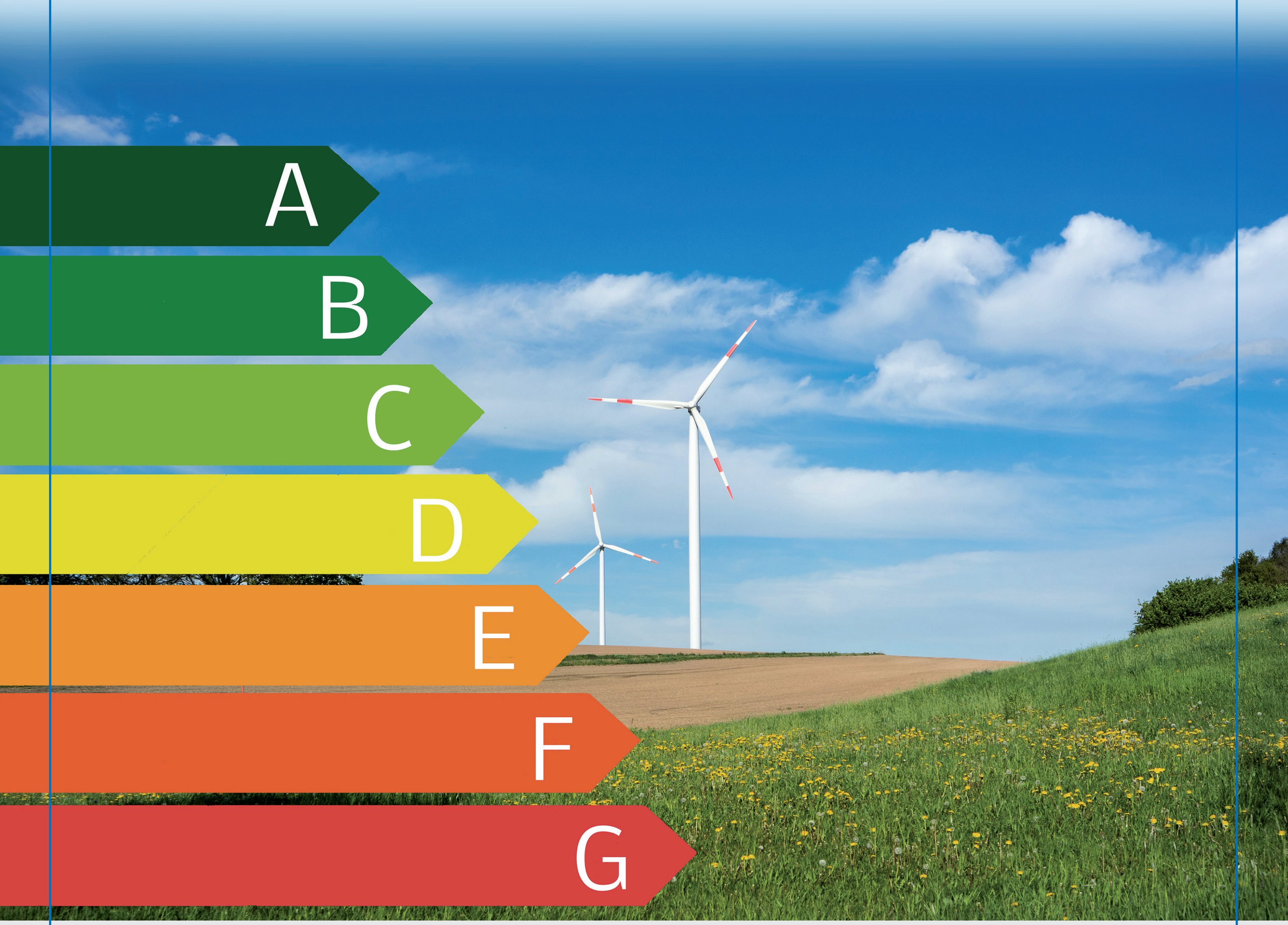
VDE | DKE Roadmap



Electrical Energy Efficiency

German Standardization Roadmap
Version 2

VDE

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CONTENTS

Foreword

New approaches have been taken in the development of this standardization roadmap. For the first time a roadmap has been developed on the Internet in the form of a blog (https://team-sp2013.vde.com/TBINK.EEE_AK_NR/blog). This meant that the roadmap could be viewed on the Internet from an early stage, allowing the public to be actively involved in the communication and consultation processes. Also, various social media channels (XING, LinkedIn, Twitter) were used to address groups of people who have hitherto not been engaged in electrotechnical standardization.

The relevant standards and committees are listed in the annex to each chapter.

1 Introduction

The German Government has abandoned its goal of achieving a 20 % reduction in carbon dioxide (CO_2) by 2020. It was an ambitious goal. Maybe too ambitious. However, it is only an interim goal on the way to achieving the climate protection targets set in Paris. And energy efficiency is one of the most important tools for this.

Electrotechnical standardization has been leading the way here for many years. Significant energy savings have been achieved through increased energy efficiency.

Greater productivity, job creation, reduced air pollution, improved health conditions, increased comfort in our daily lives, reduction of greenhouse gas emissions and cost-effectiveness are just some of the many benefits of energy efficiency.

The objectives of the Roadmap are to take stock of standardization in the field of electrical energy efficiency, including related aspects and framework conditions, and to highlight developments and opportunities for a further increase in energy efficiency and for associated standardization.

The Roadmap shows that there is still considerable potential for saving energy. It is no longer sufficient simply to improve existing standards. Systemic approaches are needed to help exploit the full potential.

Current and expected future technological and other developments also leave room for further energy efficiency improvements, both in and by means of electrical engineering.

Challenges for the standardization of electrical energy efficiency

Given the long-term objective of decarbonization, all technical advances will have to serve the principle of energy efficiency in the smart and integrated energy sector of the future.

The energy transition, renewable energy, smart home and smart grid are changing the world of energy production, distribution and use – and are giving rise to opportunities for using energy more efficiently. Challenges are arising for the standardization of electrical energy efficiency in the following areas, for example:

- **Energy transition**

The market share of renewable energy is rising steadily. Power supply is becoming increasingly decentralized and energy no longer flows only in one direction. Power availability will depend increasingly on whether the sun is shining, or the wind is blowing.

- **Integrated energy**

Electric vehicles, heat pumps and electrode boilers are becoming more and more common in the areas of transport and energy, if still rather haltingly in some cases, thus replacing fossil fuels with electrical energy.

- **Digitalization**

(smart grid, smart home, smart metering, the "Internet of Things", etc.

The resulting "smart world" is giving rise to new ways of reducing energy consumption and of optimizing various aspects. Smart, connected devices use their sensors to perform their tasks in an optimized and energy-efficient manner. However, "smartness" itself requires energy.

- **Systemic approach**

Optimizing energy efficiency requires high levels of efficiency in the individual devices, but also a systemic approach. Standards are desirable which take an integrated approach towards electrical energy efficiency, e.g. in the case of grid-connected photovoltaic systems also taking into account inverters, battery storage, heat pumps, e-mobility charging stations and so on.

2 Norms and standards

Above all else, standards provide a firm basis for technical procurement. They ensure not only interoperability in use, but also protect the environment, equipment and consumers. They provide a future-proof basis for product development and support communication among all participants by ensuring uniform terms and concepts. They define the framework and thus offer a degree of investment security. The development process for standards takes place at various levels (national, European, international) in different organizations. So-called "interested groups" (companies, commercial enterprises, universities, consumers, skilled trades, testing institutes, authorities, insurance companies, etc.) send their experts to working groups in a standardization organization where the standardization work is organized and conducted.

The intention is for standardization to be carried out "openly", ensuring that there is enough space for the development of innovative systems which are distinguishable from those of the competition. Excessively narrow specification could prevent future innovation. Prompt stabilization of the concepts through a consensus and research-based standardization process is also essential for rapid implementation. The ultimate goal is therefore to anchor all the key requirements for uniform technical functioning and applicability in national and international standards.

2.1 Norms

In Germany, a distinction is made between "Normung" and "Standardisierung". "Normung" refers to the scheduled operations and activities for the creation and implementation of regulations used to harmonize products and services.

The purpose of Normung is to avoid technical barriers to use, both nationally and internationally, through harmonization and standardization within the circle of stakeholders, and to promote the exchange of goods and services. Other consequences of Normung are rationalization, compatibility, performance and safety in the use of products and services. Normung is especially applicable if the same or similar items are used in many different contexts in different places by different groups of people. Thus, Normung is understood as planned collaboration with interested parties on the harmonization of material and immaterial objects. The most famous example of successful Normung is the unified paper size DIN A4. Norms define the state of-the-art in publicly available documents and thus provide non-discriminatory access to knowledge and information for:

- Market establishment for innovative solutions;
- Market development;
- Knowledge transfer;
- Dissemination of best practices;
- Interoperability;
- Reputation transfer to users;
- Confidence in services and products that are created based on the norms.

By definition, Normung must not lead to special advantages for individual players. Its task is to achieve benefits for society as a whole, which is the main difference to consortium-based standardization. In Germany, electrotechnical Normung is conducted in the bodies of the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE) which develop national norms and represent German interests in the European and international standardization organizations.

In our networked world, if every operator has a secure infrastructure, this also benefits all other operators, as a secure infrastructure cannot be (ab)used for attacking others. This yields positive effects for the whole network. Accordingly, Normung, more than any other instrument, represents an ideal collaborative means of promoting such network effects in a targeted manner and of increasing the overall level of security for the benefit of all concerned.

2.2 Standardization

In its literal meaning standardization denotes the harmonization of goods, services and processes based on a specific pattern of dimensions, types, or procedures. The goal of standardization is to create common parameters such as tools or manufacturing or software components. Standardization, in the German understanding of the term, is therefore technical rulemaking without the compulsory involvement of all stakeholders and without mandatory public participation.

Within the German Normung strategy, the drafting process of specifications or parameters is referred to as "standardization" to distinguish it from full, consensus-based "Normung". For the DKE, standardization represents a means of putting the knowledge and technology transfer between the different stakeholders on an efficient and effective basis, thereby supporting developmental progress. Taking research and development in innovative technology areas as the starting point, new standardization trends need to be identified and addressed. Specifications (guidelines, DIN Specs and VDE application guides) are subsequently developed which in turn are developed into norms in a consensus-based process involving all interested parties and the public. A specification contains the result of standardization work and thereby reflects the state of the art. If a public enquiry procedure has been carried out, it can obtain the status of "generally recognized state of the art".
Table 1 shows the differences between a specification and a norm.

Table 1 – Comparison of norm and specification characteristics

PRINCIPLE	NORM	SPEZIFICATION
1. Voluntariness	X	X
2. General public	X	
3. Any person	X	(X)
4. Uniformity and consistency	X	X

	PRINCIPLE	NORM	SPEZIFICATION
5.	Relevancy	X	X
6.	Consensus	X	(X)
7.	State-of-the-art orientation	X	X
8.	Economic realities orientation	X	X
9.	Public benefit orientation	X	X
10.	Internationality	X	
		X application	(X) restricted application

The term "de-jure standard" in English corresponds to the German term "Norm". In contrast, a "de facto standard" is a result that has not been brought about by at least one national standardization process. Accordingly, the English word "standard" does not represent an accurate translation of the German term "Norm".

"De facto standard" is translated as "Industriestandard", whereas "Standardisierung" is used to denote its creation. In that regard, all standards of industrial interest groups are de facto standards, such as the Bluetooth protocols of Bluetooth SIG or the IrDA protocol of the Infrared Data Association.

2.3 Structure of the standardization landscape

The International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU) all work to provide consensus-based standards and are the main standardization organizations at the international level. The related standardization organizations at the European and national levels are the European Committee for Standardization (CEN), the German Institute for Standardization (DIN), the European Committee for Electrotechnical Standardization (CENELEC), the European Telecommunications Standards Institute (ETSI) and the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE) (see figure 1).
The corresponding national standardization organizations are members of ISO, IEC, CEN and CENELEC.

Figure 1 – Overview of the standardization organizations

2.4 DIN, CEN and ISO

The DIN German Institute for Standardization offers all interested parties a common platform for elaborating standards and specifications as a service to industry, the state and society. DIN is a private sector organization with the legal status of a charitable body. DIN members include companies, associations, authorities and other industrial, commercial, skilled trade and scientific institutions.

Together with representatives of the interested groups, the main function of DIN is to develop timely, consensus-based standards which meet the needs of the market. DIN is recognized as a national standardization organization by the European and international standardization organizations on the basis of a contract with the Federal Government of Germany.

Today, almost 90 % of DIN‘s standardization work is European and international. DIN employees organize the entire process of non-electrotechnical standardization at national level and thus represent Germany at the European and international level via its respective national bodies. The DIN organization represents Germany‘s standardization interests as a member of CEN and ISO.

2.5 DKE, CENELEC und IEC

DKE represents the interests of the electrical engineering, electronics and information technology industry in national and international electrotechnical standardization work and is funded by the VDE. It is responsible for standardization work which is handled by the corresponding national and international organizations (IEC, CENELEC and ETSI). It represents German interests both within CENELEC and the IEC. DKE serves the general public as a modern and non-profit service organization by ensuring the safe and efficient generation, distribution and utilization of electricity.

It is DKE's responsibility to prepare and publish standards in the field of electrical, electronic and information technologies. The results of the DKE's electrotechnical standardization work are set down in DIN standards and are accepted as German standards in the DIN set of German standards. Those which contain safety-related stipulations are also included as VDE requirements in the VDE set of regulations.

DKE objectives:

- **Safety**
  Overall safety of electrical products, installations and their related services, also in the field of occupational safety,
- **Compatibility**
  System compatibility of products and installations in networked systems and applications,
- **Market orientation**
  Accelerated market penetration of new technologies through the support of information processes via norms and standards,
- **Consensus building**
  Bringing together the knowledge and the interests of all relevant parties, building consensus even around controversial technical issues
- **Advocacy**
  Representing German interests in the development of European and international standards in order to eliminate obstacles to trade and to open up markets worldwide,
- **Quality**
  Maintaining a high level of up-to-date rules in a consistent and widely accepted portfolio of standards which are oriented towards market and consumer requirements
- **Evaluation of conformity**
  Worldwide acknowledgement of conformity assessment results.

2.6 German standardization roadmaps

Some parts of this roadmap overlaps thematically with other roadmaps. Parts relevant to electrical energy efficiency issues are addressed in this roadmap. For further information the roadmaps can be downloaded free of charge under the respective link.

Table 2 – DKE Standardization Roadmaps

TITEL	SUMMARY	LINK
E-Energy/Smart Grid Standardization Roadmap Version 2.0	The Standardization Roadmap 2.0 not only assumes a pioneering role in the E-Energy / Smart Grid field, it also establishes a new approach to standardization itself by taking the wide range of challenges presented by complex systems in general into account. A generic model (Smart Grid Architecture Model – SGAM) is used to assess the implementation possibilities. The description of the services and the growing amount of detail required in the use cases at the functional, information, communication and component levels have laid the foundations for cooperation between the different standardization bodies involved in reaching the common goal of realising the desired services and functions.	https://www.dke.de/resource/blob/778304/96de7a637009007d65182df8c4d1a9aa/the-german-roadmap-e-energy-smart-grids-version-2-0-data.pdf
Smart Home + Building Standardization Roadmap Version 2.0	Getting Germany's households and smart home economy into shape for the digital world is the goal of the "Smart Home + Building V2.0" Standardization Roadmap". According to the Standardization Roadmap, "System flexibility, interoperability across system and technology boundaries, information security and data protection are the main requirements to be met by smart home solutions in the future, if it is to enjoy long-term success in the emerging mass market."	https://www.dke.de/de/themen-projekte/projekte/alle-normungs-roadmaps-als-download

TITEL	SUMMARY	LINK
Electromobility Standardization Roadmap Version 3.0	For Germany to improve on its competitive lead in the international electromobility market, and to ensure that the development and added value of this technology remains in this country, a major focus must be placed on furthering and combining these developments in a target-oriented manner. If German industry is to position itself successfully, it is essential in this context that the positive effects of standardisation be incorporated into the development process right from the start so that they can be fully exploited.	https://www.dke.de/resource/blob/778284/6a401ee3280cb3568e5cb3c386e39d62/the-german-standardisation-roadmap-for-electromobility---version-3-0-data.pdf
Low Voltage DC Standardization Roadmap Version 1.0	The Standardization Roadmap focuses on four major areas. Following an examination of the economic and legal framework it looks at safety, protection concepts and grid structures. It continues with a closer look at system topologies and use cases, before finishing with a concluding chapter on equipment and components. The recommendations given in the individual sections are then summarized at the end.	https://www.dke.de/resource/blob/778168/23cb82850b1c37070f3ebc5526770646/german-standardization-roadmap-low-voltage-dc-version-1-data.pdf

2.7 Coordination of energy efficiency in international standardization

IEC ACEE Advisory Committee on Energy Efficiency

The IEC ACEE concerns itself with energy efficiency issues which are not specifically covered by a particular IEC technical committee. It coordinates the energy efficiency work. The ACEE is responsible for coordinating the horizontal aspects of energy efficiency. It provides implementation guidelines for general aspects and for specific sectors. The ACEE also encourages the consideration of system perspectives in the development of energy efficiency standards.

IEC Guide 118:2017 Inclusion of energy efficiency aspects in electrotechnical publications

The IEC Guide 118 was published in March 2017. Its purpose is to help IEC working committees (TCs, SCs, …) to include energy efficiency in their publications (SMB Decision 136/8). It describes the following aspects.

- Articles in IEC publications on energy efficiency
- The concept of energy efficiency aspects
- Categories of energy efficiency aspects

In addition, Guide 118 provides a list of energy efficiency aspects which should be taken into consideration. Definition of the boundary is decisive for evaluating energy efficiency improvements.

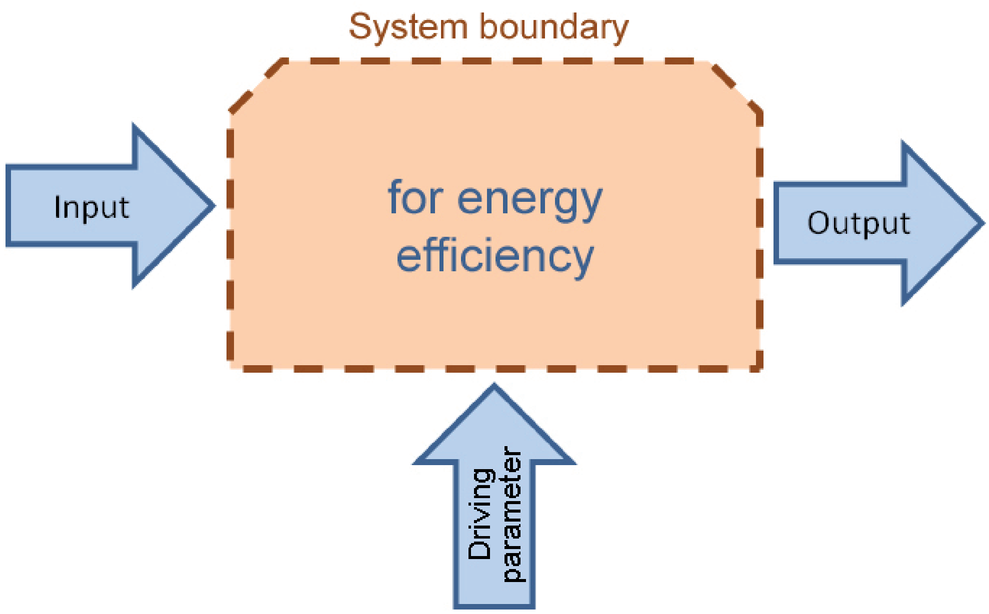


Figure 2 – Key elements in the definition of energy efficiency

A change to the boundary can also lead to a change in the definition of energy efficiency (e.g. only motor, motor as pump drive, or entire pump system).

Guide 118 defines an iterative process for improving energy efficiency.

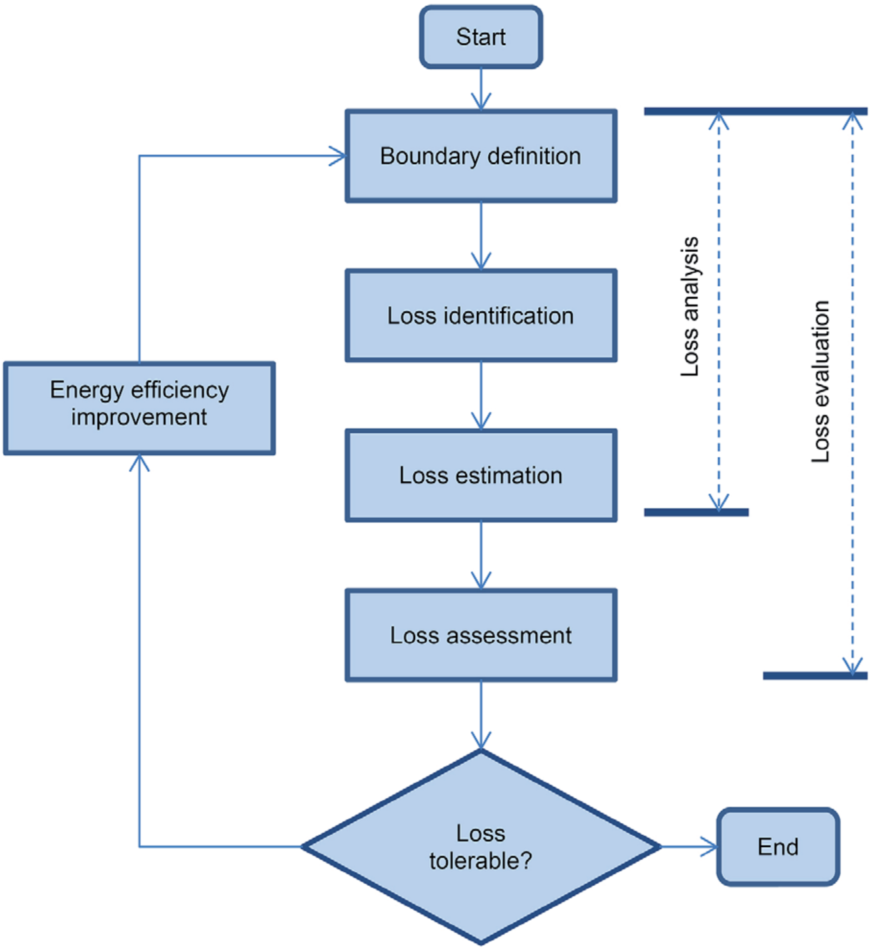


Figure 3 – Iterative process to improve energy efficiency

The criteria for deciding whether the current level of losses is tolerable or not can come from many different sources such as national/European regulations, societal decisions or standards.

Every proposal for preparing or revising an IEC publication should identify which aspects of energy efficiency are to be included. Technical committees are encouraged to focus not only on services which are offered in their product area, but also on interactions in systems which feature the product.

IEC GUIDE 119:2017 (Preparation of energy efficiency publications and the use of basic energy efficiency publications and group energy efficiency publications)

Before Guide 119 was approved, the ACEE requested that its status be changed from non-mandatory to mandatory in order to underline the significance of energy efficiency within the IEC and to ensure consistency across the different Technical Committees. This change triggered intense discussion, especially because only sections 5–8 were to be mandatory, but not the technical content in sections 1–4. IEC Guide 119 was published, regardless, in March 2017.

Guide 119 defines procedures for the production of energy efficiency publications. Similar to the safety guides, it describes a hierarchy of basic, group and product publications. The boundaries are taken from Guide 118 and expanded for systems, as only improving the efficiency of a product without taking its use into account may not suffice in some cases.

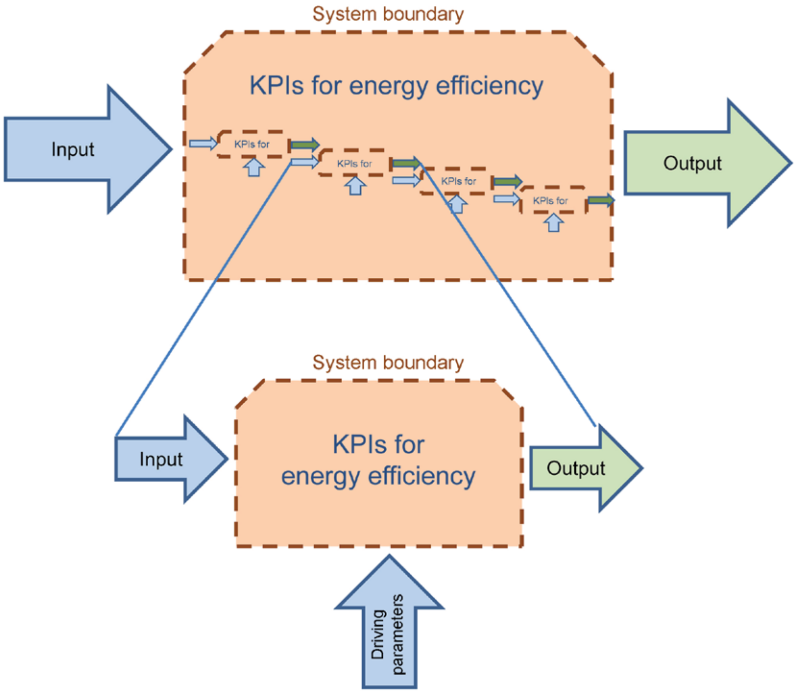


Figure 4 – Extended border description

A group or basic publication should be generated whenever a number of TCs are required to produce a planned energy efficiency publication. IEC ACEE is responsible for assigning basic and group publications (the decision must be confirmed by the IEC SMB). Technical committees can find basic and group publications in the IEC catalogue and on the IEC website.

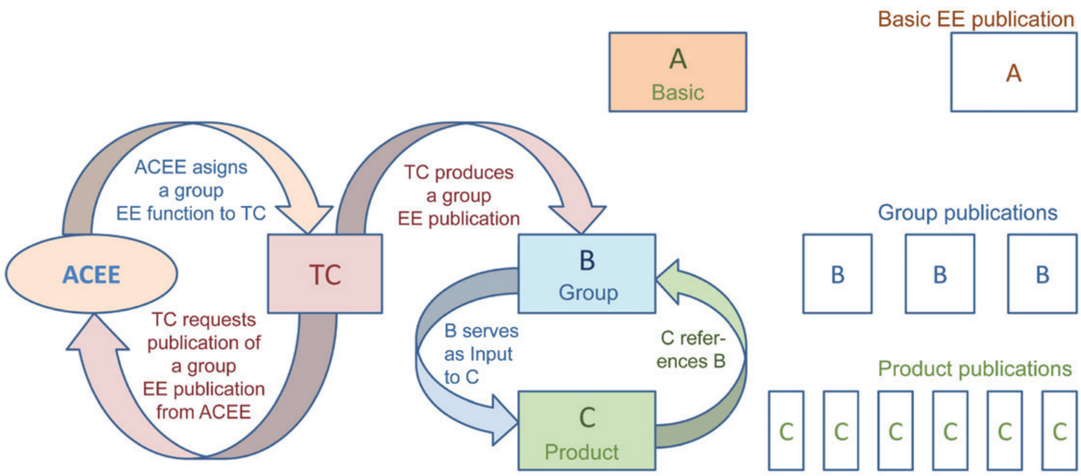


Figure 5 – Structure of IEC publications on energy efficiency and function assignment

3 Introduction to energy efficiency

Energy efficiency is a core element of the energy transition

Energy efficiency is fundamental to the future of the world: its energy security and prosperity.

Germany plays an active role in shaping international climate policy and lobbies worldwide for climate cooperation. Germany has played a central role in putting climate change on the international political map. The German government was an innovative force in the negotiations that led to the 1997 Kyoto Protocol. In this agreement, the industrialized countries pledged to reduce greenhouse gas emissions by an average of 5.2 % by 2012 compared to the base year 1990. Germany had more than met this target by reducing emissions by 21 % in 2012. At the moment we are weakening slightly. Achieving the set goals requires more and more attention. This must not diminish in the future.

Climate policy aims to reduce the speed and effects of global warming, or even to halt it completely, in particular by cutting the emissions of greenhouse gases which are responsible for climate change. Important measures here include expanding the use of renewable energy and improving energy efficiency and energy conservation – the core elements of the energy transition – and the political measures needed to achieve this [1].

Energy efficiency plays a central role in the reconstruction of existing energy systems

Energy efficiency has been a topic of major importance for many years. In the smart and cross-sectoral energy industry of the future, all technical advances will have to be energy efficient if the long-term objective of decarbonization is to be achieved.
If the target agreed by the Paris climate conference last December of limiting global warming to a maximum of 1.5 degrees Celsius is to be met, this will require technological quantum leaps: from generation and transport through to the myriad uses in industry, in mobility and in the private sector. The efficient use of raw materials and energy is the new watchword in all segments now, including heating, cooling, electricity, mobility, or industrial production – even if the current low price of oil seems to suggest that everything could continue as before.

The long-term, climate-friendly process of decarbonization cannot succeed from renewable energies alone. The energy transition project will fail without a broad cross-system approach of new, cross-linked and energy-efficient technologies.

Energy efficiency plays a central role in the reconstruction of the existing energy systems. In industrial production and in the area of mobility there is still much to do to ensure a more climate-friendly and resource-saving future on the basis of ever smarter technologies.

If the decarbonization demanded by the world community in Paris is indeed to become a possibility, ingenious technological concepts are needed in all areas to achieve the required efficiency levels.

Energy efficiency – the second pillar of the energy transition

When the energy transition was announced in 2011 after Fukushima, it was first necessary to increase the share of renewable energies in the electricity mix. The government was relatively late in including energy efficiency as a key pillar of the energy transition. Efficient technologies in the building sector and in industry are already available today and are increasingly coming to the fore.

It is a simple principle: the less energy is expended in a process, the more energy-efficient it is. "Energy efficiency" means the intelligent use of energy in order to achieve the greatest possible useful output from it. In other words: the greater the useful output obtained with the least possible effort, the higher the energy efficiency achieved.

Energy efficiency saves resources and is economical

It is not utopian to save energy and conserve resources while helping to improve the climate.

Saving energy and using renewable energies such as solar, wind and geothermal energy will become increasingly important in the future. For example, energy-efficient home appliances and energy-efficient construction methods can quickly counteract rising energy costs and pay for themselves.

