, duration, the target set (energy savings and/or CO_2 reduction) etc. (Durand and Damian 2019), there is a set of minimal requirements that an EEN has to fulfil in order to be able to register with the IEEN (BMWi 2014):

1. It was founded after 3 December 2014;
2. It has a duration between 24 and 36 months (deviations upwards are possible);
3. It consists of at least 5 companies located in Germany;
4. It is supported by qualified moderators and internal or external energy consultants;
5. It has defined a common energy saving target within the first 12 months of operation, and;
6. Takes part in the monitoring process.

The stakeholders involved in the monitoring – the Federal Ministry of Economic Affairs and Energy (BMWi) as the contracting authority, the independent Monitoring Institute consisting of adelphi and Fraunhofer ISI as the contractor, and the IEEN Steering Committee – agreed that the monitoring should be conducted at an advanced stage of the respective network in order to be able to better assess the results, including the energy efficiency measures implemented. Accordingly, it was decided that every network is to be monitored in the last year of its duration. By the end of 2019, three monitoring rounds have been conducted. The first round included all networks that concluded by 31 March 2018, the second round the networks that concluded by 31 December 2018, and the third round the networks that concluded by 31 December 2019. In order to accommodate the challenges posed by the complex real-life environment in which the EENs operate, they can ask for the monitoring to be moved into the next round if necessary.

The monitoring is intended to verify if the respective EEN fulfils the minimal requirements of the IEEN and can therefore be recognised as having participated in the initiative and contributed to fulfilling its targets. It also determines the effectiveness by documenting and assessing the plausibility of the reported energy savings and greenhouse gas emissions reductions. It further gathers additional data on the participating companies and energy efficiency measures implemented to enable the insights into the operation of EENs. Finally, it enables Germany to fulfil its reporting obligations within framework of national and international commitments to climate protection.

RESULTS AT THE LEVEL OF NETWORKS

In the first round of the monitoring, 33 networks which concluded no later than 31 March 2018 were prompted to participate in the monitoring. 21 of these were able to submit the necessary data in time to be included in the first annual monitoring report, and all have been able to do so by the time the third monitoring report was published in December 2019. In the second round, further 39 networks which concluded no later than 31 December 2018 were prompted to participate in the monitoring; 18 of them submitted their data in time to be included in the second report, along with additional four from the first round, bringing the total number of networks included in the second annual report to 43. In the third round of the monitoring, further 53 networks which concluded no later than December 2019 were prompted to participate in the monitoring, and 30 were able to send their data in time to be included in the third annual report, along with additional 10 from the second round. In total, 125 EEN have been prompted to participate in the monitoring in the first three rounds; 87 of these have submitted the data in time to be included in the third annual report. In total, four EENs have been dissolved before their planed conclusion date due to different factors. Further six EENs have not been able to document the energy efficiency measures implemented by the participating companies or the resulting energy savings; the main factors were typical operational challenges known from the business environment, e.g. key staff change in combination with insufficient documentation. These six networks are still counted as having participated in the initiative, without contributing any energy or emissions savings towards its targets.

The 87 networks evaluated in the third annual report on average saved 31.3 GWh of final energy, 40.0 GWh of primary energy (taking into account only the non-renewable part) and 11.7 kt of CO_2 annually (Table 1). The majority of the participating companies bases their reported energy savings on the calculations performed during the audit carried out to determine the energy saving potentials which also serve as the basis for decision on which energy saving measures will be implemented.

The savings are unevenly distributed among the networks: the difference between the 10^{th} and the 90^{th} percentile corresponds to a factor of about 300. The median and mean values for final energy, primary energy and CO_2 savings differ by a factor of about 6. The ratio of final and primary energy savings derived from the individual measures stands at 1.28. This means that for every kilowatt-hour of final energy, 1.28 kilowatt-hours of primary energy are saved. This value is plausible and corresponds to the value expected in the various projections and ex-ante estimates. It should be noted that due to the increased share of savings of natural gas, with a comparatively lower primary energy factor, this ratio has decreased compared to the second annual monitoring report where it stood at 1.37.

The distribution diagram (Figure 4) shows a wide range of savings achieved at the network level. The distribution is clearly right-skewed – a relatively small number of networks achieve comparatively very high savings.

