Learning Energy Efficiency Networks - Evidence based experiences from Germany

Clemens Rohde, Ursula Mielicke, Lisa Nabitz, Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany
Dirk Köwener, LEEN GmbH

ABSTRACT

Learning Energy Efficiency Networks (LEEN) is a concept developed in Switzerland back in the 1990s. Since then, the approach has been successfully transferred to Germany, France and Austria. With these networks, 10 to 15 regionally based companies from different sectors share their energy efficiency experiences in moderated meetings.

After the companies have formed the network, the process starts with an energy review and the identification of profitable energy efficiency measures in each company. Afterwards the participants decide upon a joint target, which is allocated to the partners according to their efficiency potential.

The subsequent networking process enables a continuous exchange on energy efficient solutions fed by the experiences of the network partners as well as external experts.

The performance of each company is continuously monitored and controlled on a yearly basis. The network operating period is typically from three to four years.

In the 360 participating companies of the publicly funded "30 Pilot Networks" project, approximately 3,600 profitable measures were identified, corresponding to an energy saving potential of more than 1,200 GWh per year, and a CO_2 emission reduction of nearly half a million tons per year. The average internal rate of return of more than 30% demonstrates the high level of profitability.

We will present data acquired in the energy review and monitoring processes of the "30 Pilot Networks" project in Germany. In addition, we'll highlight the role of this LEEN management system within the framework of energy efficiency policy, and discuss how the system can be disseminated so as to establish a successful efficiency strategy for industrial companies.

Introduction

On a national level and as part of the European Union, Germany has rather ambitious energy and carbon savings targets. In Germany the term "Energiewende" meaning "energy transition" is used to describe the transition of the energy system. The "Energiewende" is built on two pillars. The first pillar is an ambitious use of renewable energies, especially in the power sector. The second pillar is an increase of energy efficiency to minimize the final energy demand.

To achieve those targets, the European Union has issued the Energy Efficiency directive, which translates the abstract target into concrete measures. The directive obliges large enterprises to conduct an energy audit every four years. Member states shall furthermore encourage SME to carry out energy audits.

Germany's industry contributes to the final energy demand with an important share of more than 25 percent of the total energy demand. The remaining energy demand is split between private households and transport with equal shares and the services sector with a share of about 15 percent. It is obvious industry has to deliver energy savings if the “Energiewende” is to be successful.

Because the fact that the energy efficiency target for EU member states is currently not legally binding, recent predictions estimate that the EU will not achieve its target of 20 % primary energy savings in the period from 2005 to 2020 (EEA 2013). Binding targets, extending beyond 2020, are very important for the transformation to a decarbonized society. The EU has recently proposed energy and climate policy targets for 2030 (European Commission 2014) of which the energy efficiency target with 27% is only indicative.

Increased energy efficiency is one of two main pillars of the phase of energy system transformation (“Energiewende”) and is a decisive part of the German climate policy. For the German Federal Government, an important target according to the energy concept of 2010 and the “Energiewende” resolutions of 2011 is to increase energy productivity by 2.1 % p.a. resulting in a 50 % reduction of primary energy consumption by 2050 (with base year 2008, BMWi/ BMU 2010). The “Energy for the future” monitoring report of the German Federal Government published in December 2012 and the accompanying scientific report indicate a gap in achieving the set targets in Germany (BMWi/BMU 2012). From a historical perspective, the German industry only decreased final energy consumption by about 1.5 % in the recent years (AGEB 2013). To meet the required targets until 2030 additional efforts are necessary to double the energy efficiency progress.

In 2014, the National Action Plan on Energy Efficiency (NAPE) was published by the German federal government. The action plan adopts and extends the idea of Learning Energy Efficiency Networks by setting a target of 500 operational networks in 2020. This is an ambitious target, which would include more than 6,000 companies participating in networks. The standards set for those networks are nevertheless lower than the standards set in the LEEN pilot project. An evaluation of those activities will show the realized impacts. Within the NAPE, the federal government assumes 75 TWh annual primary energy savings achieved by these networks until 2020, which is equivalent to 5 Mt CO_2-equivalents (BMWi 2014).

Within this paper we will first explain the policy context for industry in Germany to show how the networks are embedded in the broader policy framework. Afterwards we will give an overview of the LEEN concept and present results from the evaluation of the pilot implementation of the networks in Germany.