Energy industry and energy efficiency

A significantly more efficient energy use supports the renewable energy industry through reduced investment in generation capacity. Measures for improving energy efficiency already exist, but they by no means reflect what is theoretically possible.

When people talk about the energy transition in Germany, they think primarily of the change from nuclear and coal-fired power to renewable energy. But a renewable future will, in fact, only be possible with significantly lower energy consumption.

In the last two decades, economic growth has generally exceeded the increase in energy consumption and greenhouse gas emissions. Energy productivity (economic output per energy consumption) increased by about 40 % from 1990-2013 according to estimates (see figure 6).

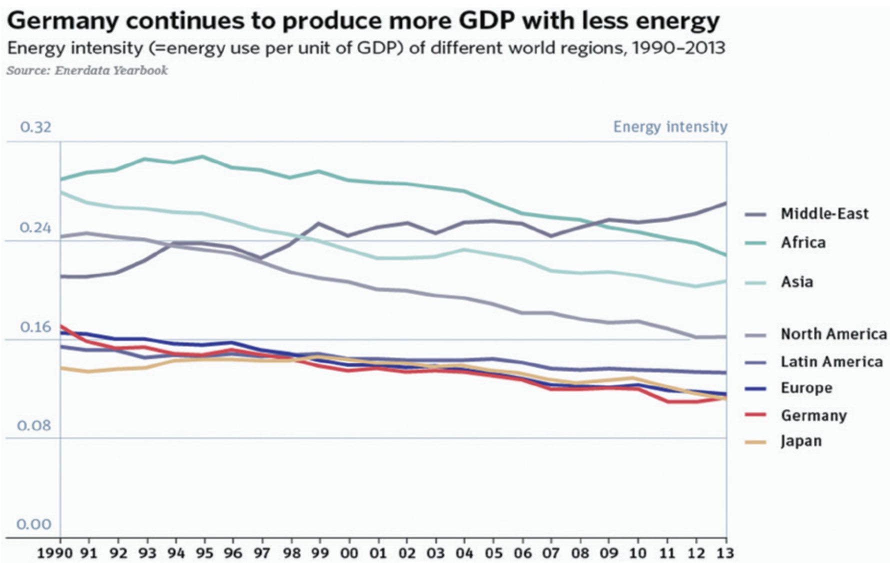


Figure 6 – Energy consumption compared to the GDP in Germany 1990-2013 [2]

The perception of energy use

People are not interested in energy itself, but in energy services, i.e. the benefit of the energy. In other words, we are not interested in electricity and fuel oil, but in chilled food and well lit, comfortable homes. Our computers and smartphones have now developed into high-performance devices, despite requiring less and less power. Such progress is possible in many areas. In our buildings, for instance, we can create a pleasant room climate not only with energy-intensive air conditioning and heating systems. On the contrary, through the use of ever more intelligent technologies the buildings of the future will require considerably less energy to offer even more comfort than we are used to today.

However, when it comes to efficiency, we are faced with a particular obstacle: information. Many eco nomists assume that the market cares about everything most efficiently. This assumes that all market participants are the same and sufficiently informed, and thus all efficiency measures are used, which pay off (see figure 7).

Without this information, it is impossible to assess any investment in energy efficiency.

Although most consumers know their monthly electricity bill, they are not aware of how many kilowatt-hours they consume. And they are scarcely capable of judging how much a particular device will cost them in electricity per year. Yet without this information it is impossible to assess the payback period for any investment in energy efficiency. Even if we believe that the market provides the best solutions, it has to be ensured that every consumer is fully informed.

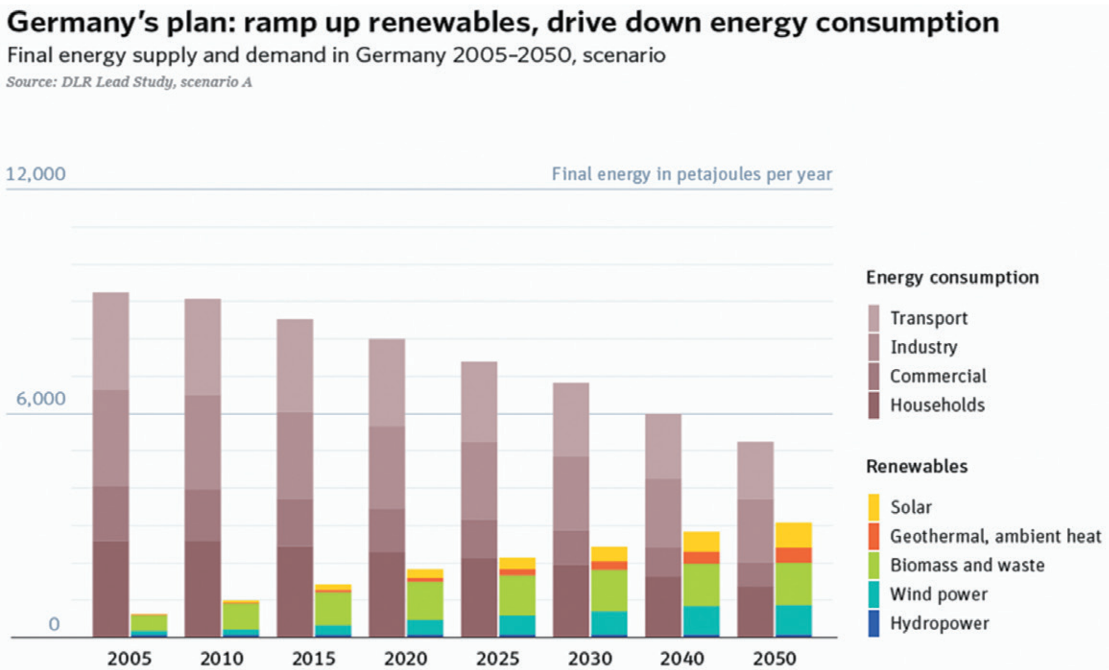


Figure 7 – Energy consumption in Germany 2005-2050 [2]

Awareness raising

Efficiency refers not only to the manufacturer's guaranteed use of the appliances, but also to their standby power consumption. Most consumers do not realize that household appliances consume power even when switched off – everything from coffee machines and toasters to televisions, game consoles and computers. It is estimated that such ‚standby consumption‘ accounted for around 4 % of the gross electricity demand in Germany from 2004 to 2006. Consumers are not always aware that the additional energy costs for a relatively cheap device can even exceed the higher purchase price of an energy-efficient device within a relatively short period of time.

New appliances must comply with Regulation No. 1275/2008 of the Ecodesign Directive. Here, the standby power was set to 1 W and 0.5 W, respectively.

An example of where the government provides market participants with information is in the European Union‘s Eco-Design Directive, also known as the ErP (Energy-related Products) directive. Its goal is to make products more sustainable over their entire life cycle (not only in relation to energy), partly through the use of energy labelling for consumers and partly through stricter minimum requirements for energy efficiency.

The European Union is also working to reduce energy consumption in buildings, and Germany is at the forefront of this movement, too. The energy saving regulation was adopted in 2002; this was then tightened in 2009 and 2014. Some of the buildings erected in the 1990s already reveal what the future standard will look like from 2020: low-energy and passive houses which become plus-energy buildings if solar roofs are added.

These new laws help when it comes to new buildings, yet Germany also has to deal with its existing buildings. The renewal rate, i.e. the number of buildings that are refurbished in a year, is too low in Germany at just 1 %. In many cases modernization does not go far enough; insufficient insulation is often used, and the building technologies deployed do not satisfy the requirements which buildings will have to meet in future.

Improvement of energy efficiency

Studies have shown that the power consumed by electric motors in industry could be reduced by about 30 TWh per year by 2020, if all motors were brought to the current technical standard. That is enough to render several large power plants superfluous. Similar savings can be made through the use of efficient lighting systems and switching from inefficient electrical heating systems to more efficient systems. For example, within the EU, only motors with at least efficiency class IE3 are allowed to be marketed. If the motor is operated in combination with a frequency converter, efficiency class IE2 is also permissible.

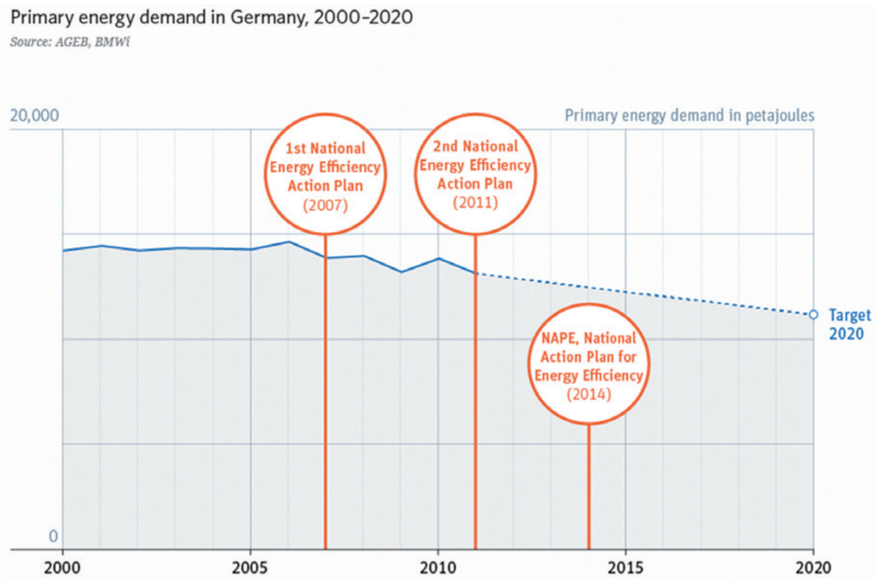


Figure 8 – Germany's plan: drive down energy demand 2020 [2]

Unfortunately, not enough is being done to promote energy efficiency. The EU has binding targets for reducing carbon dioxide emissions (20 % below the 1990 level by the year 2020), and for increasing renewable energy (20 % increase by 2020), yet the target for energy efficiency (20 % reduction of primary energy consumption by the year 2020) is not binding (see figure 8). There is a binding requirement to achieve a 40 % reduction of greenhouse gas emissions by the year 2030. The renewable energy target for this year is 27 %, but it is only binding for the EU as a whole – there are no specific targets for the member states. The efficiency target is also 27 %, but this, too, is non-binding.

Prioritizing energy efficiency

The lack of policy measures was recognized by the Federal Government in 2014, which led to the announcement of the National Action Plan for Energy efficiency (NAPE) in December 2014. This package contains dozens of efficiency instruments, including improved support for energy efficiency, a new tendering scheme for energy efficiency as well as better information and verification possibilities for companies and private households. One of the main instruments of the package, a tax credit scheme for the modernization of buildings, failed in the implementation phase due to the strong resistance of the federal states.

VDE-Trend Report 2014 gives energy efficiency top priority

According to the 2014 VDE Trend Report, Germany has especially great potential (based on a survey of 1,300 VDE member companies and universities) in the areas of energy efficiency (67 %), smart grids (65 %), electromobility (50 %), medical engineering (42 %) and industry 4.0 (31 %).

High energy efficiency and quality of life are the main focuses of the digital society. The VDE companies and universities were also questioned about the opportunities and challenges which the "digital society" brings. Here, too, energy – or more specifically, greater energy efficiency – is given the highest priority (51 %), ahead of comfort/convenience/quality of life (45 %), broadband access for all and economic growth (41 % each).

Energy efficiency reduces energy dependence

Why do we need greater energy efficiency?

Global demand for energy is increasing. The energy markets are experiencing bottlenecks, energy prices are rising. Uncertainty in many producer and transit countries is giving cause for concern, the burning of fossil fuels is still increasing and accelerating climate change. Expanding the range of energy supply is an expensive and lengthy process. By contrast, increasing energy efficiency has a dampening effect on the energy demand and thus on energy prices, reduces dependence on imported energy, helps combat energy distribution conflicts – and reduces emissions of climate-damaging carbon dioxide.

More needs to be done promote energy efficiency

Objectives of the federal Government – Energy efficiency in Germany

In its energy concept of 28 September 2010 the German government laid the long-term foundations for an affordable, reliable and environment-friendly supply of energy for Germany and set itself ambitious goals (see figure 9).

Substantial further effort is required in redesigning the complex system. A major prerequisite for the success of the energy transition is reducing the current level of energy consumption. Measures for increasing energy efficiency offer great potential for this, especially on the demand side, i.e. the end customers.

Energy efficiency does not mean sacrifice, rather smarter, more economical use of energy. In many cases, there are various ways of implementing this in an economically viable manner.

The Federal Government has set itself the goal of reducing total primary energy consumption by 20 % by 2020 and by 50 % by 2050 and of increasing energy productivity by an average of 2.1 % per year by 2050. Electricity consumption in Germany is to be reduced by 10 % by 2020 and by 25 % by 2050 (compared to the 2008 value). In the field of transport, the final energy demand is to be reduced by 40 % by 2050 (compared to 2005). In the building sector, the heating requirement is to be reduced by 20 % by 2020 and the primary energy demand by 80 % by 2050. Further targets include making all buildings virtually carbon-neutral and doubling the energy efficiency rate to 2 % per year.

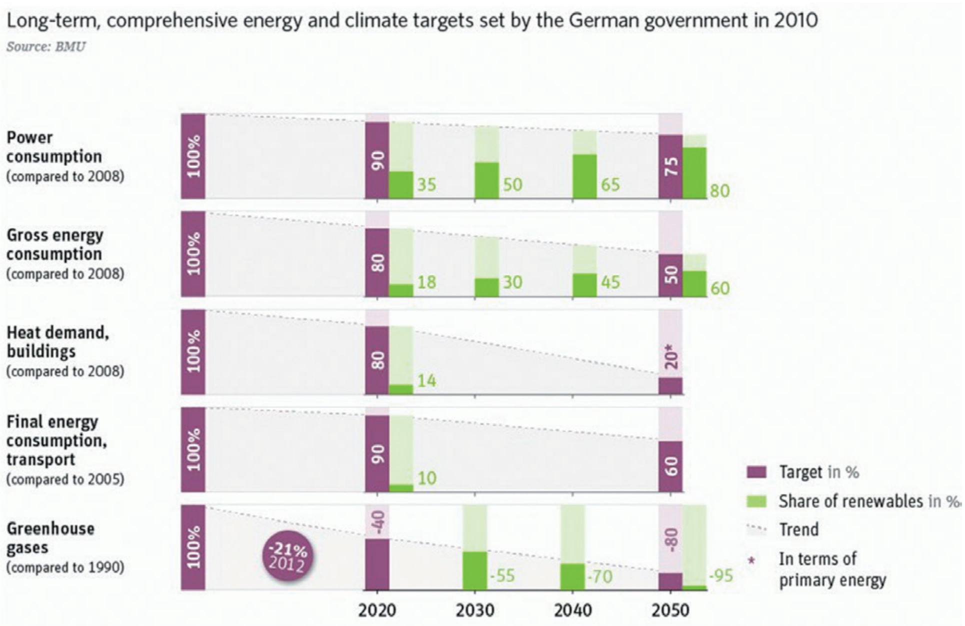


Figure 9 – Germany's energy transition targets in 2010 [2]

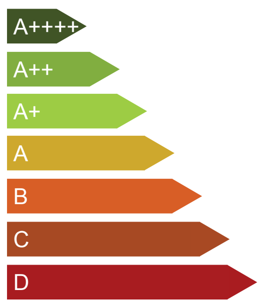
Energy efficiency in Europe

In Europe, too, energy efficiency is a key energy policy instrument. Here the EU has passed a number of legal acts (e.g. relating to eco-design, power consumption labelling or buildings) for implementation in the Member States.

The Directive on Energy Efficiency and Energy Services (ESD) was adopted back in 2006. This aimed to reduce the final energy consumption in the Member States against the prevailing trend and to support the market for energy services. The Energy Services Directive was superseded by the 2012 Energy Efficiency Directive. This updates the EU's energy policy objectives and supplements them by placing even greater demands on the Member States: its main provisions include the introduction of an obligation for energy companies to save 1.5 % of their annual energy sales or, alternatively, to implement policy measures with an equivalent effect, and an annual obligation to modernize 3 % of federal buildings. It also includes the introduction of indicative national energy efficiency targets, as well as provisions regarding metering and billing, combined heat and power, support for and a binding commitment to energy audits, and much more besides.

Energy efficiency labels

Energy efficiency plays an important role now, but it will become even more so in the future. In the European Union, the EU energy label has identified the energy efficiency of household appliances since 1998. At the end of 2011 a new, uniform EU label was launched as the start of the gradual introduction of binding new energy efficiency class labelling for a variety of devices.



"Improved incandescent lamps", LED and compact fluorescent lamps and their ballasts (where applicable) are now divided into efficiency classes and labelled for the consumer.

Since December 2011 an E-Efficiency label has been mandatory for new cars. Here the efficiency value is calculated based on the mass and the CO_2 emissions of the car/vehicle.

Energy certificates (sometimes called energy passports) as specified in the Energy Saving Ordinance (EnEV) have been used since 2009 in Germany to document the energy consumption of houses and buildings.

Energy efficiency creates jobs

Energy efficiency does not mean making sacrifices – on the contrary. It can help to limit climate change while yielding significant economic and social benefits. Simply by doubling the energy efficiency level from its current rate of 1.3 % to about 3 % per year would create 6 million new jobs within five years. At the same time, the global energy costs in 2030 would be reduced by more than $2 trillion.

3.1 History of energy efficiency

In prehistoric times people still relied almost exclusively on their muscle power and energy from their food, however they soon discovered how they could increase the effectiveness of their limited muscle power by using the first simple tools. With the arrival of agriculture and animal husbandry, people learned to exploit the muscle power of animals. Over time, various inventions such as watermills, windmills and sailboats harnessed the energy available from wind and water. Only in modern times were fossil fuels added; these initiated the Industrial Revolution in the 19th century. Much greater amounts of energy were now available to mankind. The resulting problems are leading us today to turn with renewed interest to the efficient use of energy.

Desire for greater performance boots energy efficiency

For a long time it was not only the more economical use of energy which was the driving force, but also the desire for greater performance. In 1764 James Watt succeeded in improving a steam engine in such a way that it required 60 % less coal than its predecessor. The mass distribution of the steam engine was one of the triggers of the Industrial Revolution and led to a boom in coal.

Versatile energy: Electricity

In addition to hydropower, fossil fuels have also been used to produce electricity using generators since 1882. Compared to the steam engine, electricity is an extremely convenient and versatile form of energy use: it could take care of almost all energy-based tasks, ranging from space heating and transport (electric motors) through to lighting, at the push of a button.

Germany has been a pioneer in the construction of large power plants and high-voltage lines for electricity distribution since 1885. Once the expensive infrastructure had been built, electricity grew enormously in significance. Today's modern world with communication and information technologies and automated production processes would be unthinkable without electricity. Completely new industries such as aluminium production were made possible by electricity.

In the post war period energy efficiency came to mean one thing above all else cost conservation.
The oil crises of 1973 and 1979 made Germans aware of the economic risk posed by rising energy prices for the first time. They served as a major impetus for increasing energy efficiency.

Energy conservation was recognized as a means of reducing dependency on raw material imports. At this time the Federal Ministry of the Economy launched the first campaign entitled "Saving energy – our best energy source". And the Energy Saving Act of 1976 placed demands on the thermal insulation of buildings for the first time.

3.2 Efficiency vs. Energy conversion efficiency

Energy efficiency – Definition

Energy efficiency is the ratio of the input of a certain amount of energy to its useful output. The less energy for the same benefit has to be used, the more energy efficient a product or service is.

The European Energy Services Directive defines energy efficiency as the "ratio of output in terms of performance, service, goods or energy, to the input of energy". Efficiency is therefore the ratio of useful output to cost.

The energy conversion efficiency is the ratio of useful energy to input energy.

The term "energy efficiency" is often used interchangeably with "energy conservation". However, energy conservation goes beyond energy efficiency because it also includes dispensing with the use of energy.

"Efficiency" is not the same as "effectiveness": effectiveness describes the efficacy, i.e. the ratio of what has been achieved to the defined target, whereas efficiency is concerned with the lowest possible input of resources. Applied to the energy industry, efficiency means providing services such as cooling, heating, lighting, or the transmission of messages while inputting less energy.

Apart from the energy aspect, efficiency also involves performance and cost aspects and therefore also includes procurement.

In addition to energy efficiency – the intention to minimize consumption – the plant operator as consumer of a distribution has to regard the efficient energy procurement. An energy management helps to optimally utilize the contracts concluded (see figure 10).

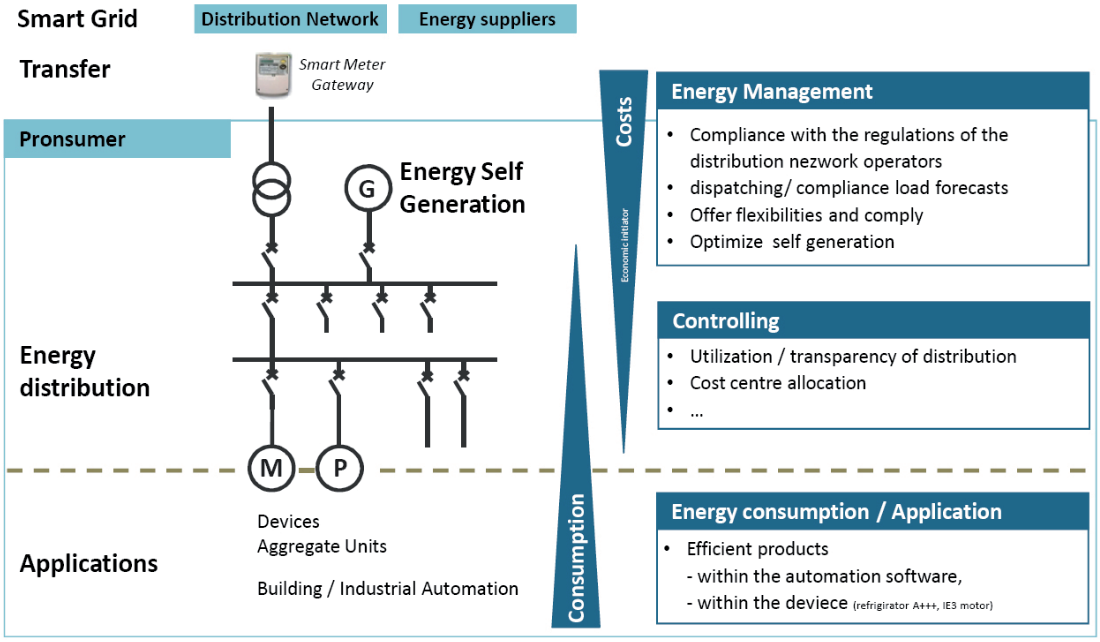


Figure 10 – Energy Management [3]

DIN EN ISO/IEC 13273-1:2016-06 und DIN EN ISO 50001:2011-12

DIN EN ISO/IEC 13273-1:2016-06 defines energy efficiency in accordance with DIN EN ISO 50001:2011-12 as the "ratio or other quantitative relationship between an output or the yield of services, goods or energy, and the energy used".

Examples include the efficiency of energy conversion, the ratio of energy required to energy used, the ratio of input to output, the ratio of theoretically to actually used energy for operation. Both input and output must be clearly specified and measurable (quantitatively and qualitatively).

DIN EN ISO/IEC 13273-1:2016-06 und DIN EN ISO 16103:2005-09

The energy efficiency ratio is defined by DIN EN ISO / IEC 13273-1: 2016-06 in accordance with DIN EN ISO 16103: 2005-09 as an "indicative value for energy efficiency".

This is mainly used as a metric in the evaluation of policies and in macroeconomic studies.

Energy conversion efficiency

Energy conversion efficiency describes the ratio of the output power to the input power. Energy conversion efficiency is a dimensionless quantity and is signified using the Greek letter η (Eta). The energy conversion efficiency describes a waveform for devices (motors, transformers).

Efficiency at the application level

Efficiency can be influenced the most during construction, during operation only over the mode of operation.

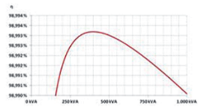
If the applications consist of systems and equipment, the technological interaction of the individual devices among themselves is responsible for their efficiency. In efficient system or plant analysis, the individual parts can assume an inefficient working point during operation. Automation plays a decisive role here. In most cases, optimization of the automation should be viewed from the point of view of efficiency (see figure 11).

When considering the efficiency of systems and plants, there is still a considerable need.

The efficiency of systems and equipment requires detailed specification of the conditions.

Efficiency
- for an entire system
- is determined during the design phase

Energy conversion efficiency η



KPI **K**ey **P**erformance **I**ndicator
Required input based on standardized unit
… kWh per PET-bottle

Devices
Energy-saving motors class IE1- IE4
Variable speed drives
EU only allows IE3 or IE2 with speed control

Systems
Automation technology
Avoid no-load operation
Operation at optimum work point

Facilities
Production planning
Avoid no-load operation
Avoid long travel distance
Avoid unnecessary energy losses
Energy recovery

Figure 11 – Energy efficiency [3]

Efficiency is not always described as a value, it can also be shown as a curve. This is useful if a system has different working points.

Recording the capacity and the associated output or the related current provides basic data for analysis of efficiency and energy conversion efficiency. Plotting the energy conversion efficiency above the recorded output or the recorded current yields the efficiency curve with its optimum working point. This should be targeted as often as possible during use (see figure 12).

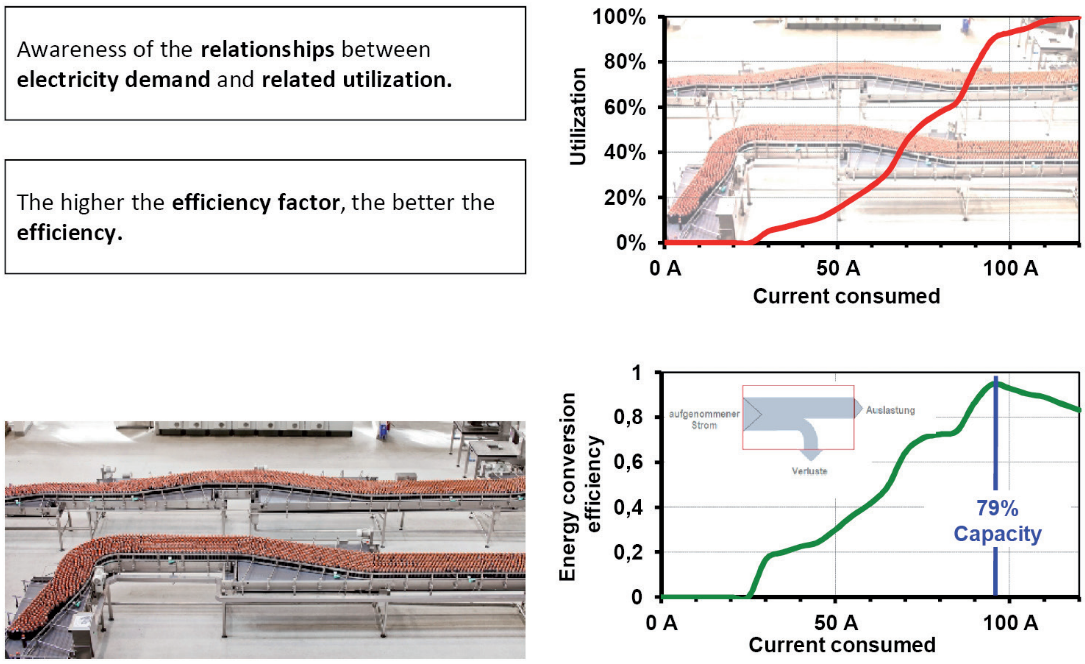


Figure 12 – Comparison of electricity demand with efficiency and utilization [3]

The standardization of efficiency in devices is already highly advanced and in most cases the optimum has already been achieved (cost effectiveness – e.g. white goods).

Most systems and pieces of equipment are individual units. The control software is adapted exactly to their needs. Their efficiency is thus determined during the software development. There is still considerable need for action in the efficiency analysis of systems and equipment.

3.3 Standardization makes an important contribution to energy conservation

The successful interplay between standardization and innovation has already led to impressive energy savings today. Energy consumption in household appliances alone has been reduced by 30 % in recent years. This corresponds to an energy saving of 10 terawatt hours per year in Europe, or the annual output of a major nuclear power plant. Electrical standards are giving rise to innovative solutions which are enjoying global market success in the form of high-quality energy-efficient products. These include washing machines, ovens, refrigerators, freezers and luminaires.

The standardization successes also include energy saving successes for information technology equipment, electric drives and many other products.

Prescribing energy savings by decree alone is not sufficient. Rather, standardization must go hand in hand with technical innovation. This opens up a great deal of innovation and market potential, e.g. in the field of home automation (Smart Home) or standby functions. The stand-by mode of consumer products alone results in the loss of nearly 18 TWh of electric power per year in Germany. This corresponds to roughly the annual output of two medium-sized nuclear power plants. The use of existing energy-saving products and technologies could result in savings of over 40 TWh of electrical energy in Germany per year, representing a reduction of about 22 million tonnes of CO_2 emissions per year. An important key to improving efficiency lies in the potential offered by electrical equipment and electronics themselves.

Before all potential sources of electrical energy efficiency can be fully exploited, the VDE believes that a number of points first need to be addressed. Existing innovative products and technologies must be used consistently, new standards and measuring procedures must be adopted and applied. And finally, industry and the government are called upon to create more transparency and more incentives, while consumers themselves need to be more aware of energy-efficient products. Standards and test labels help here.

Awareness of energy efficiency needs to be raised both for consumers and industry in the procurement of new equipment and plant upgrading.
Against this background, the significant involvement of German experts in key international standardization committees is a good sign that German technological know-how is continuing to introduce new trends in important future issues such as electrical energy efficiency

3.4 What is primary energy?

By primary energy one understands the naturally occurring energy sources, e.g. coal, natural gas, sun, wind and water.

More and more electricity in Germany comes from renewable sources like wind and solar power. In 2014 their share of gross electricity consumption in Germany was 27.4 % – reaching 31,7 % in 2016 according to UBA.