On average, the 87 networks included in the third annual report achieved 111 % of the targets reported to the Monitoring Institute (Table 2). The reported network targets of the 87 mon-

Table 1. Reported savings per network (source: Barckhausen 2019).

Savings per network [MWh/a or t CO_2/a]	Total	Mean value	Standard deviation	Fractile values				
n = 87				10 %	25 %	50 %	75 %	90 %
Final energy saving	2,726,367	31,338	73,665	287	1,141	4,687	25.627	85,356
Primary energy saving	3,481,248	40,014	84,386	441	1,504	7,510	37,550	125,467
GHG savings	1,017,178	11,692	23,158	153	477	2,421	10,668	37,893

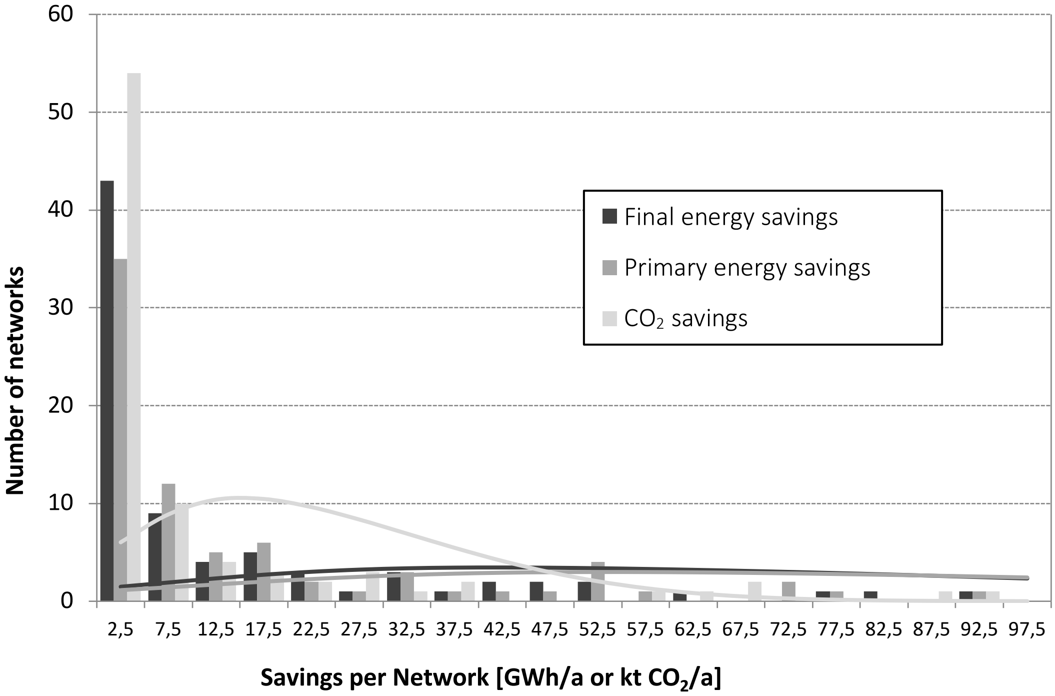

Figure 4. Distribution of savings at the network level (n=87). Illustrated range: 0–100 GWh or kt CO_2/a. Seven (final energy savings), five (primary energy savings) and one (CO_2 savings) upwardly deviating observations fall outside the diagram area. (Source: Barckhausen 2019.)

Table 2. Relative target achievement (source: Barckhausen 2019).

Per network [MW/a]	Total	Mean value	Standard deviation	Fractile values				
n = 87				10 %	25 %	50 %	75 %	90 %
Network Target	2,453,166	28,197	61,151	487	1,574	4,720	20,000	100,000
Relative target achievement	111 %	111 %	1,876 %	26 %	49 %	99 %	167 %	269 %
Deviation between objectives and initial report			100%					
Adjusted achievement of objectives			111%					

itored networks averaged 28.2 GWh of final energy saved per year.