Energy efficiency policies for industry in Germany

Within the following paragraphs the major pillars of Germany’s energy efficiency policies for industry are described to understand the context in which the LEEN networks are operated. The policy framework is a combination of carbon emission trading with energy taxation and several funding schemes. Only the measures on a federal level are described.

Emission trading

Emission trading in not a specifically German policy, but a European approach with the European Emission Trading Scheme (ETS). The ETS is the first major and by far biggest carbon market in the world. It operates in the 28 EU countries and Iceland, Liechtenstein and Norway and covers around 45 % of the EU's greenhouse gas emissions.

Energy taxes

In 1999 the federal government introduced the eco-taxation ("Ökosteuer") in Germany raising the fuel taxes and introducing a tax on electricity (beside the VAT). To ensure industrial competitiveness, exemptions from this taxation are granted for energy intensive industries as well as industries in strong international competition. To comply with EU competition regulations, industry has to deliver a service in return to the exemption. This is operationalized by a voluntary agreement with the industry to reduce the energy intensity by 1.3 % per year and a requirement for the individual company to introduce a certified energy management system. This leads to a tremendous increase of ISO 50 001 certifications in Germany with nearly 2,500 certifications in 2013 (compared to 22 in the US) (ISO 2014).

Mandatory energy audits for large enterprises

Since the beginning of 2015, large enterprises are obliged to conduct an energy audit every four years. This obligation is the transposition of the corresponding requirement of Article 8 in the European Energy Efficiency Directive in Germany. Enterprises which have implemented or commit to introduce an energy management system are exempted from the obligation. The guidance note by the federal government explicitly mentions the initial consultation of the energy efficiency networks as one way to comply with the regulation.

Energy audit funding scheme

The German energy audit funding scheme is operated by the KfW, the German development bank. The program supports initial and detailed energy audits in industry as well as the service sector. Intentionally, the scheme was to be funded by the revenues from the CO_2 allowance auctioning. At present due to the rather low CO_2 pricing, the remainder is covered by the general federal budget.

To apply for funding, enterprises must fulfill several criteria.

- As a measure of quality control, the auditor needs to be listed with KfW and certified as energy efficiency advisor.
- The project must only contain advisory elements that can be subsidized.
- The project must not yet have started.

Two kinds of audits are covered by the scheme, an initial as well as a more detailed audit. The initial audit lasts for two days, the detailed audit for 8 days. Subsidy is 80/60 % of the agreed daily rate (max. € 640/480 per day).Only one subsidy per installation can be granted.

From 2008 to 2013 about 25,000 audits have been carried out by this scheme resulting in 1.5 TWh annual energy savings and € 700 m of investments in energy efficiency. The free rider effect has been evaluated to be rather low at 14 %.

The concept of Learning Energy Efficiency Networks

Learning Energy Efficiency Networks (LEEN) is a concept developed in Switzerland back in the 1990s. In Switzerland, companies that reduce energy-related CO_2 emissions within the framework of a negotiated and mandatory target, and undergo an annual evaluation, can be exempted from a steering tax on fossil fuels. Since January 2014 this tax amounts to CHF 60 (or €45) per ton CO_2. The steering tax, introduced at CHF 12 in the year 2008, provides substantial support for the network approach (Koewener et al. 2011). Currently 70 networks exist in Switzerland. Since then, the approach has been successfully transferred to Germany, France and Austria.

A LEEN network usually consists of 10 to 15 participants from different sectors, which together determine a network target for increasing energy efficiency. In order to avoid companies not sharing their operational information in the network meetings, they normally come from different sectors, such as the manufacturing industry, the food industry, or health care sector. However, experience in recent years has shown that LEEN networks comprised of companies from uniform sectors can also be successful.