Yet the most recent Monitoring Report on the energy transition states that renewable energy accounted for around 11 % of primary energy consumption in Germany in 2014.

The difference between the two statements is that electrical power is a form of energy. But not all ener gy that we use is used in the form of electricity. Only a minority of Germany's total energy requirement is used for electricity. The majority is used for heating and transport, for example.

Primary energy is the usable energy content of a naturally occurring energy source. It is thus the energy that is directly present in the energy sources.

Primary energy is the usable energy content of a naturally occurring energy source.

Primary energy sources are those which have not yet been converted into other forms of energy. Examples include coal, lignite, oil and natural gas. Solar energy, wind power, hydropower, geothermal and tidal energy are further primary energy sources.

Primary energy is thus contained in both fossil and in renewable energy sources. It is the power that is naturally present in these sources of energy, as it were.

For the power of the sun to be used as electricity, it must first be converted and in some cases transported over long distances. A certain proportion of the energy is lost as a result.

The fully converted energy which reaches the consumer, makes the lights shine, powers cars and allows people to feel warm and comfortable in their home is referred to as final energy. Final energy forms include district heating or electrical power.

The German government's target is to reduce primary energy consumption

The goal of the German Government is to reduce primary energy consumption by 20 % in total by the year 2020 compared to 2008, and to halve it by 2050. In 2014, it was five % lower than in the previous year. The decline in the past year was in fact mainly due to the mild winter. However, even after filtering out these weather effects, the adjusted primary energy consumption in 2014 was 1.6 % below the previous year's figure.

The share of electricity generated from wind, solar power etc. is targeted to rise from about 11 % of the gross final energy consumption in 2010 to 60 % in 2050. Renewable energy should account for at least 35 % of the electricity supply by 2020, and for over 80 % by 2050. Greenhouse gas emissions are to be reduced by 40 % by 2020 and by at least 80 % by 2050. This requires an annual average increase in energy productivity of 2.1 % based on the final energy consumption.

Gross electricity consumption is to be reduced by 25 % by 2050 compared to 2008; by 2020 it should be 10 % lower. Final energy consumption in the transport sector is to be reduced by 10 % by 2020 and by roughly 40 % by 2050 in comparison to 2005.

Primary energy factors

Not every form of energy can be used equally well without being converted into another form of energy. Therefore, primary energy sources (e.g. oil, natural gas, etc.) must be converted into a technically more usable form, for example electricity.

The primary energy factor is the ratio of primary energy used to final energy delivered

Energy has to be expended in turn to extract, convert and distribute certain forms of energy. The primary energy factor is the ratio of primary energy used to final energy delivered. Here, the lower the primary energy factor, the more environment-friendly and more efficient the use and input of energy are from the source to the end user (see table 3).

Table 3 – Primary energy factor [4]

ENERGY TYPE	ENERGIE SOURCE	PRIMARY ENERGY FACTOR (ACCORDING TO ENEV, NON-RENEWABLE SHARE)
Fossil fuels	Fuel oil, natural gas, LPG, coal	1,1
	Lignite	1,2
Biogenic fuels	Bio-oil, biogas	0,5
	Wood	0,2
District or remote heating from CHP (or heating plant)	Fossil fuel	0,7 (1,3)
	Renewable fuel	0,0 (0,1)
Electricity	General electricity mix	1,8 (since 1.1.2016)
Environmental energy	Solar energy, photovoltaic	0,0
	Geothermal energy	0,0
	Hydropower, wind power	0,0
	Ambient heating, ambient cooling	0,0

The Energy Saving Ordinance (EnEV) applies in Germany; this specifies all the relevant primary energy factors of the energy sources. These factors are based in turn on the DIN V 18599-1 and DIN 4701-10/A1 standards and on the primary energy factor calculation methods referred to in these standards. The standardized primary energy factors can be changed, i.e. reduced, under certain conditions – for example documented proof and appropriate certification. This applies for some district heating providers that use a corresponding mix of energies or renewable energy sources to generate the heating.

3.5 Saving potential through improved energy efficiency

Germany needs energy – in large quantities. In 2015, the Federal Republic of Germany consumed 13,258 PJ of primary energy: 8,898 PJ of final energy was provided with 33 % losses. 29 % of this final energy was consumed by traffic, 29 % by industry, 16 % by commerce/trade/services and 26 % by households.

We have to deal more efficiently with energy in all areas

1,881 PJ and 521 TWh, respectively, of electricity were produced, 2 % of which was used by transport, 44 % by industry, 28 % by commerce/trade/services and 26 % by households (see figure 13).

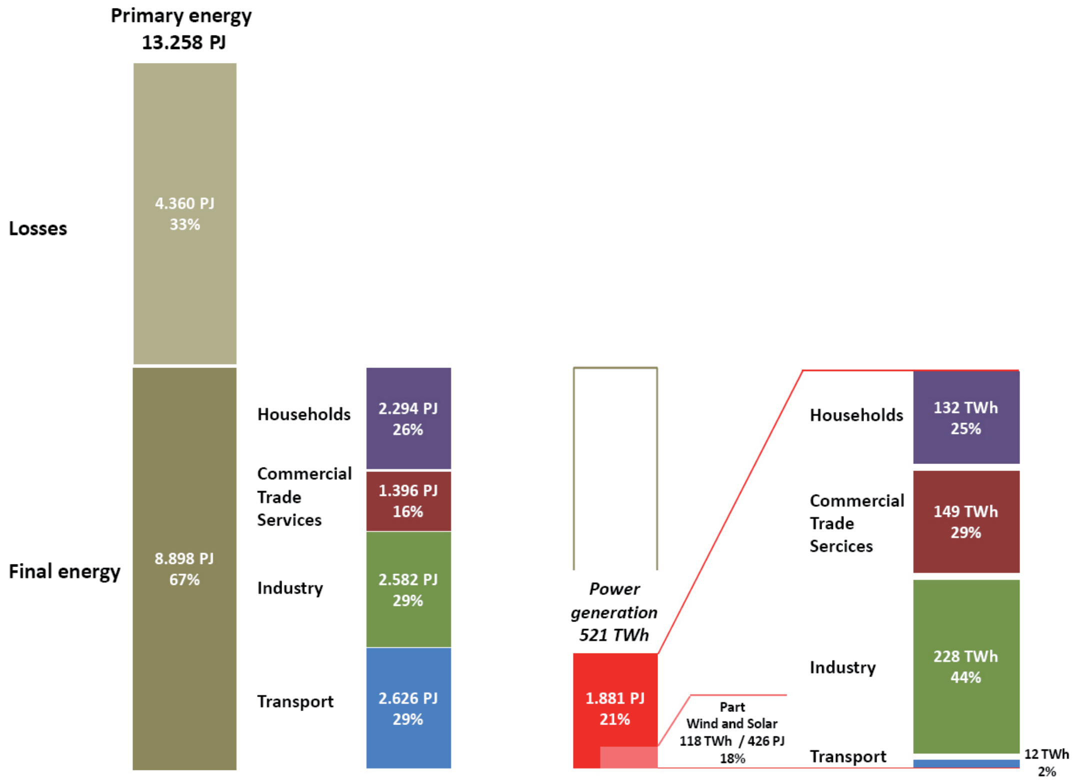


Figure 13 – Primary energy/Final energy/electricity (2015) [3]

Considered the share of electricity in the final energy, the traffic is at a low 2 %. Electricity accounts for 32 % of final energy consumption in industry, 38 % in commerce and services and 21 % in private households (see Figure 14).

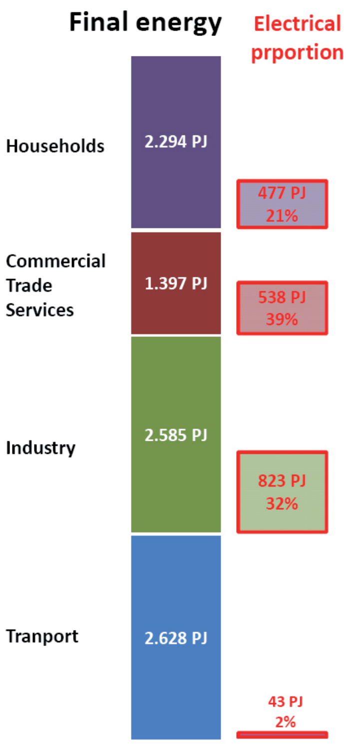


Figure 14 – Final energy [3]

Within the last 7 years (2008 to 2015) Germany's electrical energy efficiency efforts have led to a 3 % saving of electrical energy. Of particular interest here is the 29 % saving within the transport sector, and the 10 % increase in consumption in the commerce/trade/services sector (see table 4).

Table 4 – Savings of electrical energy 2008-2014

YEAR	2008	2015	SAVING
Total	536 TWh	521 TWh	3 %
Transport	17 TWh	12 TWh	29 %
Commerce/trade/service	136 TWh	149 TWh	-10 %
Industry	233 TWh	228 TWh	2 %
Household	140 TWh	132 TWh	6 %

Increasing energy conversion efficiency

Highly efficient conventional power plants will be an essential part of our energy supply in the future. It is all the more important that their energy conversion efficiency levels continue to rise. In the last 25 years, these have risen by more than 10 percentage points in gas and steam power stations (CHP).

Decreasing grid losses

We can also become more efficient in the transmission of electricity – a process which has already begun: grid losses have declined significantly since the year 2000. Thanks to the increased use of medium voltage with increased voltage as well as space-saving transformer stations in urban networks, it is possible to directly supply main consumption points.

Outlook

In the future, the efficiency proportion of households will be low. Home appliances are now highly efficient, lamps are being replaced by energy-efficient LEDs.

In industry, only motors conforming to IE3/IE4 standard (or IE2 standard plus speed control) may be used in new installations. These drives are up to 40 % more efficient and will have a positive impact in the long term. In the commerce/trade/services sector, LEDs and IE motors are also expected to have a positive effect on efficiency in the long-term.

The electrical proportion of the transport sector has yielded significant savings. However, the rising proportion of electric cars will increase the share of electrical energy significantly in the future [5].

3.6 The Rebound Effect

What is the "rebound effect"?

The term rebound is used to describe effects which prevent the potential savings resulting from effici ency increases from being realized (at all or in full). Ideally, we expect efficiency measures to result in corresponding savings. However, the greater the difference between expected and actual savings, the greater the rebound effect. In some cases, an increase in efficiency may even lead to increased energy consumption. If an increase in energy consumption which is independent of the efficiency gains mitigates the efficiency gains, there is no rebound.

The rebound effect decreases the energy savings obtained through energy efficiency by 10 %.

The rebound effect is the percentage of the theoretical savings potential of efficiency increases which cannot be saved due to consumer behaviour. For example, a 20 % increase in efficiency is expected to yield a 20 % decrease in resource consumption. However, if this only falls by 10 %, the rebound effect is 50 %.

Direct rebound

A direct rebound is an increased demand for the same good. Energy services which are provided more efficiently are thus cheaper. The cheaper the service, the greater the demand. For example, a more efficient lamp saves energy, (some of) which is then used for longer lighting periods (e.g. at night).

Indirect rebound

All those who save energy and therefore money due to increased efficiency, will spend the money on other things that also consume energy. This raises the demand for additional products that also require energy for their production, operation and disposal. For example, petrol will be saved after purchasing an efficient car. The money from this saving can then be used to book a flight.

Macroeconomic rebound effect

The energy saved is then available as additional supply on the (global) market. Additional supply reduces the price, which in turn stimulates demand. In other words: what one person saves is consumed by another. Therefore, less energy is saved overall than was expected as the result of the efficiency. This includes both direct and indirect rebound effects.

Energy efficiency strategy: factoring in the rebound

What appears to be quite reasonable in terms of personal finances can have an enormously magnified effect on an economy consisting of millions of people. The rebound effect therefore has to be taken into consideration in the energy transition and the associated increase in energy efficiency.

It is certainly not an option to use the rebound effect as justification for ignoring energy efficiency. Instead, the goal should be to make conscious savings and to take targeted advantage of the opportunities yielded by energy efficiency.

In the literature, it is assumed that the rebound effect will reduce the energy savings obtained through energy efficiency measures by an average of 10 %, although the results of individual studies vary between 0 and 30 %.

4 Legal environment and Framework

4.1 Legal basis of our energy supply system

What is the legal basis of our energy supply system? The EU has agreed a package of directives and targets which contains objectives for climate protection and energy consumption by 2020. The Federal Republic, too, has adopted guidelines for an environmentally friendly, reliable and affordable energy supply. The BMWi legislation overview in poster-form shows the corresponding regulations and directives at the European and national level and provides information on the key content while briefly and concisely outlining the links between German and European energy policy. Increasing energy efficiency is a cross-cutting issue which can only be achieved by society as a whole. It is also in the interest of energy consumers, as an increase in energy efficiency contributes to a significant reduction in energy costs.

The law card for the German power system can be found at http://www.bmwi.de/Redaktion/DE/Publikationen/Energie/gesetzeskarte.html.

4.2 EU-Energy Efficiency Directive

Energy efficiency in industry, building applications and transport

In times of rising energy prices and scarce energy resources, prosperity and competitiveness depend increasingly on the ability to make use of energy as efficiently as possible. This applies to industry as well as to private households and the transport sector.

Germany has to import most of its energy requirement. For this reason a tradition has developed in Germany over the last few decades of handling resources prudently and saving energy while still maintaining a high standard of living. The primary energy consumption is less than seven gigajoules per EUR 1,000 of gross domestic product (GDP) in Germany. In terms of its energy consumption, the Federal Republic is one of the most productive industrial nations in the world. In 2007 primary energy consumption reached its lowest value for more than 25 years, although the gross domestic product more than doubled in this period.

The label "Made in Germany" has long stood for high-quality products. Yet German technology is increasingly also perceived as offering above-average energy efficiency: Germany is regarded as the international market leader and a prime innovator in the field of energy efficiency technologies. This is also shown by the above-average number of patent applications in the areas of efficient building services engineering, energy-efficient industrial processes and energy-efficient industrial cross-cutting technologies. From 2002 to 2004 a total of 30 to 40 % of all worldwide patent applications in these areas came from German researchers and companies.

For example, the world market in condensing technology for gas and oil boilers (which allows efficiency rates of almost 100 % to be reached) was serviced almost exclusively by the German heating industry. The same is true for the systems technology market regarding the use of renewable energy.

International clients of German companies benefit from the stable German market for energy efficiency products. The continuity gives companies the planning security they need. Industries can then optimize their systems and components and assess innovations in real operation on an ongoing basis. Germany invests around eight billion euros in environmental protection, including considerable amounts in energy efficiency. With an export volume of almost three billion euros in environmental capital goods, Germany is among the leading suppliers in this field, too.

4.3 Ecodesign Directive

The Ecodesign Directive 2009/125/EC of the European Parliament and of the Council came into force in October 2009. It provides a legal framework for defining the requirements for the eco-friendly design of energy-related products. The new version replaced an earlier one which was limited only to energy-powered products; its aim is to achieve greater market penetration for more efficient products in the EU internal market.

The Directive is implemented in Germany in the form of the Energiebetriebene-Produkte-Gesetz (EBPG). The expanded scope, which is already in force at EU level (EVPG), was implemented nationally in the form of the Energieverbrauchsrelevante Produkte Gesetz (EVPG).

Essentially, the EVPG stipulates that energy-related products covered by an implementing measure may only be placed on the market, or put into operation (if they are not to be placed on the market), in Germany if they meet the requirements formulated in the relevant implementing measure. It is the responsibility of the federal states to monitor this.

The Ecodesign Directive permits the setting of minimum efficiency requirements for different product groups within the framework of individual implementing measures. Highly inefficient appliances should gradually disappear from the EU‘s single market. This will help to achieve the national and European climate protection goals. The requirements are being implemented in the form of EU regulations, offering the possibility for industry to commit itself voluntarily to minimum efficiency standards.

In order to focus the technical discussion nationally, the Federal Environment Ministry has set up an "EuP Network". This acts as a source of detailed information on the development process as well as on the current status of individual implementation measures.

The Ecodesign Directive covers all energy-related products and product groups (except vehicles)
- with a market volume of more than 200,000 units per year throughout Europe
- which have a considerable impact on the environment
- which have great potential for improved environmental performance.

Product-specific ecodesign requirements are specified for products of a product group in so-called implementing measures. These can be both requirements for the qualitative and quantitative description of significant environmental aspects, and/or quantified requirements for specific environmental aspects such as limitations on energy and resource consumption or harmful substance concentrations in the device. These implementation measures are automatically valid in all EU Member States.

The Ecodesign Directive sets mandatory minimum requirements for individual product groups. The Directive only provides the framework, whereas product-specific implementation measures (so far, without exception: regulations) are developed in a downstream process unless relevant self-regulatory initiatives (SRI) exist for the industry.

After a product group has been included in the work schedule, the steps towards establishing binding regulations are as follows:

1. Preliminary study   Compilation of background material

2. Working document   The first draft by the European Commission and discussions with the consultation forum; several drafts may be made here depending on the discussions (the links below contain the most recent document)

3. Draft of regulation for agreement in the regulatory committee

4. Forwarding of the draft to the EU Parliament for assessment

5. Legally binding Regulation: Publication in the Official Journal

Product groups and regulations related to the Ecodesign Directive are listed in Appendix 2.

CEN-CENELEC Coordination Group for Ecodesign

The Coordination Group for Ecodesign (Eco-CG) was set up in 2014 by CEN and CENELEC. Its purpose is to coordinate and advise on standardization activities in the field of ecodesign (see figure 15).

The main task of the Eco-CG is to ensure effective communication and to coordinate ecodesign activities and consistency between the European Commission (EC), the CEN-CENELEC Management Centre (CCMC) and the technical committees (TCs) of the CEN and CENELEC and between the TCs themselves.

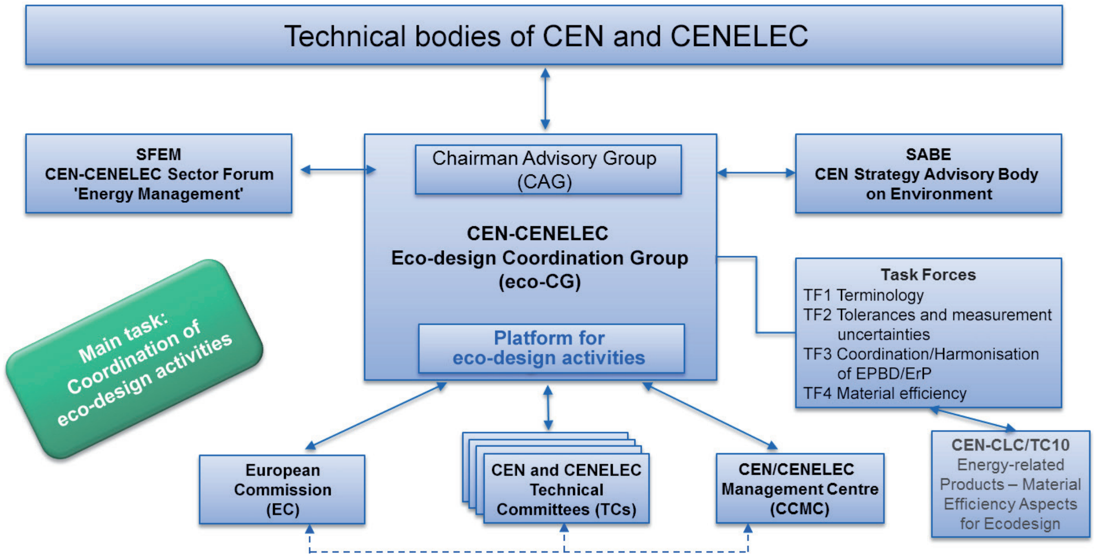
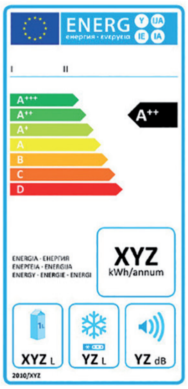


Figure 15 – Structure of the Coordination Group for Ecodesign (Eco-CG)

4.4 Energy consumption labelling (energy label)



The energy label is used to show the energy efficiency of household appliances. It creates uniform European market transparency regarding the energy consumption of products and provide consumers with important information to base their purchasing decisions on and to help them choose more efficient devices and save money.

At the same time the energy label helps retailers advise consumers on the energy characteristics of the products. It also contains additional information about the use of energy and other resources: e.g. water consumption, noise. This creates incentives for manufacturers continuously to optimize the energy efficiency of their products. Energy labelling therefore supports the market trend toward high-efficiency products.

Energy labels are mandatory for all regulated devices traded on the EU market and should be visible on all devices at the point of sale.

The legal basis for the labelling of products with the Energy Labeling Regulation, which has been in force since November 2017. This replaces Directive 2010/30/EU, which in May 2010 followed Directive 92/75/EEC which had been the basis for labelling in the EU since the nineties.

The new Energy Label Regulation applies for energy-related products. This includes also the window product category. An essential element of the new regulation is the "rescaling". This eliminates the A +, A ++ and A +++ classes introduced on some appliances. In some categories of equipment this addition is being undertaken in discrete steps over a number of years.

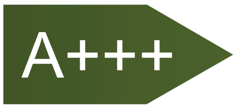
Product labelling is closely linked to the implementing measures adopted as a result of the Ecodesign Directive. Deciding which environmental parameters of a given product are considered relevant for labelling in addition to the energy consumption (e.g. the water consumption of washing machines) is based on the applicable Ecodesign implementing measure and the preliminary study drawn up for this in the preceding process. Furthermore, coordination and synchronization of the testing methods of the two regulation fields – Energy Label and Ecodesign – are essential. A great deal of importance is attached to this in the relevant standardization bodies.

The EU framework directive on the energy labelling of products has been implemented in Germany in the redraft of the Energy Consumption Labelling Act (EnVKG) and the amendment of the Energy Consumption Labelling Ordinance (EnVKV). Both regulations came into force on May 17, 2012 (Federal Law Gazette I p. 1070). The aim of these two acts of transposition is to improve the market monitoring of product labelling. This is achieved by expanding the enforcement powers and obligations of the countries with regard to market monitoring in accordance with Regulation (EC) No. 765/2008 of the European Parliament and of the Council. Effective market monitoring ensures a level playing field between companies and provides accurate information to consumers. The specific product groups which the EU Energy Efficiency Label applies to are determined by the product-specific legislative acts of the EU Commission. These also determine the point from which producer and distributor obligations apply to the individual product groups, and which transitional provisions are valid.

Linking different policy instruments can yield positive market developments.
Energy labels and tax incentives invigorate the market. Ecodesign stipulates minimum requirements for products.

The Internet label

In 2015 Regulation (EU) 518/2014, supplementing Directive 2010/30/EU, introduced a binding requi rement to provide information on the energy efficiency of products for online sale, online rental and online-purchase agreements. Upon coming into force this makes it compulsory for online stores to display the EU Energy Label (containing a colour scale and information on the best energy efficiency class within the class of products) for new products (with a new model identifier).



The aim is to increase the online transparency for consumers when purchasing energy-related products.

4.5 The new "ErP" energy label

Following adoption of the legislation by the European Union (EU), all manufacturers of space heaters, combi heaters, integrated systems consisting of space heaters, water heaters and hot water tanks should have implemented the new Ecodesign Directive as well as the new energy labels by September 2015. The regulation for energy-related products – abbreviated to ErP – evaluates different devices and divides them into various efficiency classes.

Everyone is already familiar with these from their refrigerators, televisions and washing machines, and the same will then also be implemented for heaters and water heaters. Heating pumps, hot water heat pumps, solar storage units and indirect storage systems will have to carry energy labels which are valid Europe-wide.

Heating pumps are classified into nine classes of efficiency. A++ is the best energy efficiency class, G identifies devices with the lowest values. The energy efficiency classes of heat pumps for heating are determined on the basis of an annual COP. This depends on the climate region and also on the potential heating system. Europe is therefore divided into three climate regions. The different temperatures and possible energy efficiency classes for radiators and underfloor heating systems are given on the energy labels.

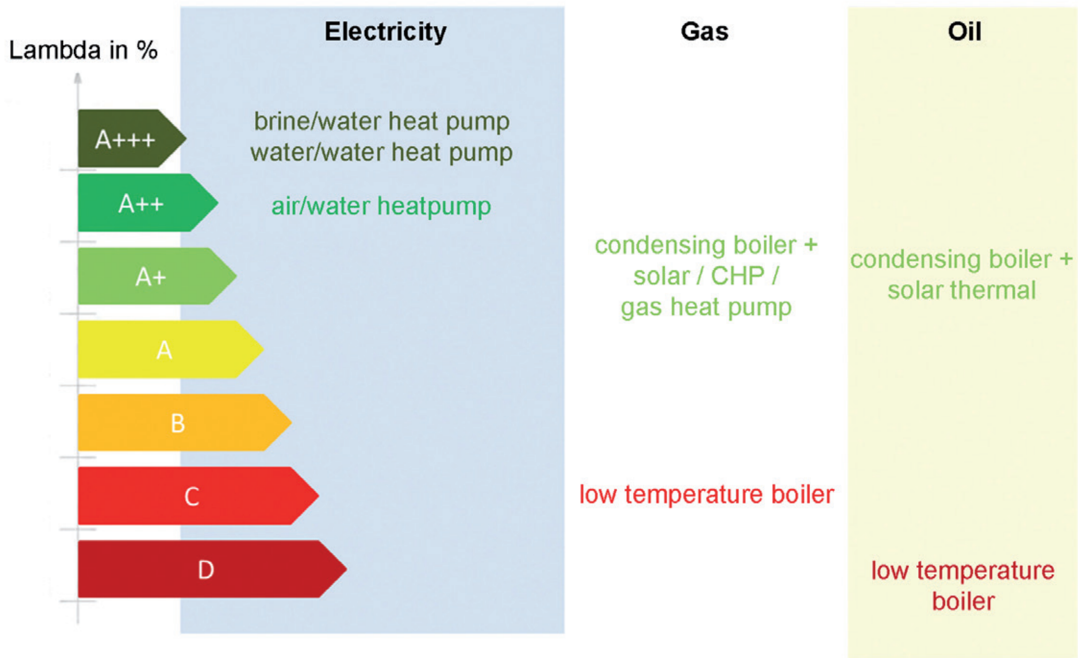


Figure 16 – Energy label – classification of product label [6]

4.6 EU ENERGY STAR programme

The ENERGY STAR is a specific voluntary label. Originally established in America in 1992, it served to identify consumer devices (office equipment) which observed certain energy consumption standards. In 2001, the European Union signed an agreement with the US EPA, following which ENERGY STAR was also introduced in Europe (only for office equipment). It is not part of the Ecodesign regulation.

4.7 The European Ecolabel

The European Ecolabel is a voluntary scheme. It was introduced in 1992 to encourage businesses to market greener products and services. Environment-friendly products or services can easily be identified by consumers from the "Euro Flower". The Ecolabel has since been eclipsed by other developments.

4.8 Energy Services and Other Energy Efficiency Measures Act (EDL-G)

The main contents of the Act are the Federal Government's authority to set an overall national target for energy savings for 2017 as well as obligations upon energy companies to develop and promote a market for energy services and other energy efficiency improvement measures. Key requirements here include information obligations regarding such services and, where appropriate, a duty of care by the energy business to provide a sufficient range of energy audits. The Act also contains provisions concerning the exemplary role of the public sector. The existing Federal Bureau of Energy Efficiency, part of the Federal Office for Economics and Export Control (BAFA), was also tasked with further data gathering and support functions.

4.9 Greenhouse Gas Emissions Trading Act (TEHG)

The central instrument of the European Union for combating climate change and increasing energy efficiency is emissions trading. Since 2005, for fossil fuel power plants and industrial plants which produce carbon dioxide:

- an upper limit for the permissible annual emissions has been determined,
- certificates have been issued or auctioned for the permissible amount of emissions,
- trading with certificates has been facilitated.

The value of currently traded emission allowances must be more expensive in order to achieve a savings effect.

4.10 Energy Saving Act (EnEG)

The Act for saving energy in buildings (Energy Saving Act – EnEG) was adopted in 1976 in the wake of the first oil crisis; it was last revised in 2005.

Its objective was to achieve energy savings in buildings.

The act empowers the German government to regulate the details of thermal protection in the Energy Saving Ordinance to prevent avoidable energy losses in heating and cooling (Art. 1 para 1 EnEG).

4.11 Energy Saving Ordinance (EnEV)

The Energy Saving Ordinance (EnEV) and the Energy Saving Act (EnEG) are essential energy efficiency policy tools of the Federal Government. The amended EnEG came into force on 13 July 2013. The EnEV came into force on 1 May 2014. The core elements of the EnEV amendment are:

- An increase in the efficiency standards for new buildings: Requirements raised by approx. 25 % (primary energy demand), and approx. 20 % (thermal insulation of the building envelope) from 1 January 2016.
- Building stock: No increase in the requirements when changes are made to external parts of existing buildings. Only two outdated special cases (exchange of display windows and exterior doors) have been brought up to the level of the EnEV 2009.
- Introduction of compulsory declaration of energetic characteristics in property sale and rental ads
- Clarification of the existing requirement to present the energy performance certificate to potential buyers and renters (energy performance certificate must be presented upon inspection of the property to be rented or purchased).
- Introduction of the obligation to transfer the energy performance certificate to the buyer or new tenant.
- Expansion of the existing requirement to display energy performance certificates in official buildings frequented by the public to include smaller buildings.
- Introduction of a requirement to display energy performance certificates in certain buildings frequented by the public but which are not used for official purposes.
- Introduction of an independent sampling control system for energy performance certificates and reports on the inspection of air conditioning systems.
- Inclusion of efficiency classes in energy performance certificates for residential buildings and duty to identify these in sale and rental property ads.
- Mandatory decommissioning of constant temperature boilers which were installed before 1 January 1985 or more than 30 years ago (previous reference date: January 1978; boilers in certain owner-occupied detached and semi-detached houses are still excluded).
- Some of the new obligations are punishable by a fine.

4.12 Directive on the Energy Performance of Buildings 2010/31/EU

The EU Directive on Energy Performance of Buildings (EPBD) took effect in July 2010. It stipulates that all new buildings in the EU from 2021 must be built close to the level of zero energy homes, thereby helping to reduce energy demand levels and CO_2 emissions. It should also significantly reduce the dependence on energy imports.