The 111 % relative target achievement already takes into account the correction factor which describes the development of the average network target during the network operation. This development can be observed by comparing the target submitted to the IEEN administrative authority (operated by dena, the German Energy Agency) within the first 12 months of the network operation and the value reported during the monitoring to the Monitoring Institute. For the 87 networks included in the third annual report, it stands at 100 %, meaning that on average, they did not update their targets. However, individual networks did so in order to respond to the changed circumstances, for example, if the duration of the network had been extended or if one of the participating companies decided to leave the network. Altogether, four networks have updated their targets to a degree deemed substantial.

Looking at the distribution of the relative achievement of targets across the networks in Figure 5, it is apparent that there are some outliers both upwards and downwards, but the results here are less heterogeneous than for other parameters. The difference in target achievement between the 10th and 90th percentile of networks corresponds to a factor of about 10. Half of the networks achieve at least 99 % of their savings target. A quarter of the networks surpass their target by 57 %. The distribution of goal achievement is relatively symmetrical at the level of the networks compared with other results; a slight right skew is noticeable.

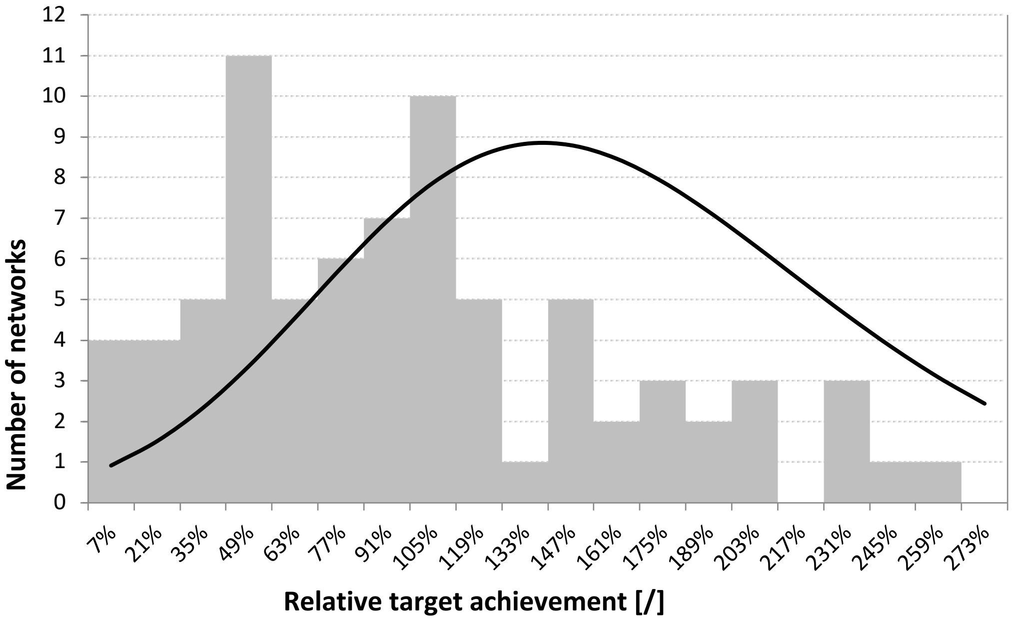

Figure 5. Distribution of relative target achievement at the level of networks (n=87). Illustrated range: 0–280 %. Six observations deviating strongly upwards fall outside the diagram area. Two of them were not taken into account when drawing the distribution curve as the distortion would have been too strong. (Source: Barckhausen 2019.)

Table 3. Savings per company (source: Barckhausen 2019).

Savings per company [MWh/a or t CO_2/a]	Total	Mean value	Standard deviation	Fractile values				
n = 549, n(n.a.) = 399				10 %	25 %	50 %	75 %	90 %
Final energy saving	1,772,686	3,229	14,207	6	37	217	999	5,003
Primary energy saving	2,185,181	3,980	16,340	10	60	355	1,401	6,952
GHG savings	617,046	1,124	4,491	3	17	109	399	1,900

RESULTS AT THE LEVEL OF COMPANIES

948 companies participated in the 87 networks evaluated in the third annual report. Due to the preference for a high degree of anonymity on the side of some of the participants, the networks were given the option of not indicating any correlation between companies and the individual energy efficiency measures they implemented. This was made use of by 20 networks with 213 companies. Of the 735 companies to which individual measures could be assigned, 552 companies (75 %) implemented at least one measure. On average, 3.73 measures were implemented per company.