Overall costs for a typical participant are approximately € 35,000 to € 40,000 for a four-year network operating period. These costs cover the 10-12 day energy review, 16 network meetings and three assessments of the monitoring results. Due to the costs of participation, each participating company should have annual energy costs of at least € 500,000 in order to guarantee that cooperation in the network will be profitable.[1] Additional transaction costs may arise for companies, e.g. costs for the internal preparation of data or participation at network meetings. These costs are to be covered by increases in energy efficiency within the company, which is the reason why company's energy costs should not be less than € 500,000. However, energy costs should also not exceed € 50 m, due to the fact that companies with such costs often already have substantial energy technology know-how, and are thus unlikely to benefit from the exchange of experiences as much as companies with energy costs below this level (Mai et al. 2012).[2]

Furthermore, it is important that all participants share a common set of cross-cutting technologies, so as to guarantee an effective exchange of experiences during the network meetings. This common basis is required because of the fact that the learning process of the network as a whole is not served if technologies relevant to only one company are considered. The typical network operating period is about four years. At the end of this period, each company decides whether to prolong the operation of the network. Within the network there are three important positions, each with different competences and responsibilities: (1) the network host, also referred to as the network manager, who is responsible for the initialization and overall organization of the network, (2) the moderator, who organizes and manages the regular network meetings, and (3) the consulting engineer, who is responsible for the energy review, the annual monitoring of each company, and assistance at the regular meetings.

The usual network process consists of three phases. The **initiation phase** (phase 0, see figure 1) involves the initial establishment of the network. During this phase the network manager, designated by the institution initializing the network such as the regional Chamber of Commerce, a municipality, an energy utility enterprise, or a regional industrial association, must undertake the acquisition of companies for the network, run information meetings, and select the consulting engineer and moderator. This phase is shown explicitly in Figure 1, as it is not an easy task to gather approximately 10 companies within a couple of months. To be successful in the network, the companies have to commit to the process; a strong support of the top-management

[1] The costs are sometimes reduced or fully covered if public or private funding is available.

[2] For companies with energy costs below €500,000 there is currently a pilot research project referred to as "Mari:e – Mach's richtig: Energieeffizient!" (Do it right: Be energy-efficient!). The Mari:e project is also based on the LEEN network management system, with a modified approach for smaller companies. In addition another initiative, named "LEEN kommunal" (Municipal LEEN), is tailored to local authorities and focuses, among others, on an energy review of buildings. A subsidy programme for this approach is in force since December 2014.

is crucial. Prior experience with energy audits and management is helpful, but not a prerequisite, as the cooperative helps to overcome the information deficit.

The network process begins with an **energy review phase** (phase 1, figure 1). An energy review is conducted by a trained consultant engineer for each company. The energy review involves a complete technical evaluation of potential energy saving measures and a calculation of the profitability of these measures. Within the energy review, profitable energy saving measures are identified for the whole spectrum of energy use. There is no technological restriction. All departments of the company are part of the review. All of the findings are then put down in a standardized report. The LEEN management system provides tools for profitability calculations. The consultant engineer and moderator must be experienced individuals who have been trained by LEEN GmbH and awarded a LEEN certificate.

The report forms the basis for the company's own program to reduce energy costs. After all of the reports for the companies participating in the network have been completed, two targets for the three- to four-year network operating period are first suggested by the consultant engineer, and then discussed with the participants and jointly determined: one target concerns the progress towards attaining energy efficiency, and the other concerns the reduction of CO_2 emissions. The energy review phase concludes with a joint agreement by all participants regarding the targets for increased energy efficiency and reduced CO_2 emissions. Those targets are usually set as measure based bottom-up targets. In some networks also intensity targets have been used. Especially if one or two companies in the network have a significantly larger energy demand, the target has to be a weighted average. These targets are to be achieved during the **network operation phase** (phase 2, figure 2). Competition among the participating companies resulting from peer pressure regarding the common network target is an important factor which promotes progress towards increased energy efficiency (Jochem et al. 2007). Continuous monitoring by the companies of measures that have been implemented permits the tracking of progress towards energy efficiency and the monitoring of reductions in energy-related greenhouse gas emissions for the company and for the entire network. This monitoring is assessed once a year by the engineering consultant. In order to guarantee an overall performance standard, the LEEN network management system provides various tools such as a data collection form, software-based techno-economic calculation tools available via a joint interface, sample reports including a measure overview, and minimum requirements with respect to the energy review report. The LEEN standard is not an official standard that has been approved by a standardization organization. It is a voluntary quality standard for establishing and running energy efficiency networks. LEEN GmbH, founded at the end of 2009 in the context of the "30 Pilot Networks" project, plays a key role regarding the development of the LEEN standard. This institution is responsible for the continuous improvement of the LEEN standard, based on both empirical data and changing political conditions. For instance, this includes the development and continuous improvement of electronic calculation tools and documents for the foundation, organization and implementation of a network.