All Member States are first required to define how they intend to meet these requirements. However, it is not only new buildings which are affected by the Directive: the minimum requirements must also be met whenever an old building is extended or modernized.

4.13 Energy transition

The energy transition is one of the most important and difficult economic and environmental policy task in Germany. The policy of shifting Germany's energy supply away from oil, coal, gas and nuclear power to renewable energy is referred to as the energy transition.

Further objectives besides energy savings include the full withdrawal from nuclear power by the year 2022, an increase in energy efficiency for more rational use of primary energy sources, greater independence from energy imports such as oil and gas, and strengthening of Germany as a business location through innovations in the energy sector. In addition, 40 to 45 % of the power supply should come from renewable sources by 2025, rising to 55 to 60 % by 2035.

In addition to the environment and climate, the German economy should also benefit from the energy transition – the dependence on international oil and gas imports in particular should be reduced. Germany currently imports roughly EUR 80 billion worth of coal, oil and gas each year. This sum is to be gradually replaced by domestic value added in the form of renewable energies in the coming years.

These measures will also generate additional export opportunities and the prospect of more jobs. The expansion of renewable energies alone has currently provided employment for over 371,000. A further central task is reinforcing the ‚second pillar' of the energy transition – the more economical and efficient use of energy.

The energy-related modernization of old buildings is of special importance in terms of energy efficiency. This is being promoted by the Federal Government. The building sector accounts for approximately 40 % of CO_2 emissions.

4.14 National Action Plan for Energy Efficiency (NAPE)

Energy efficiency is the second pillar of the energy transition. The National Energy Efficiency Action Plan (NAPE) describes the energy efficiency strategy of the German government for the 18th legislative term. Energy efficiency and energy savings are more than just slogans, especially in light of the fact that the global demand for energy is continually rising. In the future this will also be reflected in the energy price. In addition to the further expansion of renewable energy, the efficient use of energy will therefore be a key element in helping Germany retain its status as a world leader in this field. It is not just about saving energy as a means of reducing energy costs in industry and commerce or for private consumers. It is also about new business models, new energy saving innovations and innovative new products that the German economy can score highly with on the world market. At the same time, energy efficiency is an important part of the German investment strategy. The profitability of investment in efficiency is generally higher than the return on long-term investments currently achieved in the capital markets. The profitability of investment in energy efficiency can be 20 to 25 %, especially for smaller and medium-sized enterprises. This clearly shows the huge potential which lies in increasing energy efficiency.

The objective of NAPE is to persuade all market players of the benefits of improving energy efficiency and to integrate them in the efforts. The purpose of NAPE is to highlight possibilities and opportunities for all players and to ensure that commitment to energy efficiency is viewed positively. By offering a smart mix of advice, communication and information about worthwhile efficiency and support measures and by setting standards for new plants, NAPE contains a range of instruments designed to raise the appeal of energy efficiency and provide a first step towards exploiting the huge potential. NAPE defines immediate measures and further work processes which formed the core of the energy efficiency strategy in the 18th legislature period.

The predominantly already implemented key NAPE measures include
- Introducing a new competitive tendering system for energy efficiency
- Increasing the volume of funding for building refurbishment and introducing a federal and state-level tax incentive scheme to promote efficiency measures in the building sector.
- Creating energy efficiency networks in conjunction with industry and commerce.

4.15 Energy Efficiency Market Report 2015

In its Energy Efficiency Market Report 2015 the IEA reports that the per capita energy consumption has declined in IEA countries to a level not seen since the 1980s. It also reports that the per capita income has never been higher. Investment in energy efficiency over the last 25 years is the main reason for this decoupling of energy consumption from economic growth which has made it possible for consumers in IEA countries to spend USD 5.7 trillion less on energy while enjoying better energy services. Yields on investment in energy efficiency are not limited purely to financial gains; the Energy Efficiency Market Report 2015 (EEMR 2015) examines the strategic returns for consumers, industry (including utilities) and governments from improvements in energy productivity, energy security and from reduced greenhouse gas emissions.

In 2014, the estimated total final consumption (TFC) avoided due to investment in energy efficiency increased to more than 520 million tonnes of oil equivalent (Mtoe) or 22 exajoules (EJ). Supported by directives aimed at providing strategic yields, it is expected that the energy efficiency market will grow in the medium term, even against the current backdrop of lower oil prices.

Energy Efficiency Market Report 2015 Highlights

- The energy intensity of the Organization for Economic Co-operation and Development (OECD) countries improved by 2.3 % in 2014. OECD energy consumption is now as low as it was in 2000, while GDP has grown by USD 8.5 trillion, an increase of 26 %. This suggests that these countries have successfully decoupled economic growth from energy consumption growth, with energy efficiency being the most important factor.
- The security of energy supply in IEA countries has improved with increased energy efficiency. In 2014 alone, at least 190 Mtoe (7790 petajoules [PJ]) of primary energy imports were avoided in IEA countries, saving USD 80 billion in import bills.
- Energy efficiency improvements in the IEA countries since 1990 have avoided a total of 10,2 billion tonnes of CO_2 emissions and helped to make the 2-degree warming target easier to achieve.
- Global investment in energy efficiency in buildings, which accounts for over 30 % of global energy demand, is estimated to amount to USD 90 billion (+/-10 %), and is still rising.
- Electricity consumption has flattened in IEA countries partly as a result of improvements in energy efficiency; investment in energy efficiency since 1990 saved 2,200 terawatt hours (TWh) in 2014. Given the flattened electricity demand, some power utilities are diversifying into energy efficiency service companies as a means of increasing profits.

Energy efficiency – "Virtual supply" of more than 500 Mtoe

Energy efficiency has been the most important factor in the reduction of energy consumption in the IEA countries in the past decade. In 2014 alone, investment in energy efficiency in IEA countries since 1990 avoided 520 Mtoe (22 EJ) of total final consumption (TFC). This is more than the annual total final consumption (TFC) of Japan and Korea combined. The total final consumption (TFC) avoided through energy efficiency increased by 10 % or 46 Mtoe (1,930 PJ) in 2014, the fastest rate in nearly a decade.

Investment since 1990 has resulted in 256 EJ (6,120 Mtoe) of avoided total energy consumption, with reductions in electricity and natural gas usage dominating. Like other fuels, energy efficiency permits increased demand for energy services to be met, yet its role in the energy system is often overlooked. This "virtual supply" from energy efficiency is increasingly competing with oil, gas, electricity and other traditional components of total final consumption (TFC).

Various investment returns highlight the many benefits of energy efficiency

The energy saved through energy efficiency yields significant financial returns; the expenditure avoided in the past 25 years due to investment in energy efficiency in IEA countries is put at USD 5.7 trillion for energy consumers, more than the GDP of Japan or Germany in 2014. In 2014 alone, this amounted to over USD 550 billion in avoided energy expenditure. These yields for energy consumers are only part of the picture.

Investment in energy efficiency offers many different returns that go beyond the financial benefits for governments, industry and individuals. Energy efficiency can help achieve many of the key strategic goals of the various economic actors throughout the world. Investment in efficient buildings, transport and industrial processes can deliver e.g. economic, social and environmental benefits.

Domestically produced energy efficiency supports energy security

According to countries' own estimates, in 2014 energy efficiency investment since 1990 enabled the countries to avoid at least 190 Mtoe of primary energy imports (where import structures exist) with an estimated value of USD 80 billion. Each country creates its own local improvements in energy efficiency (for example, by using better insulation and more efficient vehicles), which in turn makes each country a producer of the energy efficiency fuel.

According to estimates, Germany achieved the highest reduction of all the IEA countries in the volume of imports (55 Mtoe), thus avoiding expenditure of USD 30 billion in 2014. The avoided imports resulting from this investment improved the German trade balance and resulted in a 12 % increase in Germany's trade surplus in 2014.

Energy efficiency – a "zero-emission" energy source which reduces the impact on climate change

Improvements in energy efficiency in IEA countries avoided 870 million tonnes of CO_2 in 2014 and 10.2 Gt of CO_2 in the period since 1990, effectively avoiding almost a year's worth of energy sector emissions into the atmosphere from IEA countries. Environmental benefits from energy efficiency attracted a great deal of attention during the negotiations of the UN Framework Convention on Climate Change (UNFCCC) in Paris at the end of 2015. On account of its potential for avoiding the burning of fossil fuels at relatively low cost, energy efficiency will play a central role in decarbonization efforts in the medium term.

Well-targeted directives will also continue to encourage investment in energy efficiency. Even in a low oil price environment, investment in energy efficiency will increase, driven by more assertive and wide-ranging directives. Several factors suggest that the market for energy efficiency will remain stable in the medium term. Most important here is the existence of powerful and increasingly stringent directives which include energy efficiency measures as some of the most cost-effective means of helping to overcome the challenges of energy security, productivity, local air pollution and climate change.

Buildings are a large and growing market for energy efficiency

Global energy efficiency investment in buildings in 2014 is estimated at 90 billion US dollars (+/-10 %). In Germany, energy efficiency investment exceeded USD 17 billion, including 75 % for residential buildings and more than 60 % for energy efficiency modernization.

Global energy efficiency investment in buildings is expected to rise to about USD 125 billion by the year 2020, partly driven by expanded efficiency measures. Now that energy efficiency provisions, standards and programmes are being improved and implemented to a greater extent, building-related energy efficiency investment is also set to increase in most OECD countries. However, this is much less than the estimated USD 215 billion required for building sector investment by 2020 in the IEA 2-degrees scenario (2DS).

Energy efficiency is flattening demand for electrical energy in the OECD countries and thus challenging the business models of the utility companies.

The flattening of electricity consumption observed since 2010 in the OECD countries is essentially due to energy efficiency. Improvements in appliance efficiency alone, underpinned by increasingly strict product standards, reduced the demand for electric energy by 430 TWh in the OECD countries in 2014. In response to the low growth in demand for electrical energy in OECD countries, the energy utilities are branching out into energy efficiency and other energy services to increase their revenues. The most important European suppliers have achieved billions of euros in sales with these product and service lines, with annual sales growth of 3 % to 4 %.

Various players are actively setting up energy efficiency markets

Energy efficiency is playing an increasingly important role in different national, regional and even global objectives, with policy makers, businesses (including utilities) and consumers as the main market players. In many markets around the world, the combination of energy efficiency strategies and new business models is driving substantial investment in energy efficiency.

4.16 Energy efficiency market prospects

New dynamics in the energy sector are having a major impact on the future of the energy efficiency market, both in Germany and worldwide. Comprehensive political announcements around the globe (including the proposed national contributions to the UNFCCC) are expected to stimulate further interest in the pursuit of energy efficiency for a wide range of national objectives, such as

- more sustainable economic development,
- reduced dependence on imports,
- increased energy security and
- lower levels of local pollution and greenhouse gas emissions.

In return, stable and increasingly strict policies are likely to increase growth in the energy efficiency market in the next ten years, with the aim of attracting more capital for investment in building energy efficiency, for example.

The energy efficiency market will also continue to develop as new cycles of stimulating and retarding forces exert their influence on economic and investment. The overall assessment of the 2015 Energy Efficiency Market Report is that the market is expected to grow in the next few years in size, visibility and importance. As governments continue to prioritize economic growth, energy security and a healthier environment, improving energy efficiency remains an important and cost-effective measure for achieving national, regional and international targets.

4.17 Disruptive technologies

Technologies are continually evolving – incrementally, but occasionally also in huge leaps.

"A disruptive technology is an innovation which may completely oust an existing technology, an existing product or existing services," according to Wikipedia. This can also be observed in the field of energy efficiency. Not infrequently, the gradual improvement in product efficiency is given a significant boost by new technologies being incorporated into well-known products or competing with them.

Disruptive technologies often completely redefine the rules of the game, and fundamentally alter established markets within a short time. Companies therefore need to monitor and strategically review the emergence of new technologies long before they reach market maturity. Only through early awareness of disruptive technologies can companies anticipate their future competitive environment and develop a competitive edge at an early stage.

Examples of such technological leaps in the field of electrical energy efficiency include:
- Flat screens which replaced cathode ray tubes in TVs and computer monitors. This innovation was made possible by the arrival of LCD technology.
- LED lamps which are replacing the incandescent lamp. In the European Union, lamps with a lower energy efficiency rating than "B" may no longer be sold as of 1 September 2018.
- Heat pump dryers which are especially economical. They offer the same convenience and flexibility as conventional condensation dryers but use up to 50 % less power.

4.18 User behaviour and energy efficiency

Even small changes in behaviour can lead to remarkably large savings. What is more difficult, however, is to raise awareness in users (be it in production and administration or in the home and leisure fields) of the possibilities and potential of energy efficiency.

Examples:
- Using the dishwasher instead of hand washing: a dishwasher is considerably more economical than washing by hand. It is not even necessary to pre-rinse the dishes before putting them in the dishwasher. Dishwashers work most efficiently when they are full. And the eco programme should be the programme of choice.
- Always fill the washing machine: the power consumption of older models is independent of the load in most cases, and even modern machines with automatic capacity control only save about one-third of the energy when the machine is half filled – and not half, as might be expected.

4.19 Consumer-relevant tests

It is widely accepted that consumer relevance is a major driving force behind the development of standards. This is reflected in political discussions and various developments, especially with regard to the new framework regulation for energy labelling. However, surveys carried out among consumer and environmental organizations reveal that some standards describe testing procedures which yield considerably different results to those obtained by consumers in practice.

Devices are operated by different users and work under a wide range of ambient conditions (temperature, humidity, etc.). They consume energy and sometimes use other resources (such as water and detergent) in order to deliver the desired performance (e.g. clean laundry or crockery) within a given time. All these parameters influence each other. The ambient conditions can also depend on the location of the device (e.g. kitchen, basement, garage, loft) and may vary during the year.

The results of product tests should be as close as possible to those obtained under common practical conditions. For this reason, the test standard must include a suitably wide range of conditions, input variables and types of user behaviour (including extreme conditions). The measured consumption values can then also be labelled as "consumer-relevant".

Many standards serve to determine prescribed threshold values which are stipulated in the Ecodesign and Energy Labelling regulations. The measurement methods described in such standards must yield reproducible results at acceptable cost levels. At the same time, they should reflect the expectations and behaviour of consumers as accurately as possible.

A standard can basically cover a broad range of widespread practical options. But the legislators must then select from these options with the aim of achieving reasonable testing costs and providing precise, relevant and comparable information to consumers about the specific energy consumption. Naturally, these decisions should reflect actual practice. Irrelevant information can mislead consumers.

A large selection of wash programs are described, for instance, in the washing machine standard. Yet in the regulation, the two most commonly used wash programs have been selected (with different loads) for the energy label and used to determine the energy efficiency index, as a compromise between practical relevance, consumer behaviour and testing costs.

The system approach considers not only the individual components, but also their interactions

Standard-based testing thus yields results which are then compiled and evaluated by the legislators. The consumer relevance of energy efficiency indices compiled from individual results thus represents both a standardization challenge but also a consumer-relevant regulation task.

4.20 Measurement uncertainty, repeatability and reproducibility

In order to promote the efficient use of energy and other resources, the European Commission, Parliament and Council have adopted various provisions concerning the provision of information or stipulating basic requirements. This information is conveyed e.g. through the labelling obligations contained in the Energy Labelling Directive (2010/30/EU), eco-design requirements contained in the Ecodesign Directive (2009/125/EC), and regulations based on these guidelines.

The methods for measuring energy, resource consumption and performance characteristics must be clearly described and offer sufficiently precise and relevant measurement and calculation, for example in order to meet the labelling obligations and the expectations of governments, consumers and producers.

The accuracy of a test procedure is determined by its systematic error and precision values.

Precision in the analysis of test methods is expressed in two measurement concepts: repeatability and reproducibility.

A repeatable test procedure is one which allows the same operator to obtain sufficiently accurate results over a number of tests.

Measurement methods must be clearly described and yield sufficiently precise results

A reproducible test procedure should produce sufficiently similar and accurate results in repeat tests conducted using different measurement equipment, at a different location and by a different operator. Reproducibility and repeatability are both measures of uncertainty and should be quantified numerically.

Documentation of uncertainty as part of the test results is critical for ensuring that the measurement data can be interpreted correctly. This applies in particular if measurement data is to be compared between laboratories, or if compliance with regulatory requirements is to be verified.

Each measurement contains a degree of uncertainty. Measurement uncertainty can result from the measuring device, the object being measured, the environment, the operator and from other sources.

Each standardization committee is responsible for determining the repeatability and reproducibility of any measurement standards it has developed, e.g. using round-robin tests.

The results are important for:
a) identifying differences between laboratories,
b) determining the effectiveness and comparability of test or measurement methods,
c) validating (measurement) uncertainty,
d) evaluating the performance of laboratories for specific tests or measurements, and monitoring their performance for consistency,
e) recognizing problems in laboratories and initiating improvements made necessary e.g. by inade quate test or measurement methods, inadequate personnel training and supervision or inadequate instrument calibration, and
f) providing training to the participating laboratories based on the results of such comparisons

4.21 Products vs. systems

The system approach always starts with determining the system boundaries. These are used to identify the total input and to express this in relation to the desired or achieved output. In certain cases, it may not be possible to assign a physical quantity, such as comfort, to the desired output. Optimization of energy input should start with the key consumers. At some point, however, limits are reached, as the system optimum is not the sum of the component optima.

The system approach not only considers the individual components, but also also their interactions

In order to analyze the energy efficiency of a complex system, it is necessary to adopt a system approach which takes not only the individual components, but also their interactions into account. It may then make sense to accept higher energy losses in a part of the system, if this increases the energy efficiency of the system as a whole.

Energy efficiency can therefore be increased through judicious system planning, such as using individually switchable lighting in an open-plan office (according to DIN EN 15232). Lights close to windows can be switched off when there is enough natural light, while those close to the interior walls remain on.

In any production process, there are different ways of using effective planning to reduce the energy input while obtaining the same result, e.g.:

- switching off steam supply to inactive machines
- avoiding oversized motors
- optimizing machine arrangement to reduce losses caused by material transport
- heating water as close as possible to the place of use in order to avoid conduction losses
- optimizing processes (e.g. switching off unused machines)

The following example from IEC Guide 119 shows how changing the system boundaries can lead to better solutions. First, all processes are assessed individually.

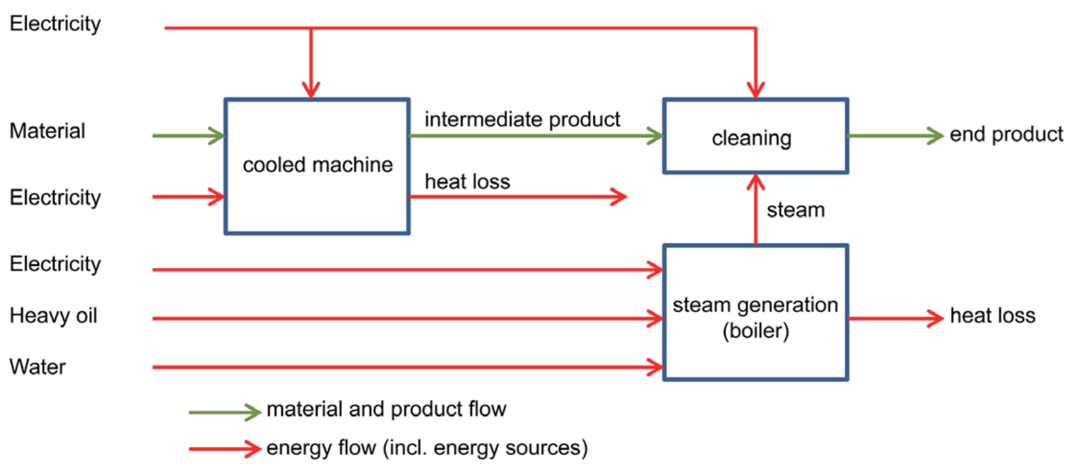


Figure 17 – Boundary setting example: three boundaries for independent solution

If machining and cleaning are combined into one system, this yields the following:

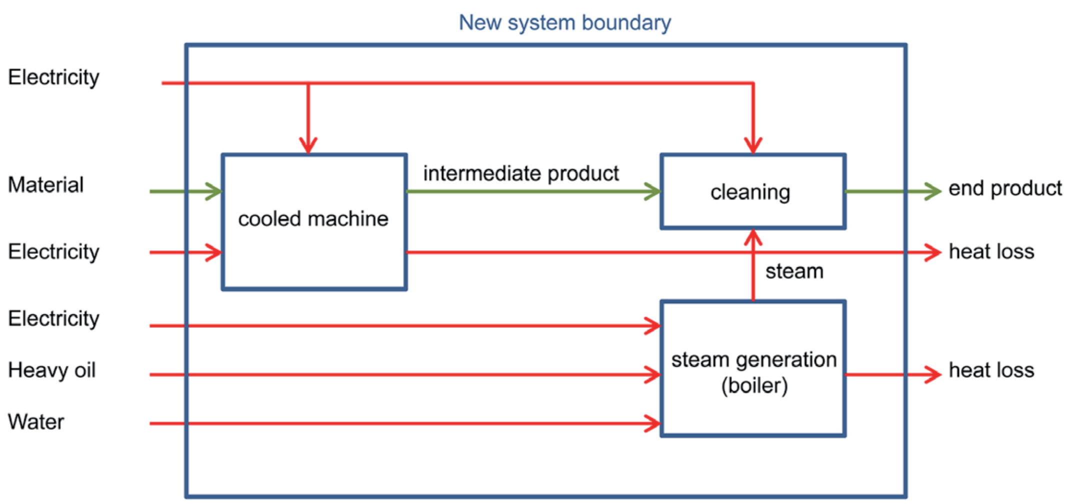


Figure 18 – Boundary setting example: a boundary of a group

By replacing the boiler with a heat exchanger, heat loss from the machine can be used to support steam generation and thus improve the overall result.

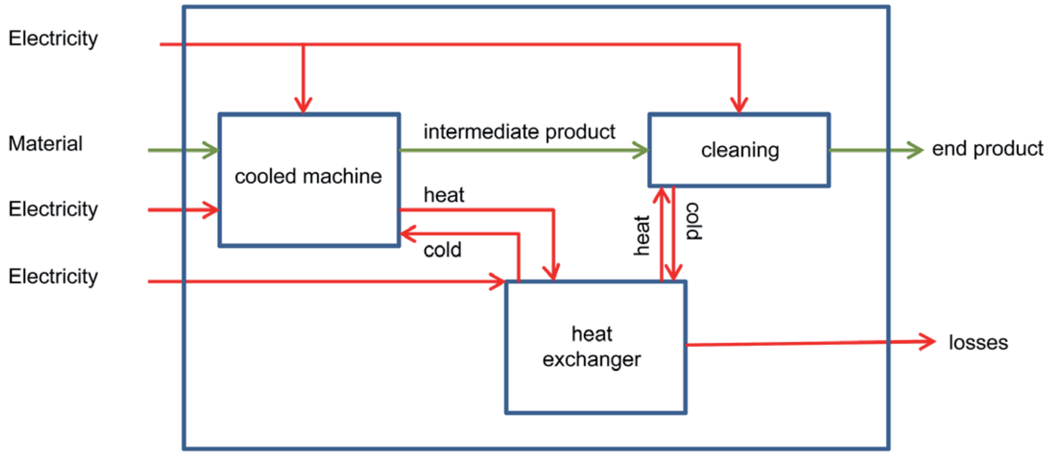


Figure 19 – A boundary of group with systematic solution

Over time, a time shift in energy consumption can also reduce the total energy consumption, as machines then operate for longer in the optimum load range. Temporary storage can also increase the energy efficiency of a system. However, it must be borne in mind that any storage results in losses.

Another area with high savings potential is the building sector. It is important to consider energy-efficient products when selecting air conditioning components, yet taking a systematic approach to planning and design is even more crucial. The effects and interactions of the components (outdoor climate, local indoor climate requirements, occupants/users, walls, windows, "heating, ventilation, air-conditioning technology" (HVAC), etc.) are thus being examined on the energy efficiency of the overall system. The choice of coolant (air, water, etc.), for example, should be determined by the energy flow through the building. Similarly, too great a focus on the cheapest supplier at the contracting stage can lead to significantly higher energy consumption and thus to much higher costs during the life cycle.

If the system approach is expanded even further, a number of buildings can be combined to form a complex or campus, and their energy exchange optimized accordingly. Here the different responsibilities (building operators, electricity, gas, water, district heating) are to be considered.

5 Local Consumption

5.1 Home

In 2014 private households in the Federal Republic of Germany spent about 69 billion on electricity, gas and other fuels. This corresponds to a 7 % share of total consumer spending.

Approximately 22 % (2014) of private households have signed a contract for the purchase of green electricity. At the same time, energy efficiency is gaining more and more in importance. A survey conducted by Initiative EnergieEffizienz shows that three-quarters of the population are convinced that they are actively contributing to the success of the energy transition by reducing their energy consumption in the home. 55 % of private consumers stated that they implemented energy efficiency measures in 2015 aimed at reducing power consumption and energy costs.

Private consumers can make a great contribution to the success of the energy transition. The average electricity costs per household can be reduced by about 30 % through energy efficient appliances.

The first major changes have already been made: from 1990 to 2012 the emissions of climate-damaging greenhouse gases were successfully reduced by almost 25 %. This puts Germany in the leading position in the EU.

The main objectives of the energy transition:
- Improvement of energy efficiency,
- Climate protection through the reduction of greenhouse gases,
- Phasing out of nuclear energy use,
- Increased use of renewable energy.

Secure-supply electricity market

The target electricity market guarantees security of supply for an environmentally sound and economically prosperous future. An important lever for achieving this is energy efficiency: every kilowatt hour of power saved reduces the need for wind turbines, fossil fuel power plants and new networks. This lowers the cost of converting the current energy system.

All stakeholders will need to do their part if the energy transition is to succeed. The 41 million households in Germany are faced with the challenge of managing their energy prudently and responsibly. They consume about 723 TWh of energy in total per year. This represents over 28 % of total final energy consumption.

Energy efficiency – Advantages for consumers

Climate protection and energy efficiency can be tackled immediately in every household – with the positive side effect that consumers directly reduce their electricity costs. An average four-person household, for example, consumes about 3,200 kWh of electricity per year. This corresponds to an annual cost of approximately EUR 900. Of this, up to 30 % can be saved by various measures.

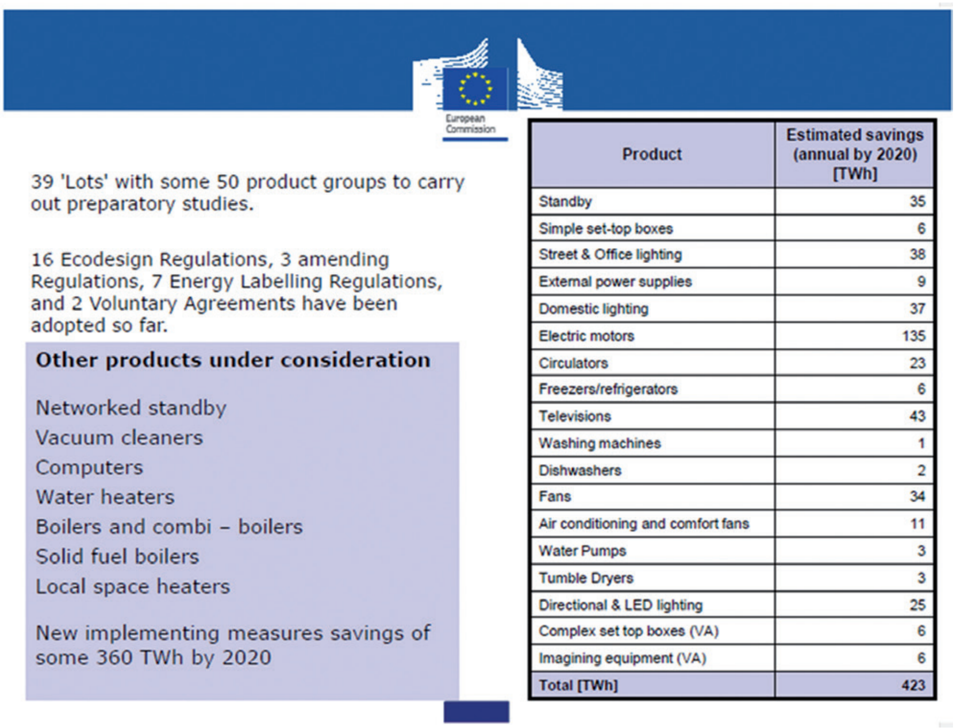
A major contribution can be made by energy efficient appliances and lighting systems. The European Union has therefore introduced the uniform EU Energy Label especially for consumer-related products. The Ecodesign Directive also requires manufacturers to meet certain minimum requirements.

5.1.1 Household appliances

Energy efficiency is an important competitive factor. This motivating force has led in recent years to today‘s home appliances being much more energy efficient than they were 20 or 10 years ago. The legal instruments of the EU Energy Label and the Ecodesign Directive have contributed to this success. And the contribution of standardization is also beyond dispute. Because only accurate test methods make technological advances apparent and allow improvements in energy efficiency to be quantified. Savings of about 50 % can in fact be achieved by replacing older home appliances with new energy efficient ones. In individual cases, this figure can also be significantly higher. Such modern home appliances are so energy efficient that it is certainly worthwhile (see figure 20).

The EU Commission estimates the potential savings obtainable through Energy Label and Ecodesign measures at several hundred TWh per year by 2020. By comparison, the figure for household appliances seems relatively low at 20 to 30 TWh. The lion‘s share is not, however, accounted for by home appliances but by industry and the building sector.

Today‘s household appliances are already very energy efficient. Further technical developments will not yield the substantial savings of recent years. Smaller advances are expected. The challenges now lie in the networking of devices and the efficient use of renewable energy sources.