The companies saved an average of 2,824 MWh of final energy, 3,606 MWh of primary energy (non-renewable) and 1,054 t of CO_2 per year. This top-down analysis refers to all monitored companies and includes those for which it was not possible to allocate individual measures to companies and for which no individual savings could therefore be determined. Looking at the companies which could be linked to the individual measures they implemented (bottom-up, Table 3), the distribution of savings at company level can be evaluated (Figure 6). This shows that the range of savings achieved at the company level in the context of network work is significantly larger than at the network level. The difference in savings per company between the 10^{th} and 90^{th} percentile of companies corresponds to a factor of about 800. The mean value is about 10 times higher than the median. The distribution is clearly right-skewed – a few companies achieve comparably large savings. The wide range of savings achieved reflects the diversity of the participating companies.

In contrast to the distribution in Germany's industry, where SMEs make up the largest share of enterprises in terms of numbers and the share of large enterprises is in the low single-digit percentage range, large enterprises account for 55 % of the companies in the 87 networks included in the third annual report (Figure 7). The share of medium-sized enterprises is comparatively low at 29 %. Small enterprises account for only 16 %. While the number of companies to which the monitoring results refer has increased significantly from 483 in the second monitoring round to 948 in the third round, the distribution by company size class has remained the same.

RESULTS AT THE LEVEL OF ENERGY EFFICIENCY MEASURES

In total, 4,012 energy saving measures were reported within the scope of the monitoring (Table 4 and Table 6). Of these, 3,532 were measures for which the energy savings were possible to quantify. Most of the remaining measures are organizational measures, such as switching off appliances at night or lowering the heating temperature in offices. The measures with quantifiable savings are analysed in the following section.

Looking at the number of measures implemented per network, the average number of measures implemented per network was 40.6 (Table 4), which is a slight increase compared to the second round of monitoring. The median is slightly lower with 31 measures per network, i.e. 50 % of the networks have implemented less than 31 measures and 50 % of the networks have implemented 31 or more measures. This indicates a slight right skew, i.e. the deviation upwards tends to be slightly larger than deviation downwards. The highest number of measures implemented per network is 132; on the other hand, one network has not reported any implemented measures. The network at the 90th percentile has implemented about 10 times as many measures as the network at the 10th percentile; on the other hand, the range for the middle 50 % of the networks is rather slim, with 18 and 53 measures per network.

As depicted in Table 5, on average, each measure has resulted in 786 MWh of final energy, 1,004 MWh of (non-renewable) primary energy and 293 t of CO_2 annual savings. These values