The entire energy review and monitoring process is in compliance with the energy review outlined in DIN EN ISO 50001. The compliance has been certified for the following steps:

- energy review (ISO 50001, chapter 4.4.3)
- energy baseline (ISO 50001, chapter 4.4.4)
- energy performance indicators (ISO 50001, chapter 4.4.5)
- energy objectives, energy targets (ISO 50001, chapter 4.4.6)
- monitoring and measurement (ISO 50001, chapter 4.6.1)

- input to management review ((ISO 50001, chapter 4.7.2)

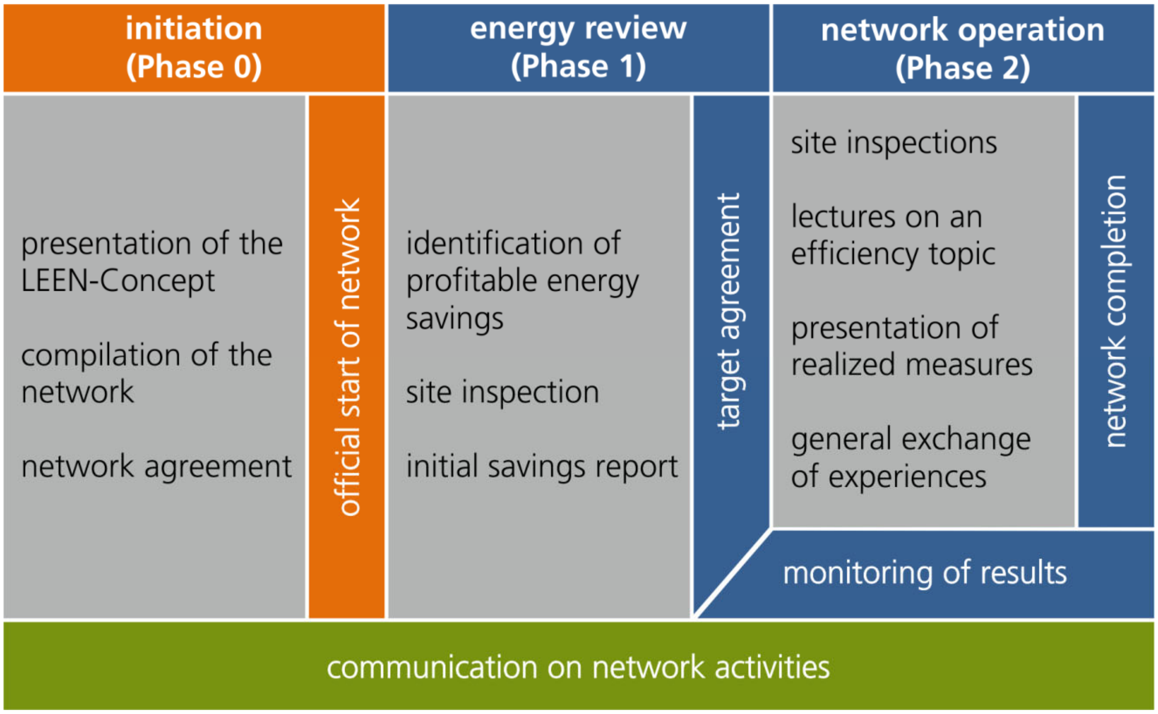


Figure 1: Stages of a learning energy efficiency network.

A core element of LEEN networks are the moderated regular network meetings held three to four times per year (phase 2, Figure 1). These meetings facilitate the integration of the capabilities and skills of invited experts and of the participants as well as the exchange of experiences. Such an exchange can focus on the implementation of saving measures for common technologies such as compressed air systems but also on organizational measures like awareness rising for employees. The participants also report on implemented measures (e.g. difficulties and achievements, and experiences with contractors). These points are particularly valuable for participants, since the information provided is objective, because the speaker is not trying to sell anything and the results are from real applications presented by unbiased peers. The exchange of such information requires mutual confidence among the participants (Koewener et al. 2011). It is this exchange of practical experience and the possibility of utilizing synergies across the network that makes the LEEN networks successful. Finally, after the finalization of the network operation phase, the network participants can decide to continue the process with a new energy review and target agreement.