Product	Estimated savings (annual by 2020) [TWh]
Standby	35
Simple set-top boxes	6
Street & Office lighting	38
External power supplies	9
Domestic lighting	37
Electric motors	135
Circulators	23
Freezers/refrigerators	6
Televisions	43
Washing machines	1
Dishwashers	2
Fans	34
Air conditioning and comfort fans	11
Water Pumps	3
Tumble Dryers	3
Directional & LED lighting	25
Complex set top boxes (VA)	6
Imagining equipment (VA)	6
Total [TWh]	423

Figure 20 – Energy savings [7]

Energy efficiency in household appliances basically concerns the ratio of product characteristic to energy consumption. Use of the devices is defined in the EU Energy Label and Ecodesign regulations, with these focusing primarily on the environmentally relevant product characteristics such as washing effect in washing machines, cleaning effect in dishwashers or dust removal in vacuum cleaners. Parameters such as water consumption and noise emissions are also included. The details and legal requirements of the EU Energy Label and Ecodesign regulations are very varied and, in many cases, not readily comprehensible by consumers and users. Nevertheless, it is generally well understood that a high energy efficiency class (A+++ or A++) is most important.

Energy labels allow customers and users of the devices to compare products on the basis of the label information.

Standardization focuses accordingly on measuring methods for determining these precise product properties. The test procedure must deliver "reliable, accurate and reproducible" values. This is essential for customers and users, and for fair competition. Only if the market monitoring can accurately check the specification values can one speak of a meaningful legal measure. Regulation, standardization and conformity constitute a single unit. Only if this unit works well can regulative measures take effect. This indispensable requirement can only be met by means of defined laboratory conditions.

The test methods for household appliances are highly complex. EN standards are harmonized standards and are listed as such in the Official Journal of the EU Commission under the relevant regulation. They must be developed on the basis of EU Commission standardization mandates.

In washing machines roughly seven cycles are tested. Three cycles at 60°C full load, two cycles at 60°C part load, and two cycles at 40°C part load. These weighted test cycles are averaged. For total energy consumption, by contrast, the operating states "switched off" and "not switched off" are included. 220 cycles are assumed for the final calculation of the annual energy consumption. It should be mentioned that washing machines are to be loaded with standard textiles. The washing effect counts in addition to the energy consumption which is why test strips with standard soiling levels are added. The washing performance is visually determined from these test strips in a standardized procedure. The "standard soiling" reflects the types of pollution which occur in reality. These are mineral oil, grease, blood, cocoa and red wine.

Similarly elaborate test procedures are defined in the other device categories in the harmonized EN standards. As far as possible they reflect everyday use under real conditions while meeting accuracy, reliability and reproducibility requirements.

Progress in energy efficiency

The recently released EU Commission report entitled "Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014", JRC, 2016 impressively highlights the energy savings obtained in recent years.

Figure 21 shows the trend towards energy-efficient device classes A+++ and A++. In just three years, the proportions have increased significantly. Besides detailed information on washing machines, dishwashers and refrigerators/freezers there is also a combined overview of these four device categories on the left. It can be seen that the proportion of A+++ tripled in these three years. The proportion of A++ doubled.

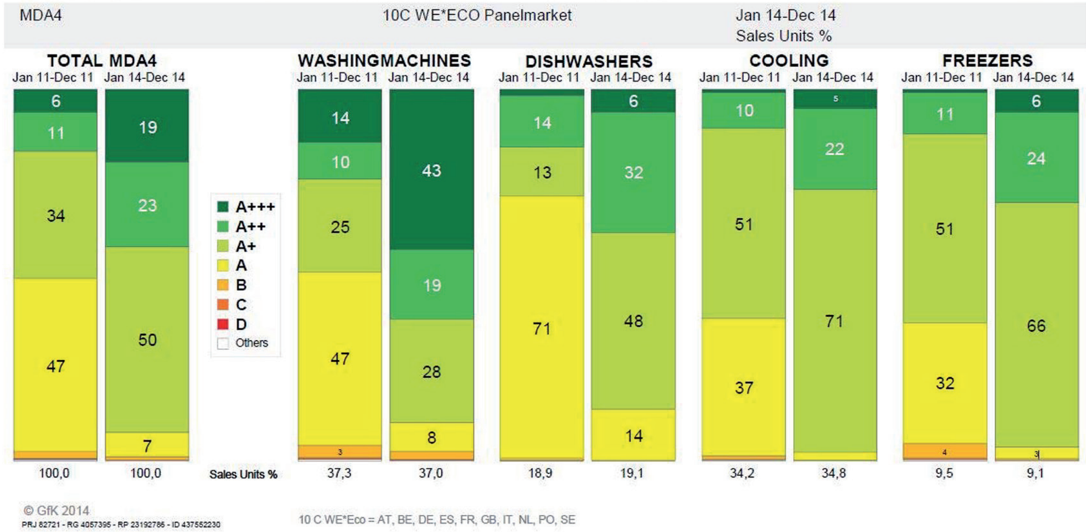


Figure 21 – Market distribution by energy class and product group [8]

Absolute energy consumption has also decreased in recent years. The chart below shows how the average energy consumption of refrigerators, freezers, dishwashers, tumble dryers and washing machines has declined.

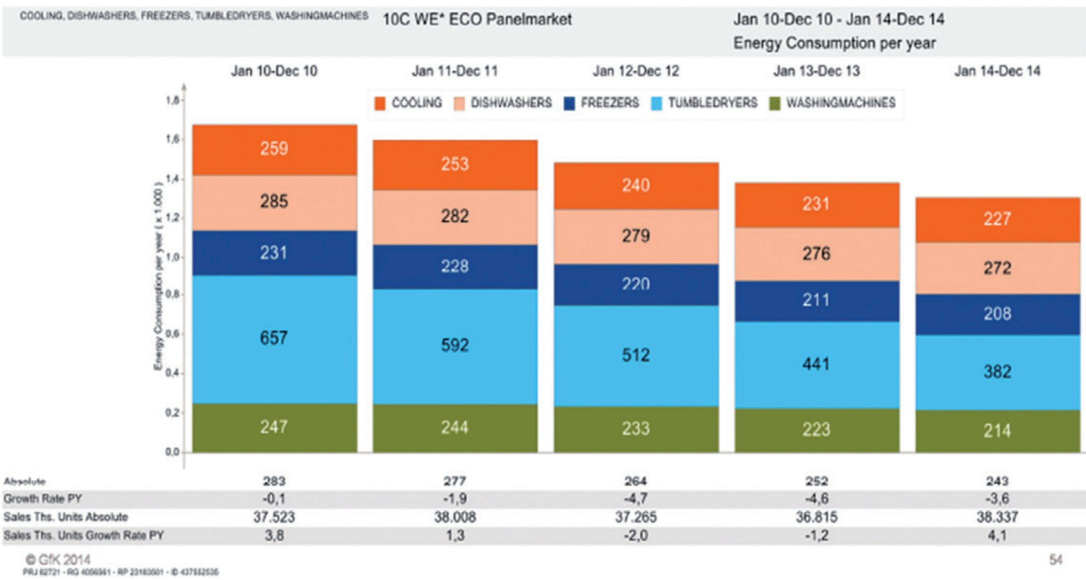


Figure 22 – Average energy consumption of different devices between 2010 and 2014 [8]

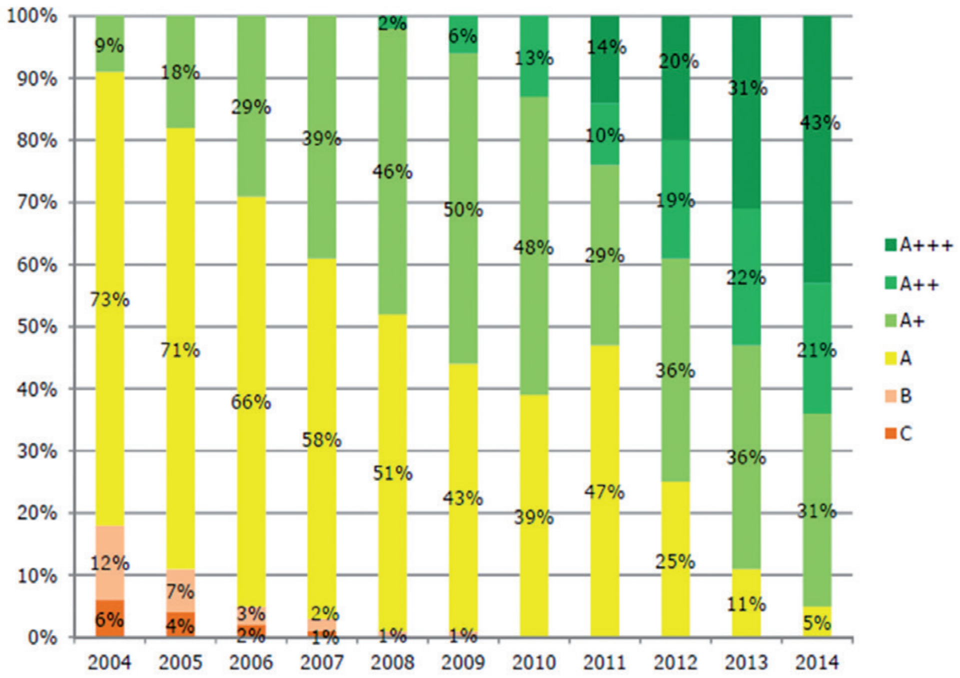


Figure 23 – Sales of different efficiency classes of washing machines, as example [8]

A particularly controversial criterion is that of power consumption for vacuum cleaners. This criterion is not the same as energy efficiency. It is nevertheless part of the total EU package.

The power consumption was limited to 1600 W by the EU Ecodesign Regulation in September 2014. From September 2017 this will reduce to 900 W. The following charts show the change to lower power consumption.

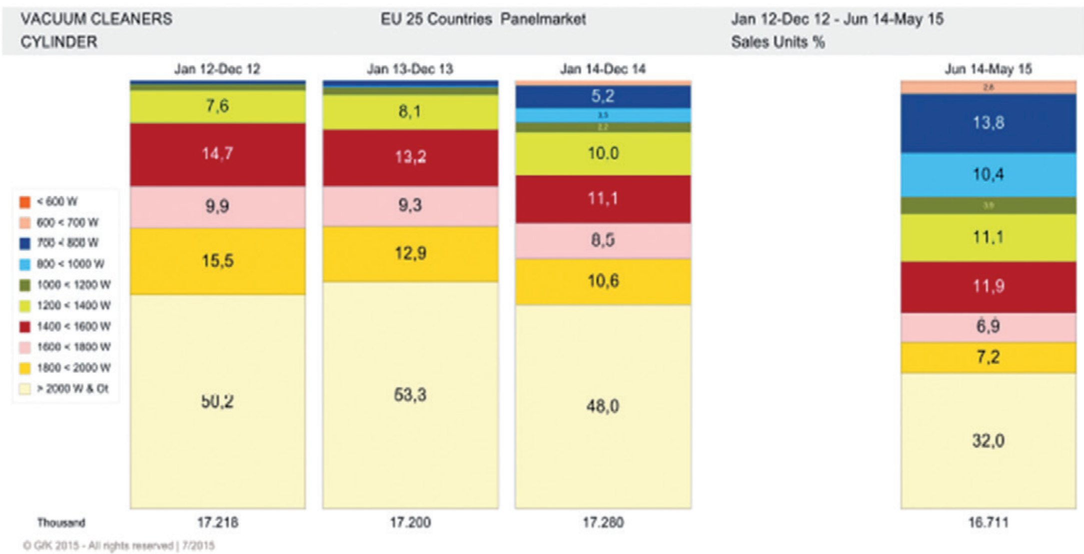


Figure 24a – Market distribution of vacuum cleaners, by output [8]

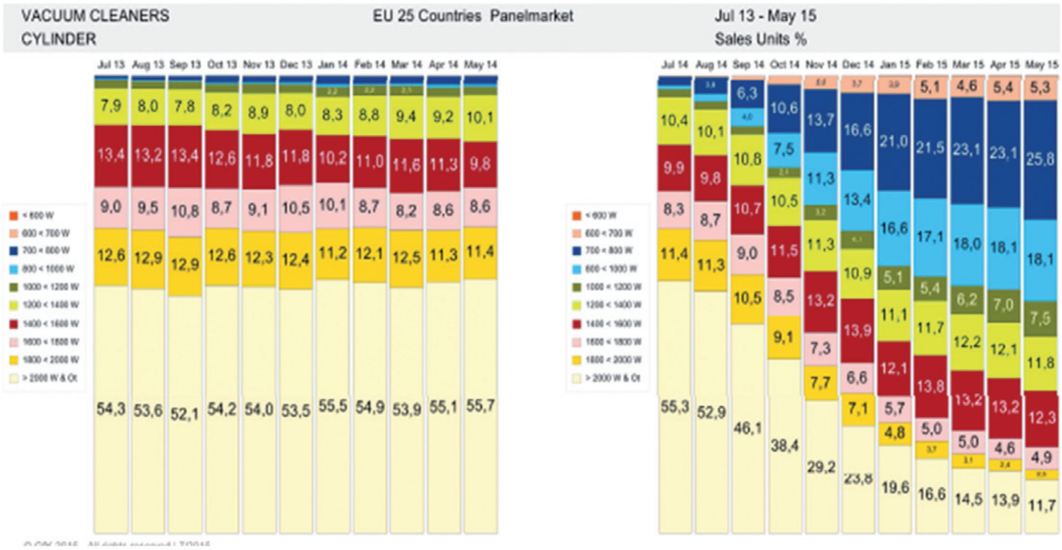


Figure 24b – Monthly market distribution of vacuum cleaners, by output [8]

It will inevitably not be possible to obtain comparable energy savings in the coming years. Today's home appliances are already highly energy-efficient in comparison with earlier devices. It quickly becomes clear that we are approaching physical and technical limits. As discussed, competition and also regulatory instruments are contributing to the success. Neither would be possible without appropriate testing procedures. The test methods themselves must continue to evolve and meet the increasing demands in terms of accuracy and practicability.

Summary/Recommendations

A range of regulations and standards exist in the area of household appliances.

The Ecodesign Directive 2009/125/EC provides a framework for stipulating requirements for the environment-friendly design of energy-consumption related products (Energy-related Products, ErP). Different horizontal (e.g. standby) and vertical (e.g. external power supply units, household washing machines) implementation measures have been put in place based on this in recent years.

Existing limits are constantly being reviewed. In addition, preparatory studies are being carried out to decide whether new categories need to be regulated, new requirements added or the limits adapted. An overview of this is provided in Appendix 2.

To assist consumers when purchasing resource-conserving products, some product categories (refrigerators, washing machines, coffee makers, vacuum cleaners etc.) carry an energy label. The measuring procedures for determining the details of the energy label and the ecodesign requirements must continually be developed in order to meet the accuracy and practicability requirements.

Then you command the oven to turn itself on so that the evening meal is ready when the family gets.

5.1.2 Smart appliances – Interconnected and energy-saving in the future

Our daily lives are becoming increasing digital. In an era in which people are used to organising their daily lives with the aid of smartphones and tablets, the household appliance manufacturers are offering growing numbers of models with web-based remote control. This is opening up numerous possibilities for making life easier and saving energy. But the technology currently found in our homes is just the beginning.

In the not-too-distant future a typical day could look like this: In the morning you load up the A+++ washing machine, but you only start the programme – by smartphone – just before you leave work. This stops the laundry from creasing and saves up to 47 % power in conjunction with a solar thermal system. The app even lets you know when the lint filter needs emptying.

Then you command the oven to turn itself on so that the evening meal is ready when the family gets home. A digital cook book connected to the app and the fridge helps you choose what to eat. The sensor-equipped oven ensures optimized cooking. And when the meal is ready it lets your smartphone know.

How about an espresso or a cup of tea after the meal? You can control the coffee machine or the kettle with maximum convenience from your sofa or bed. You can set the target temperature using a smartphone app. The milk cooler radios a signal to the coffee machine if the milk is about to run out. This will prevent it from accepting any new orders until it has been refilled.

But what is the point of enjoying a good meal only to have your evening ruined by having to do the dishes afterwards? The dishwasher is also controlled via an app. It cleans the dishes more efficiently than by hand and automatically opens the door after the wash cycle. The floor is cleaned by your vacuum robot. It uses laser navigation to scan its surroundings, including obstacles, and stores the collected information in a kind of map. This area is then systematically swept by the vacuum-cleaner robot. It uses a "point cleaning" function which is based on tracking a red laser point and even permits the targeted cleaning of specific zones.

And last but not least: your health and well-being. Your activity tracker measures the number of steps you take and your hours of sleep, transmitting the data to your smartphone. Even your weighing scales are connected. It works out your weight, your body fat, your body fat index and calorie requirement – and sends this data, too, to your phone. You can measure how dry the air you breathe is using the thermo-hygrometer. The transmitted data can be analysed by a smartphone which also allows you to control your heating and ventilation system. If you like, you can send the measurements by email, share them on Facebook and Twitter, or the data can be made available to a sensor network in the cloud for the purpose of creating additional services for the common good. The DKE technical experts are currently working on all the related interoperability and interface-related issues – without forgetting energy efficiency and information security.

5.1.3 Smart Home + Building

In the last few years the term smart home has come to describe the technologies deployed in residential rooms and buildings in which networked devices and systems help enhance the quality of living, safety and efficient energy use levels. Common alternative names for smart home are Intelligent Living, eHome or Smart Living.

The continuing digitization and networking of nearly all areas of human experience are leading to changes in the home environment which are resulting in turn in new possibilities for living and working. Smart home technology is an integral element in the efforts to create sustainable infrastructure development and to improve the quality of life in the urban environment. This includes such aspects as the economy, the domestic and working environments, the social environment, assisted mobility and interaction with the authorities. Smart home is about integrating and using information and telecommunication technologies in the domestic environment to open up a new world of experience and to make existing entertainment, comfort, energy management, health and safety activities more cost-efficient or convenient.

Those involved in the smart home standardization efforts consist of representatives of academic institutions and industrial companies in the fields of home automation, HVAC, consumer electronics, decentralized energy supply and management and system integrators or providers of security technology. The goal of the consortium is to create and maintain an international series of standards which facilitate the sustainable development of interoperable, safe, mobile and reusable applications and services in the home environment.

Functions for improved energy efficiency are a top priority for future builders

According to the representative "Damon Trend Barometer 2012" Forsa survey [DFH 2012] commissioned by Deutsche Fertighaus Holding AG, 57 % of Germans believe that it is important to integrate innovative home automation when building a house. More than half (51 %) of those surveyed who intend to buy a new house in the near future would be willing to invest between EUR 4,000 and EUR 8,000 in intelligent building technology in order to achieve greater security, comfort and energy efficiency. 64 % of all respondents, and 84 % of prospective house owners, regard a building automation function which provides a permanent overview of energy consumption as useful. 39 % believe that an automatically and optimally controlled heating system that responds to the weather would significantly increase the quality of their everyday life.

Smart homes turn consumers into "prosumers"

In line with the energy policy goals of the Federal Government, the housing stock in Germany should be virtually carbon-neutral by the year 2050. The energy consumption of houses has decreased dramatically from the beginning of the 1980s up to the present day. An average house built on an estate in the 1970s or earlier had a heating energy requirement of 200 to 300 kWh per square metre per year, whereas this value in a modern passive house is only 15 kWh/m^2a. And a so-called zero energy house has an annual consumption level of 0 kWh/m^2a.

Making use of the latest technology, "plus" energy houses are now coming onto the market which generate more energy through an ingenious combination of building management technology, PV systems, heat pumps, energy storage units etc. throughout the year than they themselves consume. Such "smart buildings" effectively become power plants. The users of these houses therefore become "prosumers" who both produce and also consume energy. In addition, they often contain energy storage facilities which can be integrated in virtual power plants via intelligent networks ("smart grids"). "Smart metering" is required to measure and coordinate all these energy flows.

Technology for improving energy efficiency levels in buildings

Greater energy efficiency can often be achieved by automatic switching, control and regulation of electrical equipment, devices and lighting, plus the use of modern electrical appliances with "built-in" energy efficiency such as washing machines or refrigerators in the top efficiency class. However, important prerequisites for this are future-proof electrical installations in the house, the values of which should meet those given in the RAL RG 678 standards. Yet technology in the form of devices, equipment, and intelligent automation can contribute to energy efficiency and, moreover, often also improve comfort levels for users. In order to achieve high energy efficiency, it is also crucial for there to be no thermal bridges in the electrical installations and for the building to remain airtight. Recently a separate standard was created which focuses on the issue of energy efficiency in electrical installations. For the first time, the new DIN VDE 0100-801 standard from October 2015 contains requirements for energy-efficient electrical equipment which electricians must observe.

Improved energy efficiency often arises from the sum of many seemingly negligible measures which, when combined, can have a striking effect. These measures range from the simple replacement of ageing light sources, brightness and presence detectors, individual room controls and ventilation with heat recovery through to cogeneration, smart metering and demand side management which enables uncertainties in the generation of electricity from fluctuating renewable sources to be compensated.

Industry has so far implemented energy efficiency measures most consistently. Yet here, too, there is still potential for improvement and savings.

5.1.4 Smart Metering

Smart metering technologies provide accurate measurement and consumption data transmission for electricity, gas, water, heat or cold between the measuring systems and relevant parties and their systems.

The widespread use of smart meters completely changes the way in which meters are deployed. They offer customers a direct overview of consumption and costs, and thus contribute to more energy-efficient behaviour.

The Smart Meter Gateway

In an intelligent measuring system the communication unit, the Smart Meter Gateway (SMGW), forms the central component. It receives the measured data from the meters, before storing and processing it for the market actors. The SMGW communicates within the wide area network (WAN) with the external market participants and in particular with the SMGW administrator. The SMGW communicates within the local metrological network (LMN) with the connected meters (electricity, gas, water, heat) of one or more ultimate consumers. The meters communicate their measurements via the LMN to the SMGW.

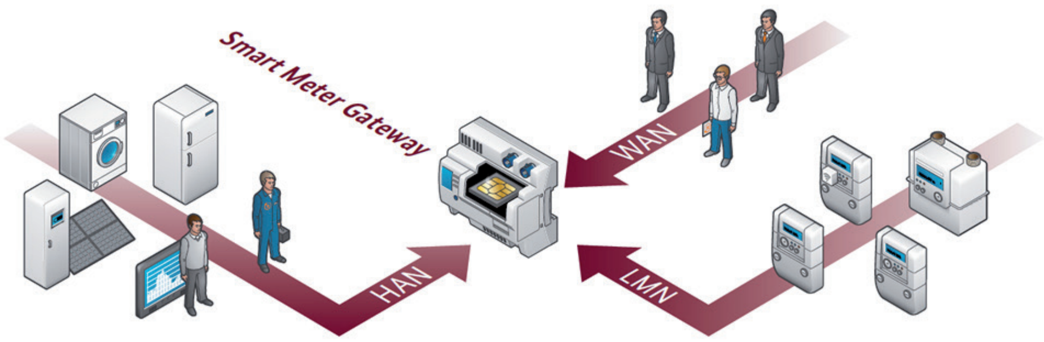


Figure 25 – The Smart Meter Gateway and its environment [8a]

All communication flows are encrypted and secured with regard to their integrity, authenticity and confidentiality.

5.1.5 Renewable heating using electricity

More than half of the energy consumed in Germany is used for heating. Space heating and domestic hot water are also responsible for 40 % of all CO_2 emissions. Yet only 13 % of all heaters are state-of-the-art.

Most heaters still burn raw fossil fuels such as oil, gas and coal. These resources are, however, finite and when burned, release the greenhouse gas CO_2 which is the main cause of global climate change. There is, therefore, enormous potential for climate and environmental protection slumbering in German boiler rooms.

Electricity as a heating source

Thermal comfort is a good thing. But only if it is actually needed. In some central heating systems, however, the heat can only be controlled – spatially and temporally – to a limited extent. Electric heating systems represent an excellent supplement here. The heat is generated directly at the point of consumption, meaning that it does not have to be transported from a boiler room via pipes. This has two advantages. Firstly, the lower investment costs, because an electric heater which requires no plumbing, radiator or chimney only incurs low purchase and installation costs. Secondly, the reduced operating costs. In addition, these systems are virtually maintenance-free. And thus they represent a viable alternative as a full or supplementary heating system. During modernization in particular, it is therefore advisable to replace existing night storage heaters with modern and energy-saving storage heaters featuring the latest control technology. [9]

Electricity from renewable energy sources

The universal energy source electricity is increasingly being generated from the renewable energy sources solar, wind, water and biomass, which according to the latest statistics of the Fraunhofer Institute for Solar Energy Systems (ISE) in 2017 produced about 210 TWh of electricity. In 2013 that was 29% less. This accounts for around 38% of net public electricity generation.

According to a study by the Federal Environmental Agency it will be possible to provide 100 % of power from renewable sources by the year 2050 [9].

Electric heat pumps

The trend is clear: one in three of all newly built detached and semi-detached houses is heated using an air, geothermal or water heat pump. The benefits of heat pumps for new buildings with high thermal insulation standards and underfloor heating systems (which are frequently used in them) are widely recognized and have been proven many times in practice. Legislation such as the Energy Saving Regulation (EnEV) as well as energy price forecasts will ensure that the numbers continue to rise sharply in the coming years.

The real challenge of the energy transition in terms of building heating systems lies less in new buildings than in the modernization of the existing housing stock. In 2014 around 56,500 new condensing boilers, heat pumps, solar thermal systems, pellet-fuelled or other efficient heating technologies were realized. Good heat pumps manage to generate 100 % of heating energy from just 25 % electrical energy and 75 % environmental energy.

Decentralized hot water production

Solutions for the efficient production of hot water can be divided into centralized and decentralized systems. In the case of centralized water heating, the high energy conversion efficiency is all too often cancelled out by the long supply pipes. This disadvantage is system-related. But a comparison is also worthwhile in terms of CO_2 emissions. Decentralized hot water production also performs much better here than is commonly assumed.

The actual energy efficiency often reveals itself only at the end of the year. This is because many cost factors, such as the hot water circulation pump of the central system, then appear in the final bill. They are rarely identifiable as hot water costs. Taking the hidden cost factors also into account, electric hot water production often performs better than oil or gas-fuelled central heating. Decentralized electric hot water offers further advantages because it is virtually maintenance-free and allows simple and consumption-based billing [10].

5.1.6 Energy efficiency of network devices

The regulation stipulates ecodesign requirements for the power consumption of electrical and electronic household and office appliances in standby and off mode, as well as in networked standby mode in terms of placing them on the market. EU Regulation 801/2013 on the energy efficiency of networked devices and smart home and office devices (known for short within standardization circles as the

"Network Standby Regulation") is aimed at widening the market distribution of technical solutions designed for lowering the electricity consumption of devices in network standby mode. According to a study carried out by the European Commission, the amount of electricity consumed by electrical and electronic home and office devices sold in the European Community while in standby mode was an estimated 54 TWh in 2010, accounting for 23 million tonnes of CO_2 emissions.

Implementation of the "Network Standby Directive" is stipulated by a corresponding standardization mandate of the Commission, to be implemented by the European standardization organizations (CENELEC and ETSI). Leading the project is CENELEC TC 100 X (audio, video and multimedia systems and equipment and related sub-systems).

A new dimension of energy efficiency standardization is reflected in the fact that, in contrast to the previous energy efficiency requirements which were mainly device or area-specific, the new regulation requires an interdisciplinary approach. "Electrical household and office equipment – Measurement of networked standby power consumption" is currently being drafted by the competent CLC/TC 100X/ JWG TC100XTC59X (Measurement of standby power) committee.

5.2 Commerce, trade, services

5.2.1 Green IT

Companies can reduce their IT electricity costs by up to 75 % by adopting a comprehensive green IT strategy. This applies to any operator with IT workplaces, including data centres and local administration bodies.

IT work places

Each IT work place generates energy costs and CO_2 emissions. By installing energy-efficient equipment and encouraging correct user behaviour, this could be avoided. Technical alternatives such as multifunction devices which combine a printer, copier and scanner can save space and consume less power (and fewer materials in the manufacture) than multiple single devices.

The mobile "laptop office" has come to prevail in many occupational groups. Laptops are significantly more energy efficient than conventional desktop machines: they consume about one-third of the energy. A crucial factor for the operating costs and CO_2 balance of IT equipment is its correct use. Today, almost all IT devices have energy-saving functions. Some devices even have a power save button.

Data centres

Data centres are the backbone of modern companies and are usually complex, highly developed systems with high energy consumption. They can account for over 20 % of the IT electricity costs.

The following measures can partially contribute to save energy without or with only small investments:

- Avoidance of "dormant" data and applications using modern HSM systems (hierarchical storage management)
- Innovative technology for cooling, ventilation and power supplies,
- Targeted selection of IT hardware and the functional structures,
- Virtualization and Consolidation.

Savings in local administrations

Local administrative bodies could reduce the power consumption of their IT by over 80 % through more energy-efficient PCs. Yet when IT equipment is put out to tender, energy efficiency is still the least important purchasing criterion. When procurement contracts are awarded it therefore pays to consider the electricity costs which are incurred over the entire useful life of a PC in addition to the purchase price. Corresponding internal administrative arrangements could contribute to significant energy and cost savings and help relieve the strain on the public purse. A nationwide survey of 200 local procurement department employees conducted by dena emerges that enormous savings could be made if highly energy-efficient computers were used exclusively in all local German authorities (see table 5):

Table 5 – Savings [11]

SAVINGS THROUGH THE PURCHASE OF ENERGY-EFFICIENT DESKTOP PCS		SAVINGS THROUGH A SHIFT TO LAPTOPS / THIN CLIENTS
Savings per local authority	45 %	83 %
Total savings for Germany	46 GWh/year	84 GWh/year
CO_2 savings	29.120 t/year	53.144 t/year

5.2.2 Energy savings from data centre enclosures

We encounter ever growing amounts of data and digital information in today‘s digital world. They are "stored" centrally in server rooms or data centres that host a large number of electronics cabinets housing the (mostly densely packed) information technology equipment. The operation of high-performance servers results in high heat losses.

Air cooling in the form of fans is often used to dissipate the resulting thermal loads. It is now common to arrange the units in rows in data centres and server rooms. The correct directional orientation of the server cabinets as specified in the standards is for the cabinet faces with cool air intake and the faces with warm air output to be positioned opposite each other. The air is taken in and expelled exclusively via the front and back of the server cabinets which are equipped with perforated doors.