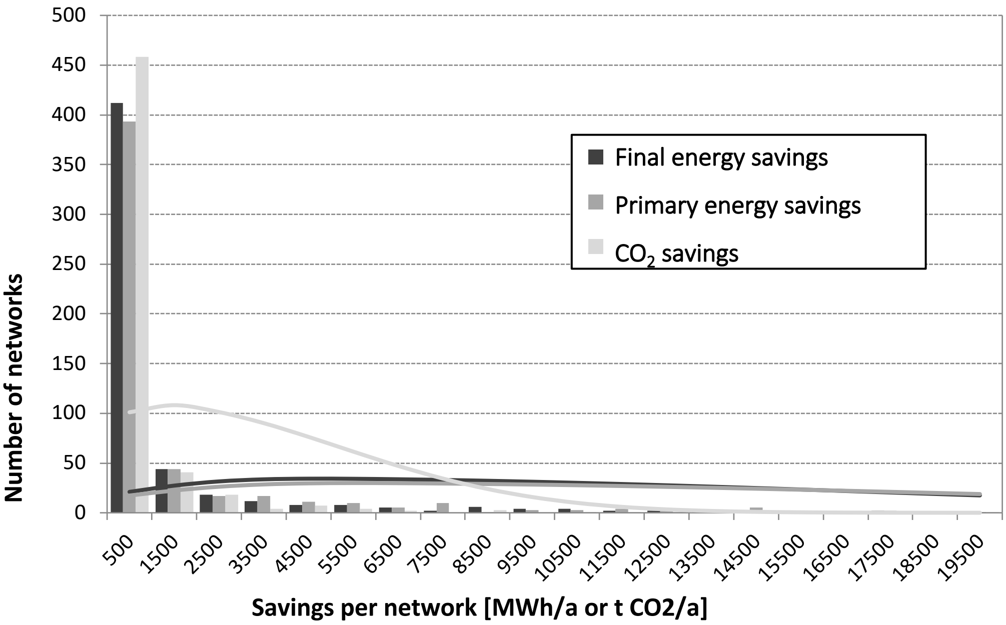

Figure 6. Distribution of savings on the level of companies (n=549, n(n.a.)=399). Illustrated range: 0–20,000 MWh/a or t CO_2/a. 17 (final energy savings), 20 (primary energy savings) or 8 (CO_2 savings) upwardly deviating observations fall outside the diagram area. (Source: Barckhausen 2019.)

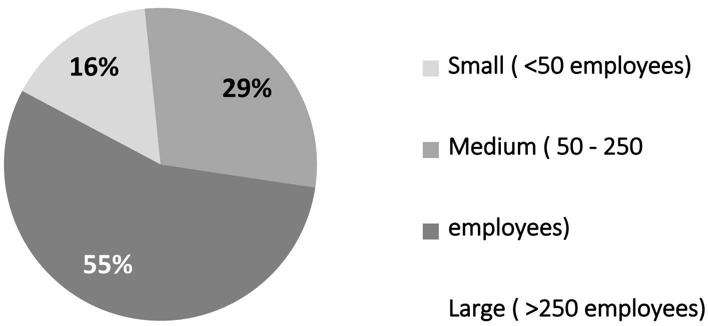

Figure 7. Companies by size (n=628, n(n.a.)=320). (Source: Barckhausen 2019.)

Table 4. Number of measures per network (source: Barckhausen 2019).

Number of measures per network	Total	Mean value	Standard deviation	Fractile values				
n = 87				10 %	25 %	50 %	75 %	90 %
Quantity	3,532	40.6	32.0	10	18	31	53	96

Table 5. Savings per measure (source: Barckhausen 2019).

Savings per measure (MWh/a or t $CO_{2/a}$)	Total	Mean value	Standard deviation	Fractile values				
n = 3,532				10 %	25 %	50 %	75 %	90 %
Final energy saving	2,726,367	786	4,978	2	9	44	199	968
Primary energy saving	3,481,248	1,004	5,462	4	15	70	308	1,377
GHG savings	1,017,178	293	1,541	1	5	22	95	400

have increased only slightly compared to the second annual report. The measures are very heterogeneous with regard to the technologies used, types of measures (new procurement, replacement, expansion, optimisation) and operational conditions. As expected, this results in a wide range of savings. The median is above 15 times higher than the average value; the difference between the 10th and the 90th percentile corresponds to a factor of about 500. Furthermore, the distribution is – just as this is the case at the level of networks and companies – right skewed. A small number of measures achieves relatively high savings (Table 5).

Even among the measures using the same technology, the picture is still heterogeneous (Table 6). The individual measures with the largest final energy savings can be found in the area of combined heat and power. The median of final energy savings for CHP measures is 561 MWh final energy savings per measure and year. In contrast, the measures on the electricity side (lighting and motor-driven systems), but also building measures, show significantly smaller savings per measure.

Figure 8 illustrates the relationship between the number of measures by category and their contribution to the total final energy savings. Aggregated by category, measures in the area of process heat make the largest contribution to the savings in absolute terms, followed by process technology, industry-specific processes, heat recovery, combined heat and power generation, lighting and other measures. This ranking underlines the importance of heat-related measures; nevertheless, lighting also makes a considerable contribution to the total savings due to the large number of measures.

FURTHER FINDINGS FROM THE MONITORING OF THE GERMAN ENERGY EFFICIENCY NETWORKS INITIATIVE

Since the Initiative Energy Efficiency Networks is a voluntary initiative, there is hardly any leverage with which the monitoring institute can motivate companies to participate in the monitoring process. Apart from the prestige, there are few advantages of being recognised as an official participant in the initiative. That is why the monitoring process has been designed in such a way that the companies need as few resources as possible.