The pilot project ("30 Pilot Netzwerke")

From 2008 to 2014 a pilot project named "30 Pilot Networks" for the implementation of energy efficiency networks has been conducted in Germany under the lead of Fraunhofer ISI. The project was funded by the Federal Ministry for the Environment.

The participants of the "30 Pilot Networks" project account for total energy costs of approximately €1 bn per year, total energy consumption of more than 15 TWh per year and CO_2 emissions exceeding 5 million tons per year. This is equivalent to the consumption of nearly

1 million households. The sectoral share of the companies is shown in figure 2. Annual energy costs of the companies range from € 150,000 to € 43.5 million.

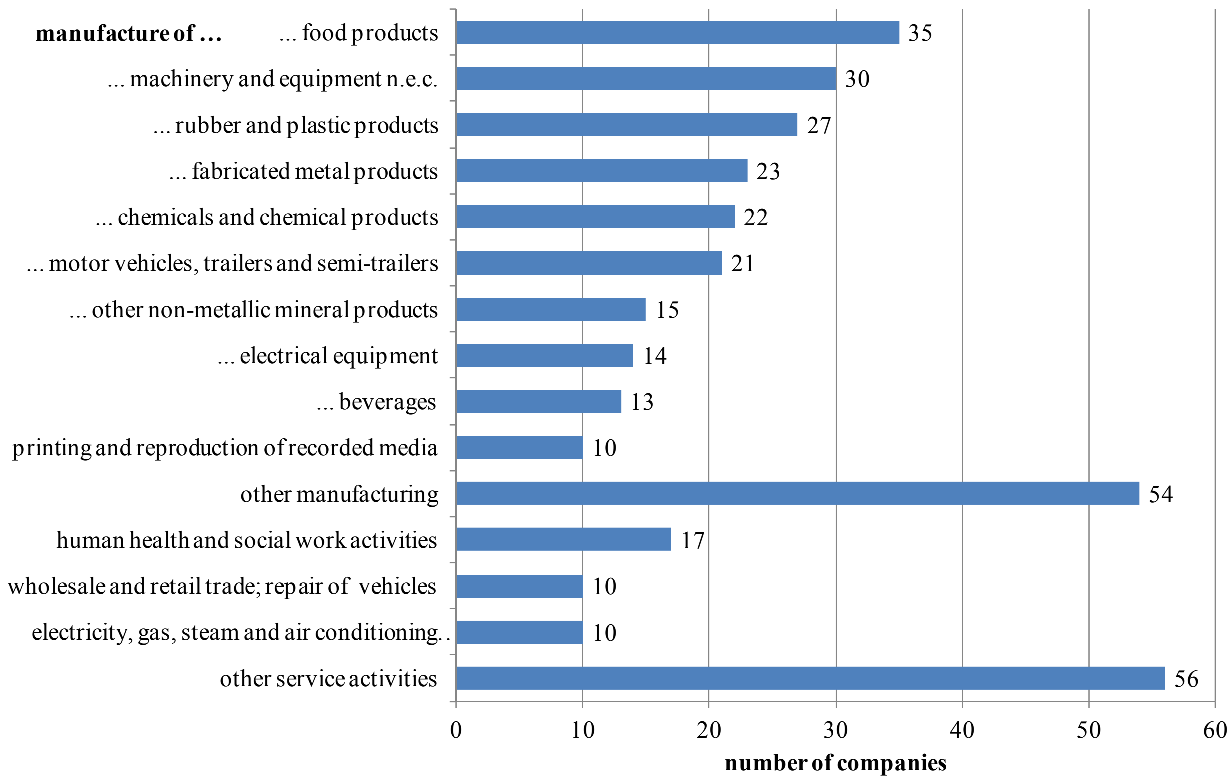


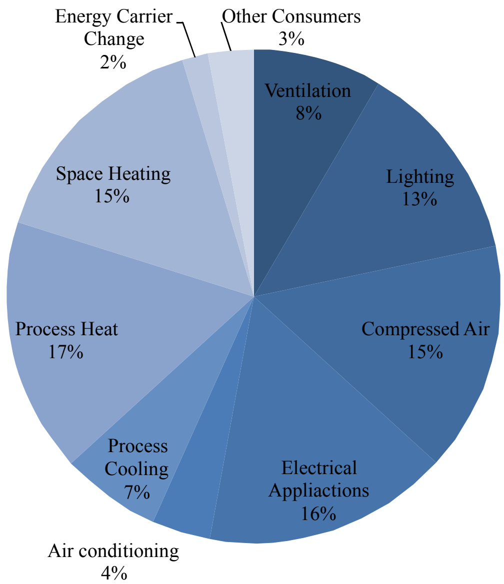
Figure 2: sectoral coverage of network companies