It is assumed that information technology equipment transports the cooling air horizontally: sucking the cool air in at the front and expelling the heated air at the rear. The required cooling air is supplied by room coolers or air cooling units arranged in series. Usually, the heated air is conveyed by fans through a liquid/air heat exchanger where it is cooled. Considerable amounts of hot air flow past the information technology equipment to be cooled, in particular the servers, and thus have no cooling effect. At the same time, recirculation inside and outside the housings means that heated exhaust air is sucked in as cooling air, which undermines the cooling effect, possibly leading to faulty operation.

To minimize this recirculation, more cooling air is supplied than is required, unnecessarily increasing the cooling effort and ultimately having a negative impact on the energy efficiency of the data centre. The separation of the enclosed cool supply air flow from the heated air flow (so-called cold aisle / hot aisle containment) largely prevents recirculation. This separation reduces the required cooling airflow. It yields a significant reduction in electrical energy consumption, thereby lowering the operating costs for data centres and server rooms.

The dimensions and mechanical requirements, the airflow, climate and operational safety aspects of aisle containment are to be addressed in a new standard project.

Data centres account for approximately 5 % of total energy consumption in Germany, meaning that issues relating to climate protection, CO_2 reduction as well as cost efficiency play an important role in their planning and operation. DIN EN 50600 has three "granularity" levels for the appropriate measurement of power consumption and for identifying potential savings.

5.2.3 Load profiles of typical purchaser types in the power grid

Standard load profiles are used within the electricity industry for consumers of less than 100,000 kWh/a. They show the average value of a defined group of consumers, a profile type (see table 6).

Table 6 – Standard load profile

PROFILE-TYPE	DESCRIPTION	EXPLANATION
G0	General commercial	Weighted average of profiles G1-G6
G1	Commercial, weekdays 8:00-18: 00	e. g. offices, doctor‘s practices, workshops, administrative facilities
G2	Commercial with heavy to predominant consumption in the evening hours	e. g. sports clubs, gyms, evening pubs/restaurants
G3	Commercial, continuous	e. g. cold stores, pumps, sewage plants
G4	Shop/hairdresser	
G5	Bakery with bakehouse	
G6	Weekend operation	e. g. cinemas
G7	Mobile phone transmitter	Continuous base load profile

PROFILE-TYPE	DESCRIPTION	EXPLANATION
L0	General agricultural	Weighted average of profiles L1 and L2
L1	Agricultural enterprises with dairy/sideline animal breeding	
L2	Other agricultural businesses	

Each standard load profile consists of ¼ hour values and represents a day (24 h), a week day, a Saturday and a Sunday in spring/autumn, and in summer and winter. The following charts show the loads during the different day types (see figure 26 – 28).

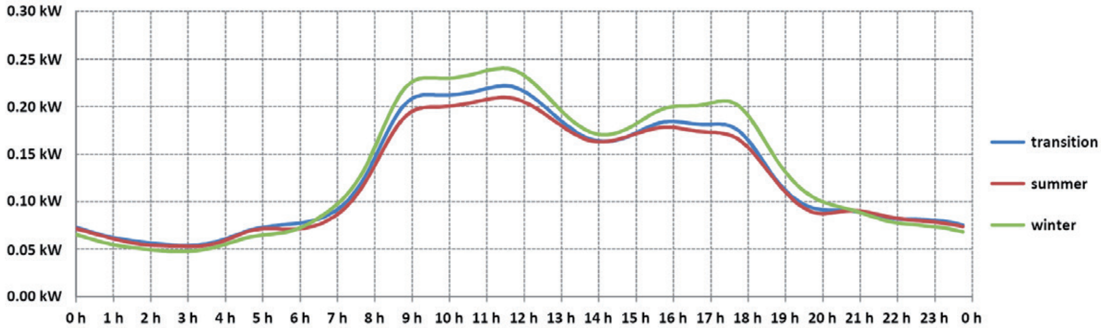


Figure 26 – Standard load profile G0 General commercial, weekdays [3]

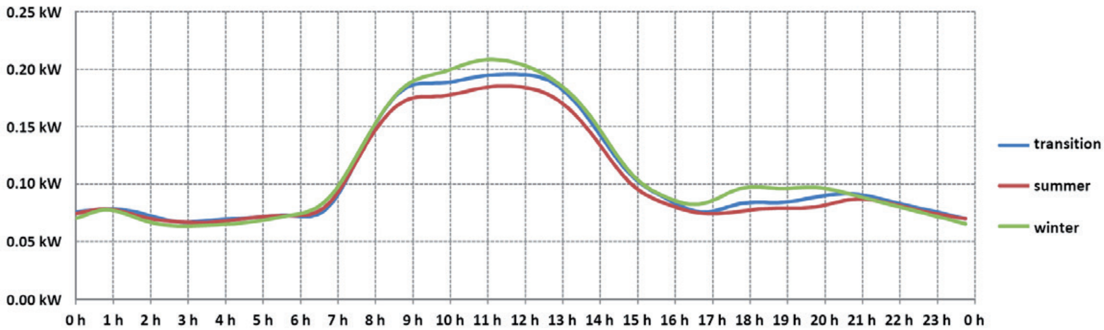


Figure 27 – Standard load profile G0 General commercial, Saturday [3]

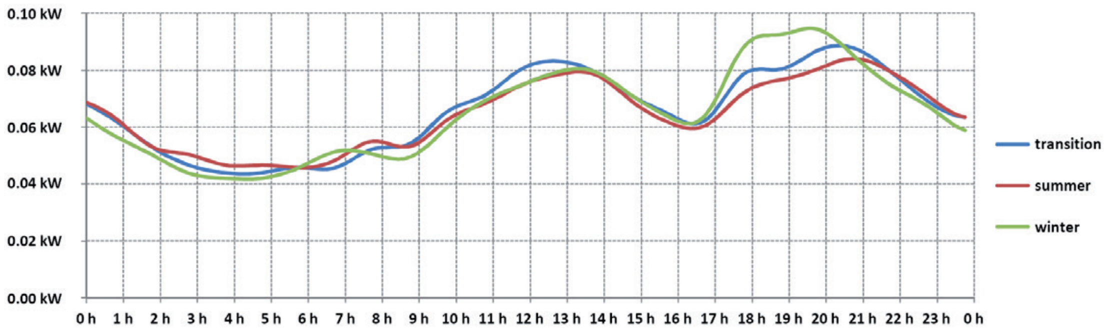


Figure 28 – Standard load profile G0 General commercial, Sunday [3]

The average is calculated from measurements of real-world commercial operations. Because not all commercial enterprises exhibit the same behaviour in terms of times and power purchased, a value is obtained which represents this group from the perspective of energy suppliers. The characteristic values represent the average within the different day types; the maximum value represents the maximum value within the day, and the peak factor is the ratio of mean to maximum value (see table 7).

Table 7 – G0 General commercial

	MEAN VALUE	MAXIMUM VALUE	PEAK FACTOR
Spring/autumn			
Workdays	0,13 kW	0,22 kW	1,74
Saturdays	0,11 kW	0,20 kW	1,80
Sundays	0,07 kW	0,09 kW	1,35
Summer			
Workdays	0,12 kW	0,21 kW	1,71
Saturdays	0,10 kW	0,19 kW	1,78
Sundays	0,06 kW	0,08 kW	1,30
Winter			
Workdays	0,13 kW	0,24 kW	1,80
Saturdays	0,11 kW	0,21 kW	1,87
Sundays	0,06 kW	0,09 kW	1,46
Maximum peak factor			1,87

The household profile is shown here as a comparison to the standard load profiles of the commercial sector. It has a completely different profile.

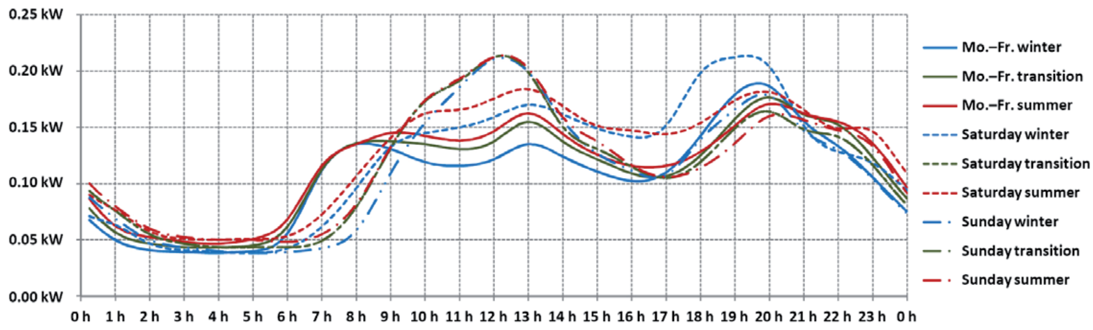


Figure 29 – Standard load profile H0 Households [3]

5.3 Industry and companies

Conserving energy in industry

Energy efficiency and productivity can also be increased in industry: electric motors, as used e.g. in conveyor belts or pumps, consume nearly two-thirds of industrial electricity. Optimized drive solutions can reduce the power consumption of industrial drives by up to 70 % – such investments can pay for themselves in less than two years through energy savings alone.

Energy efficiency in companies

Energy and resource efficiency offer commerce, industry and companies a wide range of possibilities for reducing their production costs on a sustainable basis. Energy and resources are used in many different ways in companies, e.g. for heating, cooling, ventilation, production and ancillary processes, and transport operations. Equally varied are the potential savings which can frequently be obtained by using energy-efficient and resource-efficient technologies, or by adjusting their use. Companies can take advantage of substantial public support for such savings, e.g. the KfW ‚Energy advice in SMEs‘ programme and tax relief, as well as the positive PR effects.

Research project Smart Production Manufacturing based on electricity tariffs

Manufacturing energy-intensive products at times when power is cheap: that is the vision of the "Lag-BEnS – Use of inventory for energy storage" project of the Institute for Integrated Production of Hanover (IPH) and of the Duisburg Institute for Energy and Environmental Technology (IUTA). The project will end in February 2018.
Power is cheap on breezy summer days, but expensive on windless winter nights. Because the more energy that comes from renewable sources like the wind and the sun, the greater the variations in the power supply and the price. If companies coupled their production management to the price of electricity, they could save money as the result of the fluctuating rates. This should become the standard in future. Still only high and low rates are common (HT and NT).

At present, the price of electricity can rise or fall by 70 % within a day on the Leipzig electricity exchange. The research project aims to develop suitable methods for finding out how much money can be saved in practice. More companies are being sought which wish to participate in the research project.

Academics are currently studying how this could work in detail and how much money could be saved as a result.

5.3.1 Machine tools

Overview

The energy efficiency of machine tools is determined by their technical design as well as by the type of use. A condition for high energy efficiency is optimum adaptation of the required machine functions to the particular manufacturing process. The machine concept, drive system and auxiliary functions are key interrelated aspects. Needs-based energy provision, (largely) loss-free power transmission and conversion, as well as the use of energy recovery systems are basic methods which can be applied to these.

Evaluating the energy efficiency of and comparing and forecasting the energy requirements in machine tools require a common methodology for the measurement of transparent parameters on the basis of defined reference cycles.

Machine design

The machine design should be based on a holistic consideration of the resources and take into account the life cycle phases of the machine. The use phase is important in the energy efficiency assessment, yet the main functions from an energy perspective are pre-defined in the design of the system (including its limits). Optimization potential lies e.g. in minimizing moving masses or using potential energy stored in the system.

Drive system

Any decision about how to realize essential energetic functions should take the overall system context into account. The design of the drive system for a specific application should be based on high-efficiency energy flows in the generative (deployment), conductive (transfer) and actuatory (conversion) system sections. Possibilities for storing energy in the system (e.g. DC link) or network return feed should be taken into account. Prerequisites for this are high-efficiency power electronics and negligible retroactive effects (e.g. harmonics). A necessary complementary measure for achieving optimal energy efficiency is intelligent and operator-independent energy and drive management. This should turn energies on and off, depending on the operating mode, and provide operator information for energy-saving operation plus data recording and evaluation possibilities. Based on the data obtained, it is possible to improve the energy aspects of the system machine tool and its incorporation into sibling or parent production systems.

Auxiliary functions

The process for improving the energy efficiency of machine tools is well advanced

Even if the energy requirement of auxiliary functions is usually low relative to the main function of a machine tool, the demand-based provision of energy and auxiliary media (e.g. cooling/lubrication) offers further potential for increasing energy efficiency. The resources and methods for drive systems can also be applied here. Another way to improve efficiency in the context of the overall system (in addition to controlled cooling or air conditioning) is to use water instead of air because this allows heat to dissipate effectively and be used for other purposes.

Measurement method

The actual usage patterns of machine tools and the resulting operating phases should be used as the basis for determining the characteristic energy performance values. The energy consumption should be determined based on these operation phases for a defined process. The measurement conditions in terms of measurement requirements, measurement variables, measuring equipment, measurement uncertainty and documentation should also be determined. Energy flows are measured at the defined system boundaries. The same applies for the energy analysis and determination of the efficiency of individual functions, the use of which should be considered in the respective modes. Comparability and transparency in assessing the energy efficiency of machine tools should be guaranteed through the choice of process for converting the measured values into corresponding electrical power equivalents.

Summary

In response to the ERP Directive 2009/1 25/EC a process has been launched for improving the energy efficiency of machine tools as well as its transparent assessment, which is documented in the relevant standards and regulations. This process is well advanced especially in the field of machine tools with numerical control, meaning that there is no explicit additional requirement for supporting standards. What is required are comparable transparent methods for assessing the energy efficiency of electrical components within a system, such as frequency-controlled drives.

Giving machine tools energy labels is neither useful nor practicable, except in the case of series-produced products and where a wide assortment is available (e.g. household appliances). Instead, there should be comparison and documentation of energy efficiency for each individual type of machine tool on the basis of relevant test procedures, or if possible, test specimens

5.3.2 Energy efficiency for electric motors, drives and drive systems

Statutory minimum requirements for energy efficiency are a global issue. The regulation of energy efficiency of motors in Germany and Europe is being gradually implemented from 2011 to 2017. The requirements are thus steadily increased with time. Currently newly marketed motors with a rated output of 0.75 to 375 kW must either achieve the IE3 efficiency level or, alternatively, IE2 motors will have to be run with a frequency converter. One of the reasons why the inverter operation alternative was introduced in Europe was because it offers greater energy saving potential in many applications than increasing the energy conversion efficiency from IE2 to IE3.

The DIN EN 60034-X (VDE 0530-X) standard series specifies the requirements for rotating electrical machines in general. Excluded are railway and vehicle machines (DIN EN 60349-X (VDE 0115-400-1)) and motors integrated in work machines (DIN EN 50598-X (VDE 0160-201)). The DIN EN 60034-X (VDE 0530-X) standard series is very comprehensive. For instance it defines cooling methods (IC codes), types of installation (IM codes), protection class (IP codes), noise, etc. With regard to energy efficiency, determination of the energy conversion efficiency in tests and the rated limits for the energy conversion efficiency IE1 ... IE4 are relevant.

Standards DIN EN 60034-2-1 (VDE 0530-2-1) and DIN EN 60034-2-2 (VDE 0530-2-2) apply to all rotating electrical machines, except machinery for rail and road vehicles, and those for which a specific standard exists. These standards do not stipulate output limitations. These, however, are found in the standard DIN EN 60034-30-1 (VDE 0530-30-1) which contains energy conversion efficiency limits for IE1 ... IE4. This applies to machines in the power range 0.12 ... 1.000 kW.

Electrical machines with outputs greater than 1000 kW are often designed and manufactured for specific applications. The energy conversion efficiencies are usually agreed between the manufacturer and user, or specified by the user. In most cases, poor energy conversion efficiency is then penalized. The energy conversion efficiency of these machines is typically in the range of 95 to 98.5 %, i.e. very high. Users (and also manufacturers) have a vested interest in high energy conversion efficiency levels, since any power loss leads to considerable operating costs for the user. Calculated over the life cycle (20 years), the losses often amount to more than EUR 1000/kW. Based on this figure, a machine with a capacity of 1 MW and 95 % energy conversion efficiency results in operating costs of about EUR 50,000. These costs rise with increasing power. There is thus a natural interest in high machine energy conversion efficiency levels. Specification of minimum energy conversion efficiency levels is therefore unnecessary.

The DIN EN 60349-X (VDE 0115-400-1) standard series specifies the requirements for rotating electrical machines for rail and road vehicles in general. The determination of losses is modelled on IEC60034-2-1. There are also special considerations for specific machines. The energy conversion efficiency is usually agreed between manufacturer and user, unless the machines are covered by DIN EN 60034-30-1 (VDE 0530-30-1).

DIN EN 50598-1-3 "Ecodesign for drive systems, motor starters, power electronics and their driven equipment": this European standard specifies the indicators for the energy efficiency of power electronics (e.g. complete drive modules, CDM), drive systems and motor starters for motor drive applications in the power range of 0.12 kW to 1 000 KW. The power range corresponds to DIN EN 60034-30-1 (VDE 0530-30-1).

It specifies the method used to assess the losses of the complete drive module (CDM), the drive system (PDS) and the entire motor system. IE and IES classes are defined (and limits and test methods specified) for classification of the total motor system losses.

Consumption of electrical energy

In 2014 the most part of electrical energy in Europe was consumed by industry (see table 8). Electric motors consume about 40 % of the total electrical energy generated worldwide. Electric motors consume about 70 % of the electrical energy used in the industrial sector.

Table 8 – Energy consumption by sector in Europe in 2010

SEKTOR	QUANTITY	PERCENTAGE
Industry	approx. 1.036 TWh	36,0 %
Households	approx. 843 TWh	29,7 %
Services	approx. 834 TWh	29,3 %
Transport	approx. 57 TWh	2,0 %
Other	approx. 57 TWh	2,0 %
Total	approx. 2.840 TWh	100 %

Net generation in 28 member states oft h EU in 2010 was 3199 TWh.

Summary: Electric motors and drives consume a large part of the total electrical energy generated. In industry, electric motors are the device group with the highest consumption. Energy savings in these components therefore have a major impact.

Potential savings

According to ZVEI, the energy saving potential of electric drive systems is approx. 40 %. Of this

- 10 % lies in the use of more efficient motors. This means producing motors with higher energy conversion efficiency levels, e.g. through the use of higher quality materials. This includes, for example, the use of copper instead of aluminium cages in asynchronous machines;
- 30 % lies in the use of variable speed motors. This means adjusting the motor speed and the motor torque to the load;
- 60 % lies in mechanical system improvements (e.g. pumps, fan blades, etc.).

The minimum requirements for electrical machines are given in the ErP Directive 2009/125/EC (Energy-Related Products) and its Regulation (EC) 640/2009 (valid only for asynchronous motors). This Regulation prescribes IE2 and IE3 as minimum energy conversion efficiency levels for standard fixed-speed asynchronous motors with mains starting device. The requirements for these motors are being raised in 3 steps.
In the DIN EN 60034-30-1 (VDE 0530-30-1): 2014-12 standard, the required minimum energy conversion efficiency levels are grouped together depending on the motor speed, frequency, performance and number of poles. It makes no further distinction between motor technologies (synchronous, permanent magnet and DC machines).

DIN EN 50598-2 (VDE 0160-202) provides the limits for assessment of the energy efficiency of frequency inverters. The mean value of the IE1 class is used as a reference value for the classification. If a device has 25 % greater loss it is in class IE0, with 25 % less loss it belongs in class IE2. The IE classification is calculated from a defined load of cos φ and current.

DIN EN 50598-2 (VDE 0160-202) also applies for inverter-motor combinations. This subdivides inverter-motor combinations into the classes IES0 to IES2, the same as for inverters. "S" indicates that it is a system. The IES classes of the inverter-motor combinations are upgraded/downgraded at ±20 % loss compared to the IES 1 class. The scope is identical to the IE classes for inverters.

No need for action with regard to standardization of machines

Summary

The above standards comprehensively cover the energy efficiency of electrical machines and drive systems with outputs from 0.12 to 1000 kW. This is achieved either in the form of definitions for determining losses and energy conversion efficiency, or directly by specifying minimum requirements for energy conversion efficiency.

The standard IEC 60034-30 specifies the introduction of further, improved energy conversion efficiency levels (IE4, IE5). It therefore includes future ongoing improvements in energy conversion efficiency or efficiency.

The minimum energy conversion efficiency levels that are specified in the standard 60034-30 for electric motors correspond to key international efficiency codes (table 9).

The standard EN50598 is a supplement to IEC 60034-30, expanding its focus to include the powerdrive system and any possible intermediate links.

These standards have been accepted and adopted both by manufacturers‘ associations (ZVEI, CEMEP) and by users and are regularly applied or taken into account.

They do not apply for higher power motors (> 1.000 kW) and high-voltage motors (> 1.000 V). No action is required here, as these motors basically have very high conversion efficiencies and long lives and are therefore energy efficient.

There is no need for action in the form of new or more stringent standards for motors. The prescribed energy conversion efficiency levels are high and very well regulated in the lower to medium power range.

Table 9 – Comparison of international energy conversion efficiency codes [12]

Comparison of energy conversion efficiency codes						
Efficiency	CEMEP Volunteer European Agreement	Europa IEC 60034-30	USA EPAct, EISA	KANADA EER (2010)	CHINA GB18613 (2008)	CHINA GB18613 (2012)
Low	EFF3					
	EFF2	IE1 Standard Efficiency			Grade 3	
	EFF!	IE2 High Efficiency	NEMA High	High	Grade 2	Grade 3
		IE3 Premium Efficiency	NEMA Premium	Premium	Grade 1	Grade 2
High		IE4 Super Premium Efficiency	NEMA Premium Plus			Grade 1

5.4 Traffic and transport

General

The introduction of electric vehicles represents both a challenge and an opportunity for Germany. The domains of automotive engineering, information and communication technology (ICT), as well as electrical engineering/energy technology which all enjoy high quality, safety and availability levels are set to merge in certain aspects in future.

In order to meet the future mobility needs of people on a sustainable basis, energy must be provided from environment-friendly sources. The energy supply of the future is one of sustainable energy sources which are available on a permanent and politically reliable basis, and which have a minimum environmental "footprint". By making use of these sustainable energy sources, electromobility helps lay the groundwork for a high standard of living in the future. The establishment of resource-efficient cycles and processes supports long-term progress while maintaining consumers‘ accustomed levels of comfort.

Ensuring that electricity from renewable energy sources is also readily available for electric vehicles requires adopting a strategic approach to the challenges ahead. For electrically driven vehicles, global thinking is currently still primarily a question of technical standards: charging performance, charging plugs and battery capacity. It is functionality, price, environmental awareness and responsibility across national borders that will ultimately determine user acceptance. "Round tables" are needed where participants can jointly develop the technologies and elaborate the standards and specifications which can then be used as the basis for further development. Automobile manufacturers, energy suppliers, network providers and research institutions have long since recognized how closely intertwined the electric mobility network is. The electric car of the future will be integrated as a critical element in the "smart grid".

5.4.1 Electromobility

By 2025, electric cars are expected to account for a market share of 25 % in the EU, China and the United States, according to a Volkswagen report published in the industry journal "Automobilwoche". By 2030, half of all cars sold could then be electric vehicles. In addition, electric vehicles can be integrated as mobile power storage units in a smart grid. In public transport, low-floor trams represent an energy-saving and environment-friendly alternative.
Electromobility is increasingly becoming a reality. It is gaining market share at a quiet and evolutionary pace, thus reflecting the technology itself. Without making use of electric drive solutions, the automotive industry will not be able to meet the future CO_2 requirements.

Thus, hybrid drives will initially be the technology of choice, particularly in passenger cars. After all, customers must be convinced of the usefulness of the product. A comprehensive mobility pledge is sold along with each vehicle, which must then be honoured. The vast majority of car buyers will behave accordingly, securing with their demand the large number of jobs in Europe related to automotive manufacturing and support. As storage and charging technology develops, the present need for a range extender in the form of a traditional internal combustion engine required to meet the mobility promise will diminish.

Automobile transportation requires the use of energy and takes place predominantly in public spaces. In addition to questions concerning the vehicle itself, issues regarding research funding, the quality of energy and in particular the necessary infrastructure are thus also of fundamental importance.
In contrast to traditional internal combustion engine vehicles, electric vehicles have not enjoyed continuous development over the past 115 years. Considerable distances can already be achieved today, yet there is still much room for further development and perfection to ensure that the electric vehicle is a serious alternative to combustion engine automobiles. There is therefore an ongoing need for public funding, in particular in the field of battery technology.

Electric vehicles will initially be significantly more expensive to buy than conventional cars for some time. The ZVEI therefore believes that financial support should be provided for a limited period, e.g. in the form of tax exemptions or corresponding preferential tax treatment. This should help ensure that the offers made to fleet/company car operators are so attractive that there are no disadvantages in comparison with conventional drive technology.

Support for electric and hybrid vehicles was introduced in July 2016.

Advantages
- High energy efficiency,
- Negligible local emissions,
- Lower energy costs,
- Use of renewable energies,
- Easy to use, good driving dynamics.

Disadvantages
- DTE (distance to empty),
- Higher procurement costs,
- Smaller payload,
- Charging procedure,
- Heating, air conditioning.

Electric vehicles and the smart grid

Electromobility gives rise to a unique opportunity to combine the advantages of environment-friendly mobility with efficient and optimized use of resources of power grids and sustainably produced electricity. The result is a number of specific requirements, in particular regarding the technology and standardization of the interface between electric vehicles and the power grid. Charging an electric car covers a variety of different use cases, for which the development of standards is an important prerequisite.

From the point of view of the smart grid, an electric vehicle represents a smart mobile system with integrated storage functionality which can be used both as an electrical consumer and as a producer (when return feed becomes possible in the future). One target of the smart grid is to influence electric consumption as a means of integrating renewable, volatile energy (for example, from the wind and sun) more easily into the overall system. Current can only be stored to a limited extent, meaning that the load profile needs to be influenced in order for renewable energy to be used efficiently. Load management should therefore influence energy consumption to ensure that consumption is based more strongly on generation levels. There are basically three types of load management:

Supply-side charging (one-way communication on the basis of price signals)

Smart charging (charging negotiated between car and charging infrastructure operator based on two-way communication)

Charging controlled by charging infrastructure operator

Incentive-based regulation can represent a huge motivation for users not to charge their car immediately at peak load times during the day, but to shift the charging process accordingly. Incentive-based regulation must take the requirements e.g. of the networks and of the energy market into account.

Especially in the early days, it is expected that electric vehicle customers will also have an environmental policy motivation. Load management can help to move towards reaching this goal of CO_2-optimized mobility. In extreme cases, only electricity from renewable sources is used for which there would otherwise have been no use. In technical terms, the load management options increase when high load capacities are available and/or the vehicles are regularly connected to the network, even when there is no direct need to recharge the vehicles.

Standardization of electromobility

The hitherto largely separately considered domains of automotive engineering and electrical/power engineering as well as information and communication technology (ICT) must converge if electromobility is to be a success. A long-term strategy needs to be developed for this which takes into account national interests while opening up access to this expanding international market for the German economy. To achieve this, the National Platform for Electromobility (NPE) was launched as an advisory body by the Federal Government in May 2010. Working Group 4 "Standardization and certification" (AG 4) of the NPE is responsible for the standardization strategy, the result being the current German Electromobility Standardization Roadmap prepared by the DKE/EMOBILITY.30 society.

A range of standards already exists in the established domains of automotive and electrical engineering. These must now be properly applied and publicized. Information on this standardization work and its status can be found in the German Electromobility Standardization Roadmap. The focus of the work lies less on launching new standardization projects than on extending or adapting existing norms and standards to the requirements of electromobility. Cross-domain cooperation must take place at the international level, especially on interface issues.

Environment-friendly mobility

80 % of all carbon dioxide emissions (CO_2) from the transport sector are emitted on the road. In 2010 passenger vehicles (cars) and motorcycles caused around 128 million tonnes of CO_2, HGVs 51 million tonnes of CO_2. Rail transport accounted for 4 % of CO_2 traffic emissions.
It is not only electric cars which run on green energy that are cleaner than combustion engines.

In a simplified consideration of CO_2 emissions which assumes that fuel is available at the pumps, and that internal combustion engines cause no emissions other than CO_2 and that only grey electricity is available at all charging stations (in fact, most charging stations use green electricity), the following picture emerges:

Table 10 – Typical consumption data for cars [13]

VEHICLE TYPE	CONSUMPTION	CARBON DIOXIDE EMISSIONS
Diesel car	4,8 litre/100 km	127 g CO_2/km
Petrol car	5,8 litre/100 km	135 g CO_2/km
Electric car	15,4 kWh/100km (incl. charging losses)	78g CO_2/km (general electricity tariff of EnBW, 508 g CO_2/kWh)

History of electric cars

The electric car appeared once before in history. The first vehicles drove on electric power alone and not with an internal combustion engine. Even before Karl Benz presented his engine, vehicles with an electric motor were already very popular. At the beginning of the 20th century there were almost twice as many electric vehicles as petrol-fuelled vehicles in the United States.

5.4.2 Energy-optimized rail transport

VDE Study: Energy-optimized rail traffic moving towards "1-litre train"

Greatest potential in energy optimization of the entire railway systems

Electric railways already offer very high performance levels while being energy-efficient and environment-friendly. The main reasons for this include the electric drives which power them and which are far superior to other drive technologies, as well as the low rolling resistance, favourable aerodynamics and the possibility of optimal energy control. Yet there is still a great deal of unused energy-saving potential hiding in long-distance, freight and regional (urban and underground railways and trams) railways. In a study containing simulation calculations and cost-benefit analyses for all relevant types of rail transport, subsystems and the entire railway system, the VDE Power Engineering Society has now determined where exactly this potential lies and how it can be exploited.

According to this, energy losses can be further reduced by improving the energy conversion efficiency - e. g. through low-loss energy production and conversion, and reduction of the traction resistance. Further key factors in avoiding energy wastage are energy-saving driving styles, demand-based air conditioning, the maximization of recuperative braking and energy-optimized wiring systems. The greatest potential lies in energy optimization through improving the network structure of DC railways and avoiding irregularities. However, the more significant measures for the energy optimization of rail transport can only be achieved successfully and quickly within the framework of a joint initiative involving the government, the operators and the rail industry. The VDE therefore recommends cooperation between all stakeholders in the railway system. The legislators therefore need to create reliable framework conditions and thus enable long-range measures with large investment volumes. The operators should attach greater importance to energy aspects in the specifications of the vehicles and railway power supply than has previously been the case so that appropriate technologies can be implemented by the rail industry. And the rail industry is called upon to exploit smaller savings, and to make its expertise available to the government and operators in order to optimize the overall system. The most important key to greater sustainability and efficiency in mobility lies of course in the general public: in its increased use of the rail system.