Based on additional observations the individual feedback from the networks, both from those who were concluded successfully as from those who have dissolved before the planned conclusion date, certain factors can be identified that contribute to either success (some of which are closely related):

- Commitment and conviction with regard to the topic of energy efficiency both on the side of the participating companies and on the side of the moderator has a strong positive effect in various aspects of the networks, including with regard to the monitoring, where such networks typically provided data of higher quality (in terms of completeness and accuracy);
- Provision of the necessary time and material resources by the companies and moderators;
- Actively engaging with the topic of energy efficiency even before the network was officially established, which contributes to building up the necessary expertise;
- Familiarity with and understanding of basic principles of the concept of energy efficiency networks, such as the involvement of external experts, the importance of regular meetings, thoughtful planning, etc.;
- Early announcing and explaining the details of the monitoring process by the Monitoring Institute, personally contacting by telephone the networks that are due for monitoring, sending the necessary monitoring forms to the networks at an early point to give them enough time to get familiar with them, actively reaching out to the networks to clear any questions with regard to the monitoring process and/or the monitoring forms, providing support documentation such as FAQ, etc.

Table 6. Final energy savings per measure by category (source: Barckhausen 2019).

Final energy saving per measure by technology (MWh/a)	Total	Mean value	Quantity	Fractile values				
n = 3,532				10 %	25 %	50 %	75 %	90 %
Adaptation of operational processes	52,048	867	60	2	8	78	391	2,155
Building envelope (insulation, windows)	20,499	223	92	3	12	27	116	448
Cold	50,202	306	164	7	23	65	209	783
Combined heat and power	190,626	3,738	51	-200	92	561	3,000	15,880
Compressed air	46,766	183	255	4	14	45	138	488
Heating, hot water	138,434	507	273	2	11	53	229	845
Heat recovery, waste heat utilisation	216,054	2,038	106	11	84	213	1,000	4,620
Industry-specific processes	289,739	3,184	91	9	35	300	1,634	8,838
Information and communication technology	6,704	92	73	0	1	5	63	261
Lighting	173,989	170	1,025	2	4	15	62	192
Miscellaneous	150,184	705	213	1	6	36	220	1,400
Motors, drives	36,319	162	224	3	12	40	131	481
Process heat	825,415	4,127	200	1	36	214	1,644	8,296
Process technology	528,579	1,183	447	6	27	107	670	3,010
Training, information campaigns	11,935	519	23	1	4	14	85	802
Ventilation, air conditioning	27,900	149	187	4	12	42	122	414