Measures and savings

Due to the inter-sectoral approach of the networks, the implemented measures are clearly focused on cross-cutting technologies. No technological preference can be identified. The average payback-time for the profitable measures is between 2.2 years for the compressed air systems and 4.3 years for air conditioning.

The absolute share by measure type is illustrated in the left pie chart of figure 3. A major share of the identified measures addresses electrical cross-cutting technologies. Yet, more than 30 % of the measures deal with process heat and space heating. Energy carrier change resulting in a reduced energy demand or reduced CO_2 emissions represent only a smaller number of the measures. Measures addressing other energy consumers account for only 3 % of the overall measures.

Not all of the measures are simple and cheap low hanging fruits. Some require a notable investment. The major part (~85 %) of the identified measures requires investments below € 50,000, but 17 % of the measures require an investment above € 50,000. The distribution can be seen in the right pie chart in figure 3.



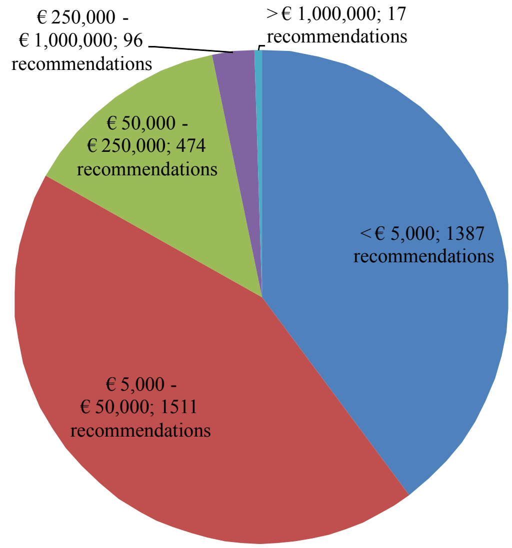


Figure 3: Identified profitable measures and corresponding investments (iRR > 12 %)

The overall savings of the different technologies also vary significantly. Figure 4 shows the different quantiles of the proposed economic measures. Not surprisingly, measures dealing with process heat and energy carrier change deliver the highest absolute savings. On the other hand, those measures require also the highest investments as shown in figure 5.