Specific methods and models for a differentiated consideration

In order to subject the complex issue of "energy-optimized railways" to an objective and substantiated analysis and to show the energy-savings potential of individual measures under consistent and realistic boundary conditions, models were developed in the VDE study for the relevant types of traffic and subsystems, as well as application-specific methods for preparation and presentation of the simulation results. In addition, four criteria for the "cost-benefit analysis" were defined for assessing the technical and/or economic costs of implementing individual measures: implementation period, investment or development requirement, energy-saving potential or "savings factor" (calculated for a group of individual measures) and technological potential (share of the single measure within the influencing factor).

Such a differentiated approach is essential because there are large differences in the technical possibilities as well as in the economic benefits of individual measures in the different areas. In all modes of transport, for example, the drive system represents the subsystem with the highest energy demand. However, the savings factor calculated in the VDE rating system varies in this example between 0.16 and 0.32 in the individual transport modes. And even though the influence of traction efficiency is strongest in the transport modes with relatively large numbers of stops, as the losses are reduced both during driving and electric braking (recuperation), the savings factor is still disproportionately low because the energy conversion efficiency is already very high at the outset of the calculations.

Reducing energy losses through innovation

Based on the simulation calculation and the cost-benefit analysis, three main categories of recommendation for action were identified: "Reduce energy losses" (beyond the present boundaries of the technologies used), "Avoid wasting energy" (by rectifying existing inadequacies) and "Promote energy optimization" (with regard to the entire rail system consisting of infrastructure, vehicles and operation).

Reducing energy losses includes improving the energy conversion efficiency of components and equipment. However, such measures can only be applied efficiently to components or elements where high losses occur. This effect is generally greater at the beginning of the energy transmission chain (power plants, converter stations) where the "energy flow" is bundled, than at the end (railway traction units). The use of technical innovations is basically required to minimize energy losses. Important leverage points here are low-loss energy production derived by switching to renewable energies, low-loss energy conversion in the vehicles, but first and foremost an increase in the drive efficiency in particular types of transport with frequent cycles (regional transport, underground systems) and reduction of the traction resistance, primarily of the aerodynamic resistance in higher speed (long-distance) railways or high air resistance (goods traffic).

Minimizing energy wastage through changes in behaviour

Behaviour changes in railway operations are necessary which can primarily be achieved through targeted training of the staff involved: energy-saving driving styles or adjustment of the comfort features to the environmental conditions are just two examples. On the other hand, there are technical innovations that have so far only been realized in individual cases due to the long lifetime of the rolling stock and the infrastructure. These require targeted support for modernization, and not only in terms of funding but also through the elimination of red tape.

The technical preconditions for measures aimed at minimizing energy wastage are generally built into newer vehicles. These include measures such as energy-saving driving styles (use of existing driving time reserves, avoidance of unnecessary drive/braking cycles through the introduction of "request stops"), measures for automated climate control (increased matching of the temperature setpoint to the ambient conditions, reduction of door opening times, minimization of switching times during parked phases), for maximizing regenerative braking and for energy-optimized vehicle electrical systems. However, they must also be safely connected to a control system.

Energetic modernization of the whole rail system is desirable

The greatest potential lies in prioritizing energy targets throughout the rail system. However, the effort required is usually considerable. Moreover, there are sometimes clashes with other targets. Among these are reconstruction of the distribution networks with the aim of yielding higher recovery and lower losses, or the unbundling of traffic types. This requires greater investment in the infrastructure of roads/railways and/or power supply and is costly and time consuming, especially due to public conflicts of interest.

An important element is optimization of the network structure for DC railways. In Germany the long-distance, freight and regional transport systems operate on a 110/15kV AC power grid which is basically absorbent and low-loss; the situation is different for light railways: a significant part of the regenerative braking energy has to be "burned off" in braking resistance if there are no consumers active at the time. Effective countermeasures include bilateral supply and intermeshing of the grid, establishing efficient regenerative substations, creating a legal and regulatory framework and installing stationary energy storage facilities.

A further element is the avoidance of irregularities. Trams in particular are subject to frequent changes in speed because they have to share the road with independent road users. If it is not possible to give rail traffic priority, driver assistance systems can at least help avoid unnecessary drive cycles. A precondition for this, however, is links to the road traffic control centre. Appropriate urban planning policies must be initiated for this. Once the optimization of operational planning has reached its limits, the only solution is to extend the railway system as a means of unbundling the transport modes.

Joint initiatives by the government, operators and the rail industry are now needed

All the above measures contribute both to increasing the efficiency of the railway system and saving energy. However, the more significant measures can only be implemented successfully and within a reasonable timeframe in a joint initiative between the government, operators and the rail industry. Further measures are needed in order to optimize the energy efficiency of the electric rail system in addition to a reliable framework, an increased focus on energy aspects, the exploitation of smaller potential savings and the increased use of rail transport by citizens.

Many innovative developments such as permanent-magnet traction motors, gearless drive systems, mobile energy storage, the replacement of conventional transformers by converters with high-voltage semiconductors, superconducting transformers or medium-frequency transformers are in their infancy and are seldom economical at today‘s energy prices. There is still untapped potential here, however, which leads the VDE to believe that such targeted development efforts should be bundled by the rail industry and universities and funded by the state. At the same time, the operational and technical regulations of the operators as well as the relevant norms and standards need to be updated. In addition, a government incentive system similar to that for the energy-related modernization of buildings would be desirable for existing rolling stock. This is because the current energy price levels are not a sufficient motivator for energy optimization. Given that the time from the development of innovations through to their operational implementation is very long in practice, such initiatives should be initiated comprehensively and as soon as possible, according to the VDE.

5.5 Impact and potential of product networking

Networked devices, Internet of Things (IoT)

The networking of devices is nothing new in itself. Up to now, however, this has been limited to within individual "technical fields" such as building automation, IT, audio-video.

The growing number of IT-based communication possibilities brought about a trend which allows different technical fields to merge by exchanging information with each other. The increased performance of processors coupled with falling costs for the same level of performance then gave rise to the idea of representing all devices in virtual space, i.e. in the Internet. This is referred to as the "Internet of Things (IoT)".

The term IoT is not clearly defined at present. It denotes the vision of exchanging information among everyday objects. This mutual exchange of information is giving rise to new application possibilities.

Guide 118 defines an iterative process for improving energy efficiency

5.5.1 Arguments for growth

The IoT market is currently evolving, resulting in large discrepancies in the market forecasts.

Increased comfort

The networking of devices is opening up new possibilities and applications for assisting users (e. g. fridges) or completely new applications (e.g. heating, predictive maintenance). A distinction must be made between comfort applications which require a rapid response (a few 100 ms) and those in which the response time is of secondary importance. Examples of applications which require a rapid response include: turning on lights, detecting (presence) of persons, intrusion detection or hazard warnings. The response times are only of secondary importance, on the other hand, in applications such as refrigerator content monitoring, temperature setting, consumption displays, scene-controlled blinds or predictive maintenance.

Energy savings

The networking of devices allows them to be activated only when they are actually needed, e.g. turning on a light only when people are present. The optimization of control circuits (such as constant light control, building heating) allows further energy savings to be obtained.

However, the additional sensors and actuators require energy themselves, making it necessary to identify the point from which using them makes sense. A motion sensor for switching lights on and off in the intensive care unit of a hospital makes little sense, for instance, as these are always on. A motion sensor in the basement of a hospital makes a great deal of sense, by contrast. In order to achieve the goal of saving energy, it is necessary to conduct an accurate analysis of the application/use (How often is the service (e.g. light) required? Which people use the service? What load does the service require?). Further aspects such as comfort and safety/security should also be included in the analysis.

Increased safety/security

Targeted safety or security-related information can be transmitted directly from the sensor/system.

Increased device and system availability

The IoT is a prerequisite for predictive maintenance. Messages relating to planned service activities, such as certain components reaching the end of their service-life, or low liquid levels, are sent directly to the appropriate places. This increases the availability of devices and systems, thereby having a direct positive impact on production costs.

Multiple use of sensors

In the past it was customary for each technical field only to use its own dedicated sensors. The burglar alarm system included its own presence sensors, while the lighting system used other presence sensors. Horizontal networking means that presence sensors can now send their data to the light system or to the burglar alarm control panel, as required. Such multiple use of sensors allows comfort levels to be increased and energy savings to be made.

Sensors can send their information simultaneously to multiple users. It is no longer necessary for systems to pass through data; this, in turn, enables them to be simplified.

Telemedicine

Smart sensors now permit health-related data, such as blood sugar levels, blood pressure, etc. to be made available to the doctor via an app. This can save the patient the inconvenience of arranging an appointment with the doctor, however such solutions mean that aspects such as data security and data privacy need to be considered more carefully.

5.5.2 Risks and challenges

The risks associated with using the IoT, however, must also be considered.

Communication resulting in increased energy consumption by devices

Communication-related energy demand results in disproportionately high costs for low-energy-consumption devices. This is especially crucial in the case of white-goods, in which efficiency plays an important role. Here, their use, cyclic response and response times are critical.

More complex systems

The information to be communicated also needs to be produced or, in many cases, calculated in the first place. Complex systems are more difficult to handle, thereby increasing the demands placed upon service staff.

Dependence on device communication

The IoT only yields benefits if the systems communicate with each other. In there is a communication dropout, it is assumed that the device remains functional, which is not necessarily the case and can lead in turn to malfunctioning.

Data security/Data privacy

Some of the IoT data are highly personal or security-relevant in content. Information about a home user being out of the house should not be universally available. Details of how a particular machine is used within a company are not intended for general consumption, either. The higher costs of encryption need to be weighed up against simple and low-cost communication.

The required security methods of the physical layer (wired/RF communication) are based on a security and confidentiality analysis of the necessary data.

Interoperability

In order to be able to use the IoT in the ways discussed here, some important interoperability boundary conditions need to be considered.

Interoperability must be ensured at different levels. First, there is semantic interoperability. If a sensor detects the presence of people, then the relevant actuators must also interpret the received data stream as "person present". At a lower level, the protocol used for exchanging information must support the exchange of information between the devices concerned. Also of relevance is the physical level required for the information exchange.

CEN, CENELEC and ETSI covered the subject of interoperability in detail in the M/490 Standardization Mandate for Smart Grids. This points in particular to the following interoperability levels:

- Business layer (e.g. economic and legal requirements),
- Function layer (use cases),
- Information layer (context and semantics),

- Communication layer (syntax and network interoperability),
- Component layer (hardware).

Of particular relevance for system planning and integration are the use cases, which should also feature the information flows between different objects. The required standards and technical specifications can also be narrowed down and selected within the use cases, otherwise a plethora of standards may apply, particularly in systemic examinations.

An accurate description must then be given of how the required technical standards and specifications are to be implemented in relation to the use cases. This is known as "profiling" which is intended above all to exclude options from these documents and to clearly identify the requirements as a result.

The last step concerns interoperability tests, in which distinctions are made between

- conformance testing (checking implementation against a single standard or technical specification)
- interoperability testing (checking implementation against one or several use cases, with the aim of ensuring that the required functions are performed).

Further information:
https://www.cencenelec.eu/standards/Sectors/SustainableEnergy/SmartGrids/Pages/default.aspx

Since interoperability can be assured through gateways or cloud services, we do not explore the issue of interoperability in any detail here.

The above points are covered below in more detail. It should be noted, however, that the individual aspects cannot be viewed independently of each other. An increase in comfort is usually accompanied by increased energy consumption.

Data exchange between devices at the local level

The exchange of data between devices at the local level can be associated with considerable difficulties. Especially in the reinforced-concrete structures commonly used for industrial buildings, wireless communication is only possible using high transmission power levels. The IoT systems cannot deliver this in most cases, as they are designed for low energy consumption and thus low transmission power. For simple information, non-cloud-based data exchange between devices is less susceptible to interference. Larger-scale analytical processes require a cloud solution.

Use of cloud services

Evaluations of IoT data by cloud services are giving rise to additional or new fields of business for suppliers and service providers.

Example: The energy consumption of a water pump in the heating system increases over time. The IoT in combination with big data (many heating systems send their data to the cloud) mean that the probability of pump failure can now be calculated and, if necessary, a maintenance order issued for pump replacement.

Such an application can only function if communication with the cloud service is possible. Stand-alone operation is not possible. Dependency on providers of cloud services also arises. Costs for data communication are incurred, in addition to those for equipment and energy.

Increased data traffic

The entire communication route requires additional energy. The extent to which this negates the savings in the devices needs to be assessed.

The IoT is resulting in ever-growing amounts of data traffic. This means higher energy consumption by data communication server farms. A study by Datacenter-inside published in 2014 revealed that the annual energy consumption of servers and data centres rose from 4 TWh in 2000 to 10 TWh in 2010. 12 TWh is forecast for 2020.

5.6 Summary/Recommendations

Home

The European Union‘s EU energy label provides uniform labelling of products with a high consumption relevance. The Ecodesign Directive also requires manufacturers to comply with certain minimum requirements.

Household appliances today are therefore already highly energy-efficient. For this reason, future technical developments will not be able to match the high savings levels achieved so far. The networking of devices and the efficient use of renewable energy sources represent significant challenges. However, the measurement methods used to determine the energy label and ecodesign requirements must be continuously developed in order to meet the changing accuracy and practicality requirements.

Household appliances are very efficient. Networking them is a challenge.

In addition to using the highest possible efficiency class of electrical appliances, energy efficiency can be achieved by controlling and regulating – and through the automatic switching of – electrical installations, equipment and lighting. For standardization, this means that, in contrast to the existing energy efficiency requirements (which were defined primarily on a device- and sector-specific basis), the new EU regulation 801/2013 with regard to the energy efficiency of network equipment and intelligent household and office equipment now requires an interdisciplinary approach.

Commerce, trade, services

Recirculation can be more or less eliminated by separating the enclosed cool intake air from the heated exhaust air (cold aisle/hot aisle containment). This separation reduces the cooling air requirement. This leads in turn to a considerable reduction in the amount of electrical energy consumed and thus to lower operating costs for data centres and server rooms. To this end, a new standard will address the dimensions, the mechanical, fluidic and air-conditioning requirements as well as the aspects of operational reliability of aisle containment.

The energy consumption of data centres can be reduced considerably

Energy savings through system optimization

Electromobility opens up new opportunities for energy efficiency

Industry and enterprises

According to the ZVEI, the energy-saving potential of electric drive systems is approx. 40 %. Of this,

- 10 % comes from the use of more efficient engines,
- 30 % comes from the use of variable speed drives,
- 60 % comes from mechanical system optimization.

The relevant standards cover in great detail the energy efficiency of electric machines and drive systems with outputs from 0.12 to 1,000 kW. This is done either by providing definitions which determine the losses or the energy conversion efficiency, or directly by specifying minimum energy conversion efficiency requirements.

This process is well advanced in numerically controlled machine tools, meaning that there is no explicit demand for additional standards here. Instead, comparable and transparent methods are required for assessing the energy efficiency of electrical components in the system context, such as drives controlled by frequency converters.

These standards do not apply to motors with higher power ratings (>1000 kW) and high-voltage motors (>1000 V). However, there is no need for action here, since these motors have very high energy conversion efficiency levels and service lives and are therefore energy-efficient.

Traffic and transport

One purpose of the smart grid is to influence electrical consumption as a means of facilitating the integration of renewable, volatile energy generation (e.g. from wind and solar energy) into the overall system. Since electricity can only be stored to a limited extent, influencing the load profile allows renewable energy sources to be used efficiently. Electromobility opens up unique opportunities for combining the advantages of environment-friendly mobility with the efficient and optimized use of the electricity network resources and sustainably generated electrical energy.

Electric trains are already highly effective, energy-efficient and environment-friendly. Nevertheless, there is still a great deal of untapped energy-saving potential in long-distance, freight and local transport. The most important key to greater sustainability and efficiency in mobility lies, of course, in the citizens themselves and their increased use of rail systems.

Many innovative developments such as permanent magnet traction motors, gearless drives, mobile energy storage systems, the replacement of conventional transformers with high-power semiconductor inverters, superconducting transformers or medium-frequency transformers are still in their infancy and are rarely viable at today‘s energy prices. The standards, but also the operators‘ operational and technical regulations, must be updated if this potential is to be exploited

6 Transmission & Distribution

6.1 Introduction

This section contains an overarching consideration of power supply – from generation through to consumer distribution. It includes both the relevant regulations, guidelines and standards as well as resulting recommendations in relation to electrical energy efficiency.

6.1.1 The energy supply structure in Germany

The electrical power supply consists of the transmission grid, distribution grid and consumer distribution. It also includes additional facilities such as generation equipment, switchgear, transformers, inverter and compensation systems.

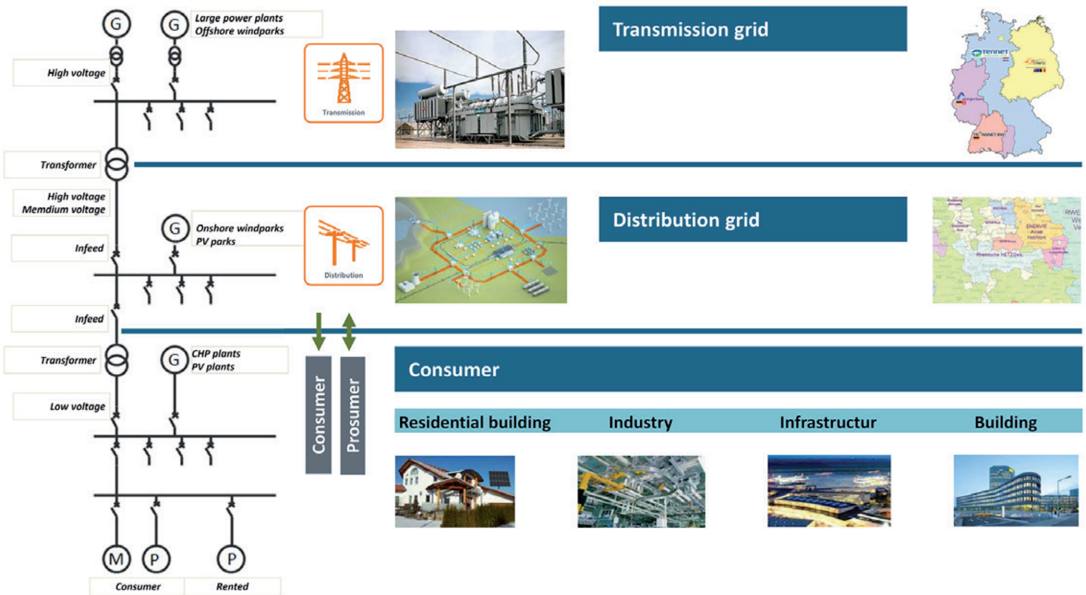


Figure 30 – Electrical energy supply structure in Germany [3]

6.1.2 Liberalization of the energy market within the EU

The liberalized energy market was anchored in European Union (EU) legislation at the turn of the Millennium. The liberalized electricity market is part of the liberalized energy market.

According to the EU Internal Market Directive Electricity from December the 19th 1996 Article 14 the functional areas generation, transmission and distribution as well as the sales area must entrepreneurial separated (unbundling).

The field is separated into the following primary areas
- Power generation,
- Power transmission,
- Power distribution and,
- Power delivery.

Since the liberalization of the electricity market, a distinction has been made between physical electricity supply, following the laws of physics, and trade contracts for on-time power delivery at corresponding bilateral or meritorder trading prices. The trading unit on the electricity exchange is megawatt hours (MWh). However, the price paid for one megawatt hour on the stock market adds a lot of fees and taxes.

Most electricity volumes in Germany are not sold on the electricity exchange, but in OTC (over-the-counter) trading, i. e. off-market bilateral direct contracts between power producers and energy suppliers, so that only the remaining amount of electricity is traded on the electricity exchange as Futures or spot contracts (today for tomorrow).

Since the liberalization of the electricity market, the consumer has the option of choosing the energy supplier according to his preferences (e. g. CO_2-neutral electricity, price-optimized electricity, etc.).

The main roles involved in electrical energy efficiency are briefly described below (see Figure 31).

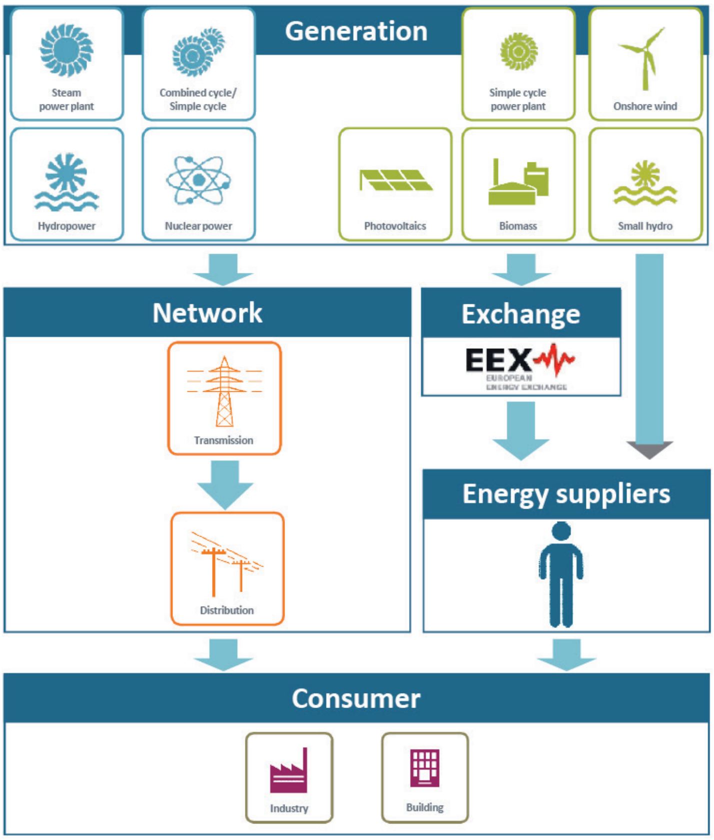


Figure 31 – Roles in the liberalized electricity market [3]

Electricity producers

The producers generate the electricity in power plants or in distributed generation plants and feed it into the transmission or distribution grid.

Transmission grid

The major power plants, wind farms, etc. feed their electricity into the transmission grid. The nominal voltage is 380 kV or 220 kV. Transmission networks link the large energy producers and distribution networks.

Distribution network

The distribution network is below the transmission network in the hierarchy and distributes the electrical energy from the transmission grid to the consumers. The nominal voltage usually ranges from 110 kV down to 0.4 kV. Smaller distributed energy producers such as wind turbines, PV systems, biogas plants etc. feed into the distribution network, where more than 95% of regenerative energy producers are connected to the distribution network.

Consumers

Consumers connect to the distribution network. Depending on their power requirements, this is at the low voltage (typically 0.4 kV or the medium respectively high voltage level (above 1 kV). Large industrial customers with very high demand for electric energy (e.g., rolling mills, aluminium industry, etc.) draw their energy directly from the transmission grid.

Customers who only withdraw electrical energy from the distribution grid are called consumers. Those who not only withdraw electricity but at certain times also feed it into the distribution grid are known as prosumers.

Consumer facilities are further subdivided into the following main categories according to DIN VDE 0100-801 (VDE 0100-801): residential, industrial, infrastructure and buildings.
Consumers have a physical link to the relevant distribution grid operator. They conclude a grid connection contract for operation of the grid connection, and a grid usage contract for use of the grid. Consumers take out a power supply contract with the energy supplier of their choice.

The economic aspect is the main focus of the Federal Government white paper entitled "Ein Strommarkt für die Energiewende" (A power market for energy transition) from July 2015. The procurement costs of the energy producers and of the power exchange are determined by supply and demand. Time-variable energy costs are becoming common for consumers; the electrical energy efficiency of these needs to be evaluated.

Energy suppliers

The agreed quantities of electricity are delivered to consumers via the energy suppliers. The power suppliers bundle their customers‘ orders and buy the electricity as base-load, peak load, off-peak-load or hours contracts directly from the power stations and from the electricity traders at the power exchange. Consumers enter into a power supply contract with the electricity supplier.

Each consumer is assigned to a balancing group. Consumers with consumption < 100,000 kWh/a are evaluated using standard load profiles; consumers purchasing larger quantities are defined by their own load profile. The balancing groups forecast the demand on a quarter-hour basis.

Power exchanges

The European Energy Exchange (EEX) is a marketplace for energy and energy-related products. As a public institution, the EEX is governed by the German Stock Exchange Act. The electricity is traded on the spot market, intraday market and derivatives market.

Only authorized traders are allowed to trade on the exchange. They execute the electricity suppliers‘ orders on the power exchange.

6.2 Transmission and distribution network requirements

This section contains an overarching analysis of energy systems in electricity supply networks. ‚Overarching‘ because various electrical energy efficiency measures can be implemented independent e.g. of the size or voltage level of the power systems.

The Energy Industry Act (EnWG) stipulates that operators of electricity distribution networks must consider energy efficiency and demand-side management measures and distributed generation systems when planning any distribution network expansion.

Energy systems as defined in the EnWG are facilities for the production, storage, transport or distribution of energy, except in cases where they merely serve to transmit signals.

In this section the focus is on systems for the transport or distribution of energy, in particular switchgear, substation and converter systems. The electrical energy efficiency of equipment for production and storage is treated separately in the "Energy production" and "Storage" sections.

These systems usually contain further active sub-systems for which specific measures can be implemented to improve the relationship between energy input and the consequent result in the areas of energy conversion, energy transport and energy use:

- Inverter system,
- Transformer system,
- UPS system,
- Primary cable/conductor system,
- Reactive power compensation,
- Heating, air conditioning, ventilation, smoke extraction (HVAC),
- Fire protection system,
- Lighting,
- Communication and information systems,
- Automation (SCADA),
- Metering and measuring,
- Management system (operation and monitoring).

An important way of increasing the energy efficiency of energy supply systems is optimizing the selection of equipment and auxiliary systems. This includes selecting equipment with the best energy rating and assessing the overall concept. The energy conversion efficiency of transformers, motors and inverters which are often operated in partial load depends greatly on the mode of operation and should be designed accordingly, as should the dimensioning of the conductors (see figure 32).

Aggregate units, systems, automation and management systems can also be planned without functional limitations in terms of energy efficiency, e.g. in the form of adapted dimensioning, processor power and cooling.

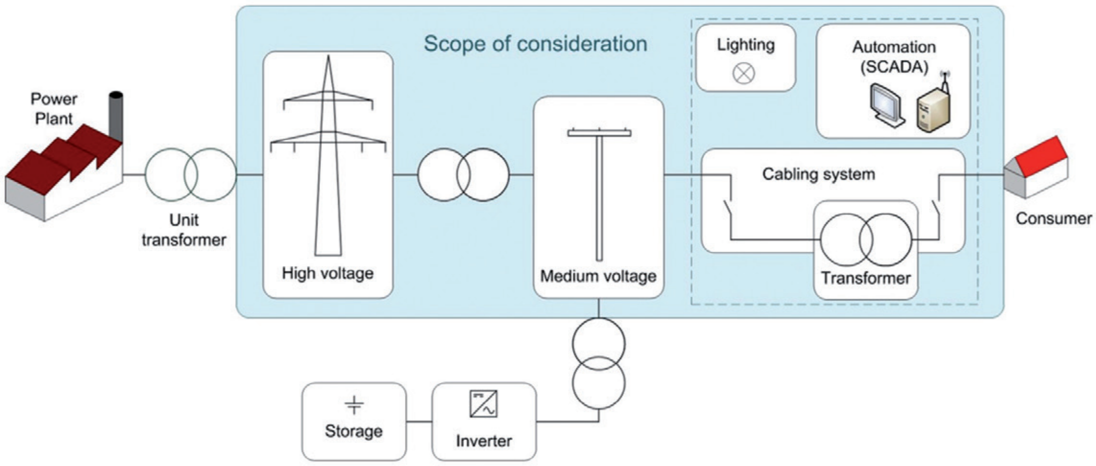


Figure 32 – Scope of consideration of electricity supply networks (simplified) [14]

6.3 Consumer network requirements

6.3.1 Introduction

This section contains an analysis of consumer networks with an annual energy requirement of 100,000 kWh/a. Which measures are viable in the case of consumers with a lower annual consumption should be ascertained. The connection of a consumer to the distribution network is referred to as a transfer point.

The energy demand forecast forms the link between the distribution network and energy supplier and consumer. It describes the predicted energy demand in defined time periods (e.g. quarter hours). The forecast is binding and must be adhered to at a defined quality.

Consumers are subdivided into (see figure 33)

- Applications,
- Distribution,
- Self-generation,
- Energy purchasing.

Lighting, electrical machines, drives (e.g. motors), white goods (e.g. fridges), brown goods (e.g. TVs), heating/air conditioning/ventilation, transformers and aggregate units (e.g. machine tools) fall into the category of applications.

Primary distribution consists of conductors, cables, busbars, protective devices such as circuit breakers and fuses. Distribution forms the connection between the transfer point, self-generation and applications.

All electrical generation plants in the consumer network such as PV systems and cogeneration units are covered by the term self-generation. In the broadest sense this also includes electrical storage.

Energy purchasers procure electric energy from the electricity traders and enter into contracts with the distribution network operators.