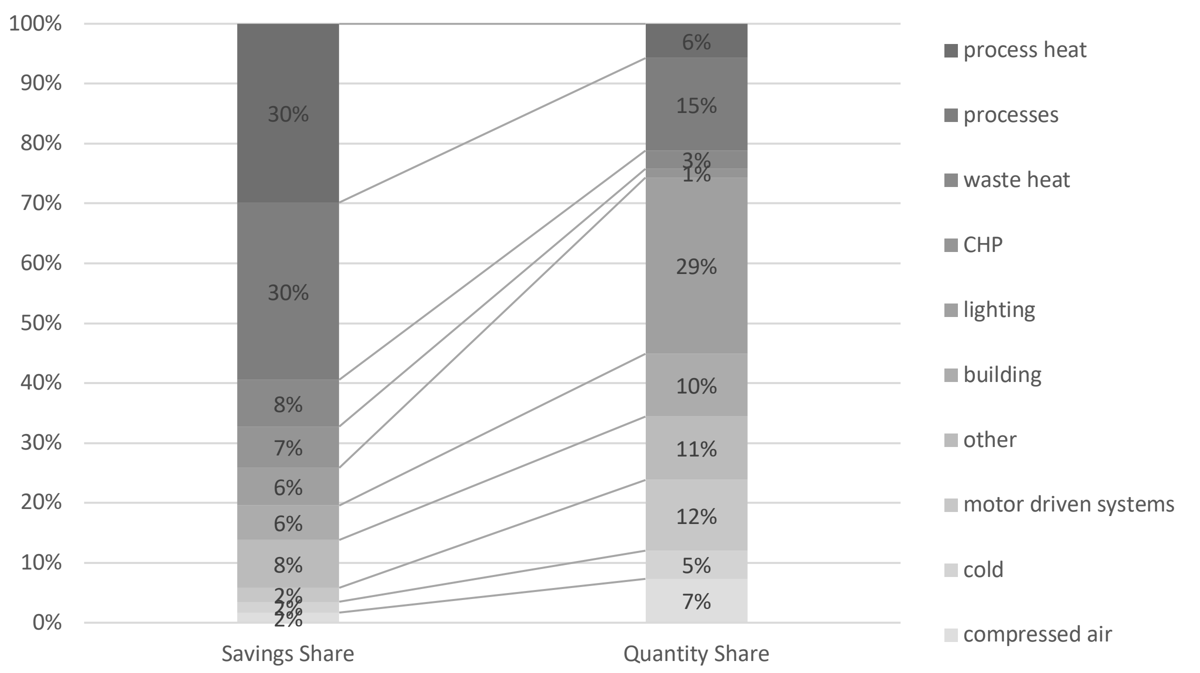

Figure 8. Relative share of savings and measure count by technology (n=3,532). (Source: based on Barckhausen 2019.)

On the other side, factors were identified which typically pose challenges to the networks and can contribute to delays in gathering data or even failure to successfully complete the network and/or monitoring process:

- The typical operational problems associated with the business environment, e.g. lack of necessary resources or expertise, longer absence or change of key staff, insufficient documentation etc.;
- On a few occasions, it has also been pointed out to the Monitoring Institute that participation in the Initiative is voluntary and that value creating activities always take priority in the company.

The participants generally assess the network work very positively and praise in particular the knowledge gained. The majority of the network contacts confirmed that the participating companies value the cooperation in the network, recognise the benefits and would in some cases like to cooperate with other companies in some form after the network has been officially concluded. Despite the fact that considerable effort is necessary on the part of the companies to collect the necessary data, most of them also see the benefits of an external review of their results and feedback that the Monitoring Institute provides.

Summary and conclusion

The concept of EENs, where companies share knowledge and learn from each other's experience has become an important part of the international energy efficiency landscape in the past years. The EEN approach proves to be a good catalyst for motivating companies to increase their awareness of importance of energy efficiency and implementation of both energy management systems as well as energy efficiency measures.

However, there is generally a lack of detailed evaluations of the EEN programmes across the world. Most programmes focus on the voluntary implementation, hence the motivation of companies to participate in evaluation and monitoring is limited.

The authors of this paper recognise two major issues which need to be addressed in the future:

- **The political level:** Programmes facilitating a wide implementation of EENs are still rather rare in the world. Two main tendencies can be observed on the political level. The first is a fully voluntary approach without material compensation as seen in Germany. The second approach is more engaged, as seen in Switzerland or China, where participating in an EEN brings clear additional benefits to the companies, e.g. tax exemptions. Both of these approaches have their strengths and weaknesses: With the voluntary approach, there is no incentive on the side of the companies to break the rules and therefore no need to enforce them. However, there are also limited incentives for the companies to significantly increase their commitment to energy efficiency. In the case of material incentives for the participating companies, there is need for a comprehensive monitoring scheme which may be complex and costly to implement. Choosing the right option or finding the ideal balance for every specific context can be challenging.
- **The operational level:** The concept needs to be adapted to the local context. One of the main challenges in every country will be to transform a successful pilot project into a program me for large deployment of EENs. As Germany's Initiative Energy Efficiency Networks has shown, this instrument is extremely flexible on the level of individual energy efficiency networks and can accommodate companies across different sizes, branches and levels of knowledge of energy efficiency. However, the programme design has to make the right choices with regard to the crucial parameters such as size, duration and others. Support activities by the initiator, be it the government, a trade or industry association or a market actor, can also greatly contribute to the effectiveness of the network. These can be training and/or subsidising the moderators and external experts, facilitating knowledge creation and exchange among different networks, etc.

Enhanced monitoring which goes beyond the effects of EENs such as energy and CO_2 savings and studies the processes, experience of the participants and key success factors within a specific context can provide valuable insights necessary to inform the decisions regarding future energy efficiency network initiatives.

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