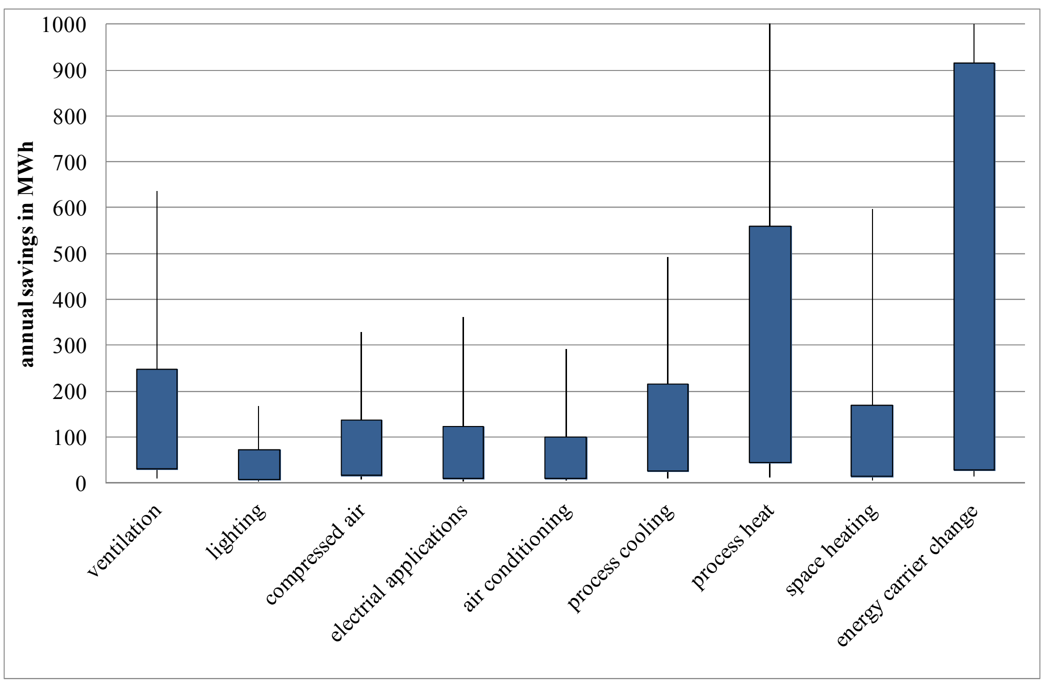


Figure 4. energy savings per measure and technology type (10, 25, 75 and 90 % quantiles)

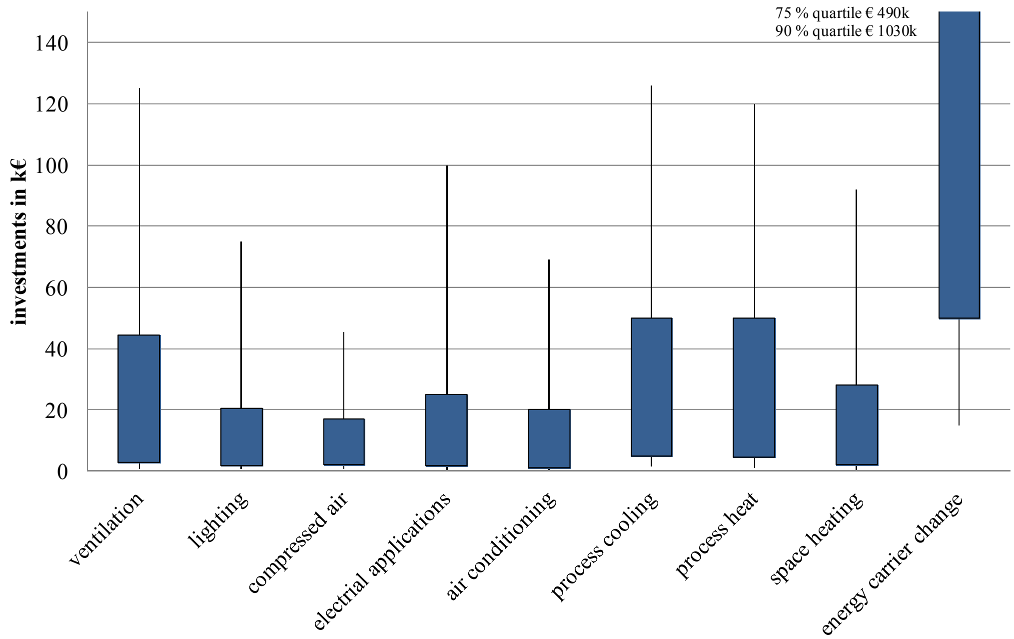


Figure 5. investments per measure and technology type (10, 25, 75 and 90 % quantiles)

Conclusions and outlook

The companies participating in an energy efficiency network realized notable energy savings within the implementation phase. For better comparability, savings are shown as additional annual savings per year in figure 6. Only two networks realized savings below 1 % p.a., whereas the remaining companies realized an increased energy efficiency of 2.1 % p.a. in average. Over the whole implementation period of the individual networks this is equivalent to annual savings of nearly 6 %. The top 3 of the networks realized more than 10 % of annual savings.

Within the evaluation, the participating companies were asked about their experiences with the networks:

- More than 75 % of the companies see high or very high benefits in their network activities, only two percent see very low benefits.
- Likewise, more than 70 % evaluated the expenditure of time required for network participation as “rather low”.
- More than 60 % indicated that contacts gained were used in other situations going beyond the network meetings.
- Around 20 % of these indicated the use of the contacts gained for purposes transcending energy efficiency issues.

During the network meetings different topics were discussed, accompanied by a site inspection allowing participants to see e.g. measures implemented in another company.

- 90 % rated the topics discussed during these meetings and site inspections as good or very good. In particular, viewing realized measures was seen as very useful.
- In terms of the exchange of experiences, more than 80 % rated the network meetings as good or very good.

- The measures identified during the energy review phase fully met the expectations of 80 % of the companies.
- Approximately half of the measures identified were described in sufficient detail to be implemented directly.
- At the same time, almost 80 % of the participants discovered new aspects of energy savings.
- More than 80 % of those surveyed had already implemented straightforward and cost-efficient measures, and
- 90 % indicated that they had implemented or planned to implement cost-intensive and organizationally more complex measures.

The LEEN network concept succeeded in realizing untapped potential:

- Approximately 80 % of those surveyed indicated that without a network some of the measures identified would not have been implemented in the company.

The LEEN network increased the priority of energy efficiency in the companies:

- More than 60 % of those surveyed stated that the network enhanced the attention paid to energy efficiency by company management.

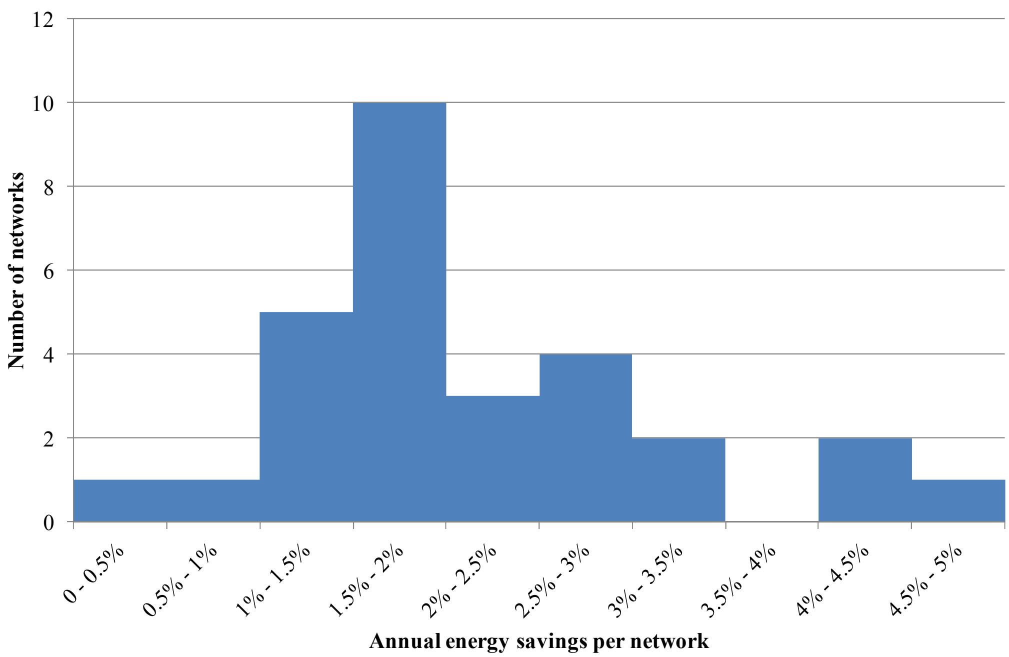


Figure 6. average annual energy savings per network

Within the context of the national energy efficiency strategy of Germany, the networks play an important role for the industrial sector. Nevertheless, the requirements for networks in the National Action Plan for Energy Efficiency (NAPE) are rather low, as only a minimum set of requirements for a network is made. It will have to be observed carefully, whether those networks will be able to deliver the same results as the more elaborated approach of the LEEN networks presented in this paper.

Following the Swiss example, Germany serves as a pioneer with regard to the implementation of Learning Energy Efficiency Networks (LEEN). LEEN networks can serve as an important instrument for meeting the goal of an energy efficient economy. This instrument not only contributes to energy cost reduction and climate protection, but also provides opportunities for domestic manufacturers and installation firms. The network approach will help to reduce the burden on the energy infrastructure, while at the same time minimizing dependence on energy imports (Bradke/Köwener 2012). The idea of energy efficiency networks has already spread to other countries such as Austria and France. With the support of the German Chamber of Foreign Trade and TÜV Rheinland, the LEEN standard is currently being transferred and adapted to the Japanese context. Worldwide dissemination is a conceivable and desirable goal for the near future.

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