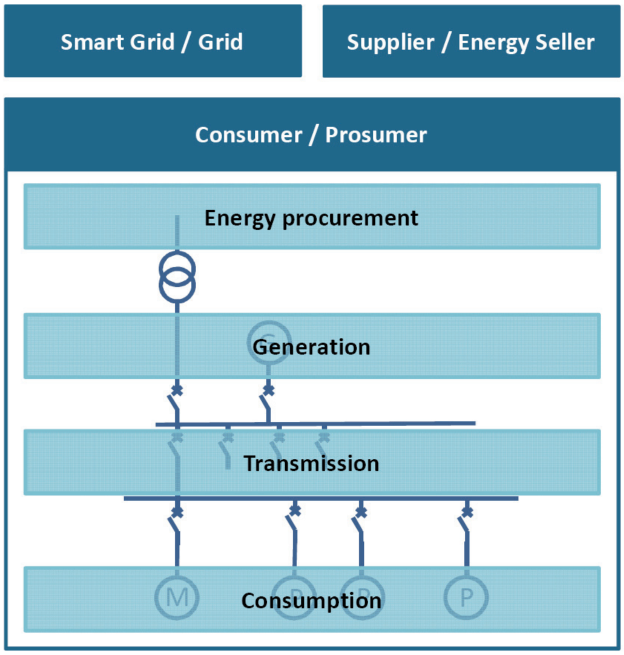


Figure 33 – Consumer structure [3]

6.3.2 Efficiency analysis – Consumers

Applications

At the application level, efficiency is regarded from the viewpoint of reducing consumption. Efficiency is application-specific and therefore an integral part of the product, the device or the aggregate unit. Here, manufacturers are committed to designing energy-related products covered by the regulation efficiently according to 2009/125/EC and the national implementations. The energy label is one of the best-known examples of this.

However, responsibility for the effective use of the application lies with the user and is determined by the building or industrial automation. Applications should be turned on only when needed, otherwise they should be put into standby mode or turned off entirely if possible.

Distribution

In analyses of electrical energy distribution within the consumers, the efficiency is described using DIN VDE 0100-801 (VDE 0100-801).

Distribution dimensioning is carried out during the planning stage and is based on the maximum power levels required. The energy to be transmitted is not the priority here. Efficiency is related to optimization of the system design of transformers, cable cross-sections, switching and protection devices, taking the use during the assumed operating life of twenty or more years into consideration.

The equipment should be dimensioned in the planning phase to ensure as few operating losses as possible. A major factor here is the distribution load. Load here refers not only to an operating point, but also its load profile, because the transmitted power has a quadratic effect on operating losses.

Special emphasis is placed on the use of measuring instruments for monitoring and documenting energy flows and other measured electrical quantities in the plant operation.

Another aspect relates to minimization of the reactive power and harmonics. It is assumed that the applications being supplied operate efficiently. Since the use and hence the energy flows can change during the operating time, documentation and optimization should be made possible by the measurement technology as defined in DIN EN ISO 50001.

Self-generation

Providing the required power to the energy application must be effected through a combination of purchased power and self-generation. The difference between self-generation and consumption must be bought on the energy market by the electricity supplier.

Electricity suppliers deliver power nationwide from the mains supply to the transfer station. District heating networks for heat supply have a smaller radius and are usually only available in cities. An extensive network exists for the distribution of natural gas. Coal, heavy oil and fuel oil are delivered by rail or HGVs; local storage is imperative.

Combined heat and power (CHP) plants generate heat and electricity at efficiency levels of almost 90 % from renewable or primary fossil energy. This high level of energy conversion efficiency means that such systems are ideal for decentralized heat supply plus power generation. The ratio of heat to electricity generation depends on the construction type (e.g. 1/3 electrical and 2/3 thermal energy). Heat demand and its provision cannot be separated from electricity production in CHP plants. A special aspect of efficiency lies in the sizing of the generation plants. In most cases, such systems are heat-controlled, i.e. the provision of electrical energy is a consequence of the thermal generation.

When electrically driven heat pumps are used, the power demand also depends on the heat generation.

Chillers are also electrical loads; the cooling process has a corresponding power requirement.

Energy storage plays a special role. Electrical energy can be stored in batteries and retrieved when required. Electrically powered chillers fill the accumulator, they influence the electrical energy demand through their operation. Excess electrical energy can also be used for filling of heat storage units.

Most self-generation involves interconnected electrical and thermal energy systems which influence each other.

The efficiency of energy self-generation is thus increased in the interplay between power, heat and cooling generation. In normal circumstances the main focus is on cost-effectiveness. CO_2 efficiency is the primary quantity in a small number of cases [see figure 34).

In the future, electric vehicle charging stations will need to be integrated in the distribution of energy. Electric vehicles can also be used for power storage as well as charging.

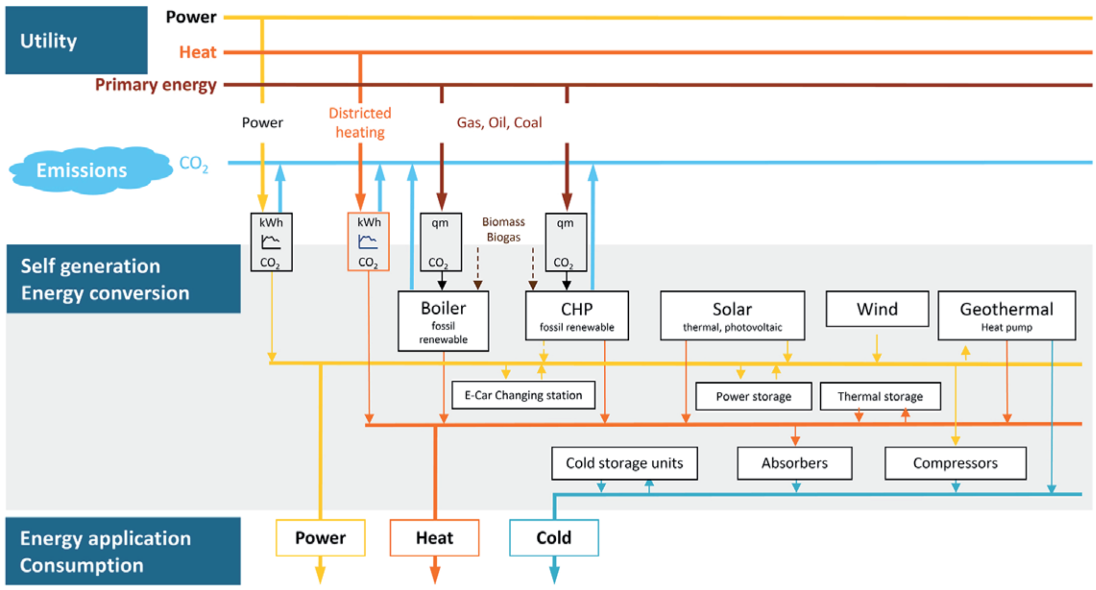


Figure 34 – Self-generation as the link between purchasing from an energy supplier and consumption [3]

6.3.3 Energy purchasing

Energy purchasing forms the link between consumers and providers and is based on forecast energy demand. The energy purchasing costs are based on applying this demand forecast to the current energy costs. The energy purchasing costs can be influenced by changing the forecast. Energy purchasing efficiency arises from the optimal use of energy costs by influencing the energy demand. Energy demand can be influenced by changing self-generation or consumption levels.

An energy management system can only function if the energy consumption is documented transparently (which application requires which energy in which situation) and the energy producers are known in their control area. Electrical and thermal storage offers a large degree of freedom here, as it can decouple the demand of the applications from the purchasing demand within certain limits.

Efficiency at the transfer point from the distribution network is achieved purely in commercial terms. As far as the consumer is concerned, the required energy should be purchased as cheaply as possible, yet the energy fed into the grid should be sold at the highest possible price.

The "Ein Strommarkt für die Energiewende" (An electricity market for the energy transition) white paper issued by the Federal Ministry for Economic Affairs and Energy focuses not on the capacity market, rather on the trading of energy products. This means that energy demand forecasts down to a quarter hour are imperative.

Demand forecasts require precise knowledge of the energy demand. This must first be acquired by the operator. It is based on the transparency of the energy flows in existing installations and, in new installations, on statements issued by the suppliers of equipment/units.

Batch-related system processes break down into process steps which can be described using an energy forecast over a relative time. An energy demand profile of the production steps is created through addition of the various process steps in accordance with the production plan. The sum of all production steps according to the production plan yields the energy forecast of production (see figure 35).

Consumers with daily repeating work patterns are defined using synthetic load profiles based on past usage.

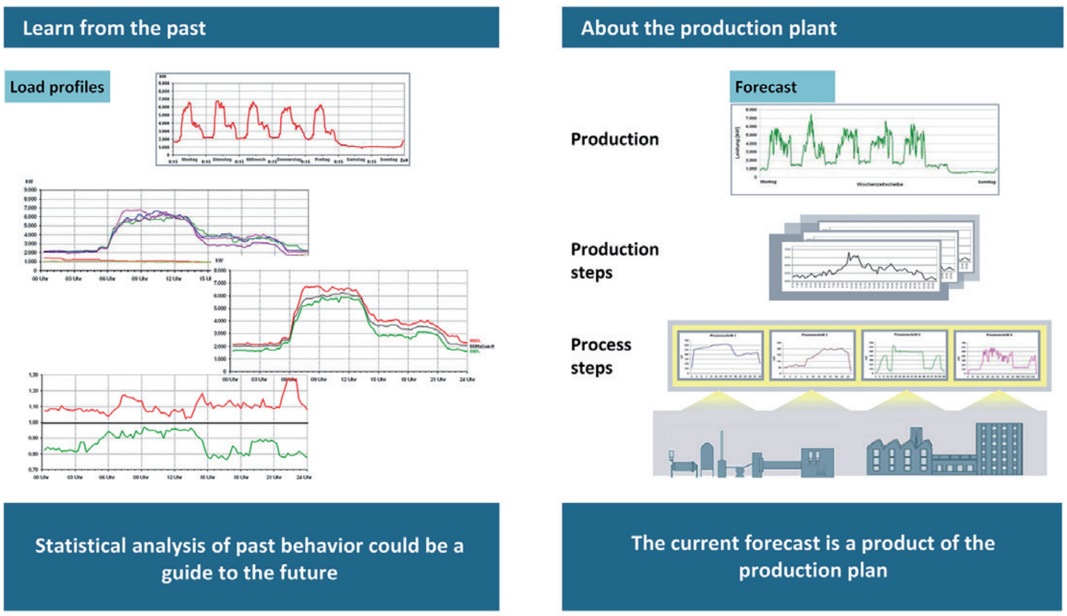


Figure 35 – Load profile for different consumers [3]

Actual consumption cannot be predicted within a quarter of an hour with 100 % accuracy. These discrepancies are balanced by forecast management. Adjustments are made by turning individual applications on and off in order to use the ordered energy within the quarter hour and therefore to be cost-effective (see figure 36).

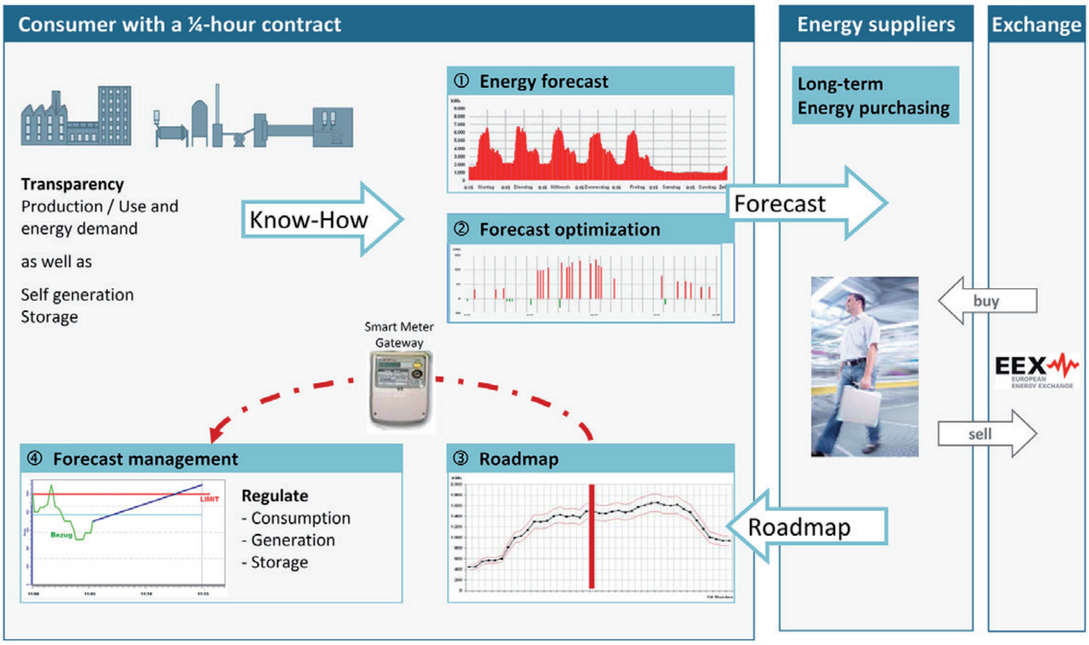


Figure 36 – Adherence to demand forecasts [3]

6.4 Load profiles

The transparency of the energy flows to the individual applications plays a key role within the distribution. Load profiles offer a targeted overview here. Energy management and efficient energy purchasing are not possible without this ongoing processing. Controllers can use the collected data for their tasks. The ongoing improvement process based on DIN EN ISO 50001 also benefits from this data. Load profiles graphically display the measured values over time. In the energy sector, the load forecasts are based on load profiles which describe the energy demand in quarter-hour units.

The load profiles are needed both by the transmission and distribution system operators to estimate the network load and grid usage and also by the energy buyers to estimate the amounts of energy to be procured.

The load forecasts for consumers < 100,000 kWh/a are based on standard load profiles [see chapter 5.2.3). These show an average from the individual groups and are used to determine the generation load or the load for the distribution transformers. The standard load profiles cannot be used for assessing a specific consumer. The BDEW (German Association of Energy and Water Industries) provides standard load profiles (see figure 37).

Consumers with an annual energy requirement of > 100,000 kWh/a are assessed based on their own individual load profile.

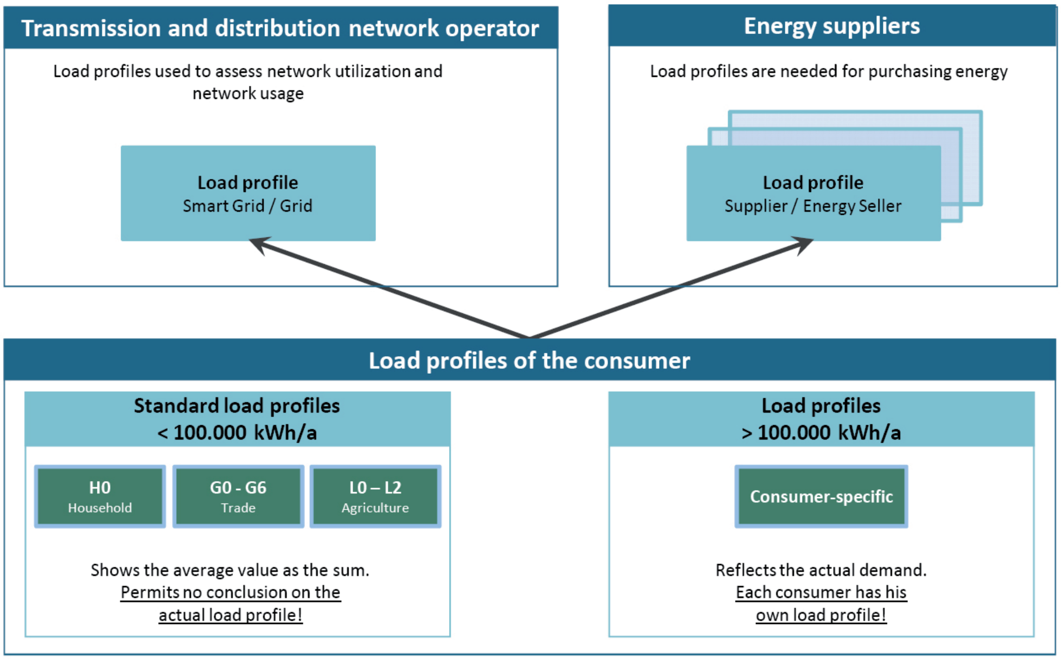


Figure 37 – Load profile users [3]

Standard load profiles distinguish between working days, Saturdays and Sundays as well as the three time zones of winter, spring/autumn and summer. For consumers > 100,000 kWh/a a distinction is made between those with a continuous and a discontinuous load profile. All consumers who display the same behaviour during the course of each day have continuous load profiles. Such behaviour is exhibited for example by office buildings and department stores. Industries characterized by batch-oriented production have discontinuous load profiles. The load profile of the office building is continuous; the individual days of the week are shown as annual averages. The office building has no air conditioning: there is no need in this case to distinguish between the individual seasons.

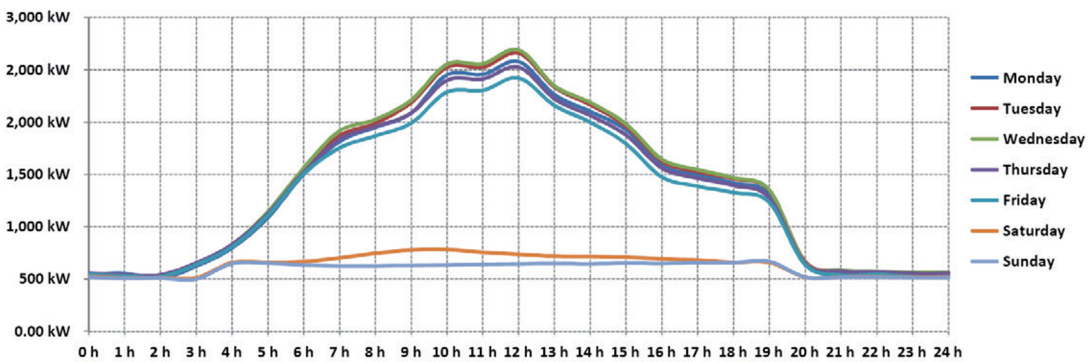


Figure 38 – Load profile of the office building [3]

6.5 Planning of electrical energy distribution for consumers

6.5.1 Outline of the relevant standards

The standard DIN VDE 0100-801 (IEC 60364-8-1) describes the efficiency planning requirements within the planning of electrical power distribution systems. The measurement technology to be installed is of great importance here. Measurement technology accounts for a third of the target items. The standard requires the energy or output level to be recorded, as well as the power factor, the voltage and the harmonics. The concept of efficiency covers not only energy efficiency but also includes all criteria which have a negative impact on the optimal effective power transmission. The standard explicitly states that the measuring technology contained in the planning should support the requirements and recommendations for the electrical part of the energy management system according to ISO 50001. Another new aspect concerns the annual energy requirement values for each individual application. The sum of the annual consumption of individual applications yields the annual energy requirement of the entire system. The individual efficiency measures are weighted on the basis of these annual consumption values.

Energy consumption indices are also given in the EnEV. They map the energy consumption of heating, water processing, cooling, ventilation, and built-in lighting per year and square metre of net floor area. The energy requirements for individual uses, such as office machines and kitchens, are not included in these values.

Energy demand levels are also given in VDI 3807 part 2. These show the total demand at the transfer point to the distribution network.

Planning offices design electrical energy distribution based on the maximum power to be transferred – not on the energy to be transferred. The invoices are based on empirical values: there is no standard or guideline.

An electrical energy distribution system is designed to cope with the maximum current levels. The transmitted energy only plays a subordinate role to dimensioning. All the guideline requirements (VDI 3807) and maximum values (EnEV) relate to the total energy demand. The required annual consumption values according to DIN VDE 0100-801 (VDE 0100-801) are based on energy values at the application level.

Synthetic load profiles could form the bridge between load profiles, annual energy consumption and annual consumption indices.

6.5.2 Synthetic load profiles for system planning

Synthetic load profiles are based on the Black Box concept; only the infeed is considered, and not the internal structures themselves. The synthetic load profile approach assumes that industries with the same usage behave the same way, thereby allowing conclusions to be drawn on general behaviour.

Creating standards based on the average gives rise to standardized synthetic load profiles which can be applied to all sectors with the same properties. The peak power is reflected in the peak value. The distribution must be designed to cope with this power at least.

Synthetic load profiles can describe both the behaviour of complete building types (office buildings with air conditioning) as well as their sub-groupings (catering business).

Other types of buildings such as hospitals, data centres, department stores, hotels have their own synthetic load profiles.

Within the synthetic load profiles, the VDI 3807 Sheet 2 value is represented by the mean value; the EnEV value is below the mean as it only describes a subset of the required electric power (see figure 39).

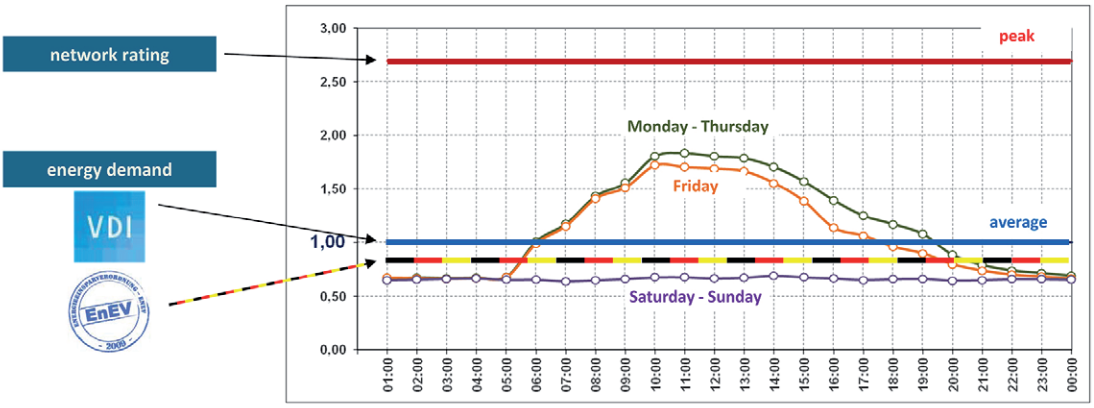


Figure 39 – Relation between synthetic load profiles – VDI 3807 values – EnEV requirements [3]

During operation of the system, synthetic load profiles can be used as the basis of energy demand forecasts.

A specially tailored synthetic load profile is obtained by averaging the measured quarter-hour reference values. This synthetic load profile can be used for load forecasting. In an analysis conducted in line with DIN EN ISO 50001, the synthetic load profile can serve as a reference value which can be used to identify and quantify specific deviations.

6.6 Transparency

6.6.1 Background

The standards of the DIN NAGUS AA9 "Energy management and energy efficiency" Energy Committee are not electrotechnical standards and most of them are not product-specific. Instead they are over-arching basic standards, in particular organizational standards for energy management, energy audits and energy performance. DIN EN ISO 50001 defines energy performance in terms of ‚energy use', ‚energy consumption' and ‚energy efficiency'.

The DIN EN ISO 50001 ‚Energy management systems' standard calls for energy use, energy consumption and influencing factors to be measured and evaluated. It also stipulates determination of the energy-related performance, its monitoring and measurement against a baseline/starting point using performance indicators, and a plan for energy measurements, the requirements of which the organization sets itself.

6.6.2 Measurement concept

The measurement concept is described in general terms in DIN EN ISO 50001. There are no specific instructions as to where measurements should be taken, the sampling rate or media. It is required for

- all relevant energy media to be measured,
- the consumption of the main consumers to be measured,
- relevant performance indicators to be generated,
- the main factors to be known.

Generating the relevant indicators also involves recording production volumes and possibly also other key factors. The level of detail, sampling rate, and type of recording are not defined in specific terms.

The following table shows the SpaEfV requirements and can be used as orientation.

Table 11 – Recommendation for appropriate energy data gathering systems for the introduction of energy management [15]

ENERGY COSTS PER SITE* AND YEAR (ORIENTATION VALUES)	MONITORING OF MAIN ENERGY CHARACTERISTICS AND ENERGY PERFORMANCE
Up to 10.000 €	Measurement by meter operator, theoretical estimation, measurement concept
10.000 € – 100.000 €	Measurement by meter operator, theoretical assessment, verification by mobile measurement, measurement concept and (if necessary) retrofitting of individual meters
100.000 € – 1.000.000 €	Measurement by meter operator, theoretical assessment, verification by mobile measurement, continuous sub-measurements, measurement concept, long-term automatic data gathering necessary
More than 1.000.000 €	Measurement by meter operator, continuous sub-measurements, theoretical estimation for sub-distribution possible, verification by mobile measurement, measurement concept, automatic data gathering

* The sum of the annual energy costs mentioned in the table above is per company site. Consumer points without employees such as locally operated facilities including pump stations, cogeneration plants, etc. are also classified as sites.

Further information can be found in the following standards and national requirements: SpAEfV/DAkkS/BAFA, ISO 50002, DIN ISO 50003, DIN ISO 50006, ISO 50015, DIN EN 16212 and DIN ISO 17741

6.6.3 Measurement technology

Multifunction measurement equipment, meters and other energy quality measuring instruments are available on the market. Voltage can be directly measured by instruments within the low-voltage network; current requires transducers which then feed it as 1A and 5A rated current to the meter. Meters which can measure directly up to 63A represent an exception.

Digital measurement devices are similarly priced to analogue ones, but have a larger range of functions and allow the automatic readout of consumption. Generally, the measuring instruments of all well-known manufacturers are suitable. The optimum equipment should be chosen based on the type of connection, automation environment and price (see figure 40).

In addition to pure measurement devices, motor protection devices, control units and protection devices also have measuring functions today.

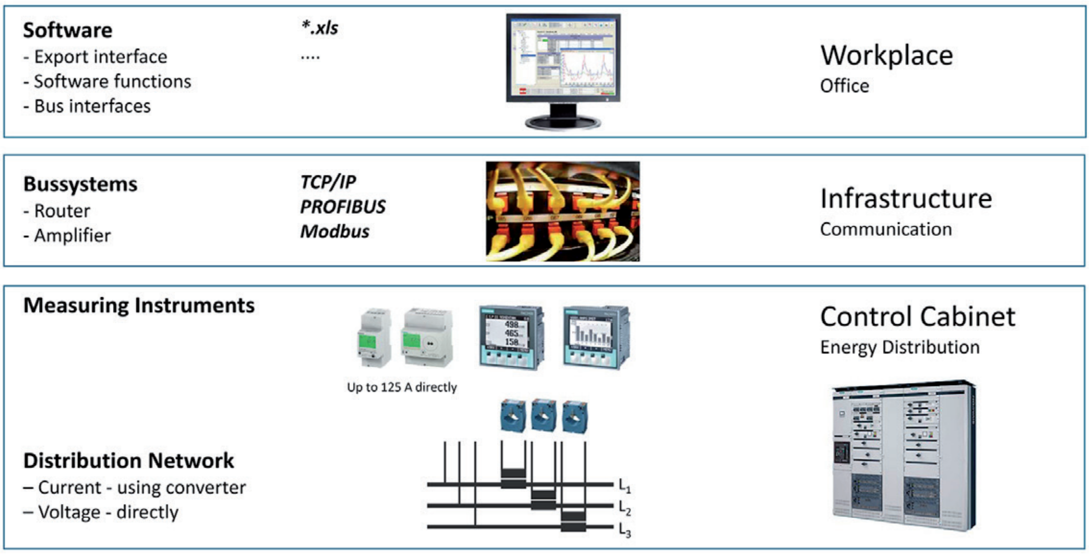


Figure 40 – Equipment for energy transparency und energy management [3]

6.6.3.1 Measured variables

Different variables need to be recorded depending on the application. Details can be found e.g. in DIN VDE 0100-801 (VDE 0100-801). This specifies particular measurements. The higher the score, the more efficient the plant (see figure 41).

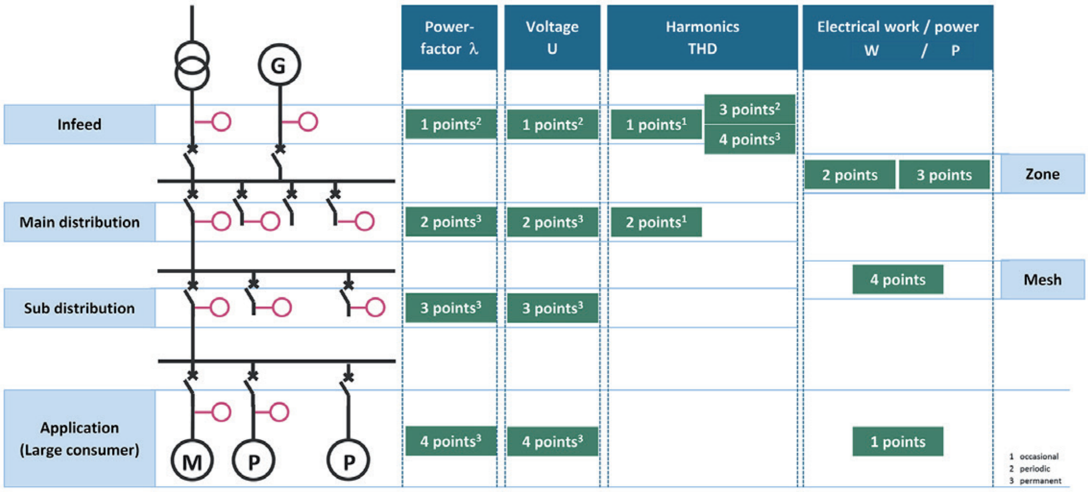


Figure 41 – Measurement according to DIN VDE 0100-801 (VDE 0100-801) [3]

Measurements of electrical energy and power

Measuring energy in defined time units is the basis for transparency in the distribution energy flows. If the power is measured, the result is an average over a defined unit of time. 1/4 hour units are generally given as the time basis for power measurement.

For special contract customers, the energy is measured every quarter of an hour and from this the average power is calculated and invoiced. For billing the amount of energy consumed by the customer in the annual billing, the energy consumed (working price in €/kWh) and the power peak (power price in €/kW) will be taken into account.

Measurement of power factor

The power factor λ is defined as the ratio of the active component to the apparent component of the fundamental plus all measured harmonics. It can be based on the current or power measurement. The easiest method is to record in periodic time intervals. For a better assessment, permanent measurement including archiving is needed. This must be conducted either centrally or at the main distribution points to the main loads.

Measurement of voltage

The voltage drop should be measured according to the recommendations contained in DIN VDE 0100 520 (VDE 0100 520). The calculation is based on the maximum load of the cable and the conductor. In normal operation, the voltage drop is below these calculated values. The main switch cabinets, the distribution cabinets and the main loads should be measured when measuring voltage.

Measurement of the harmonic

All electronic loads generate harmonics. Current harmonics put a strain on the cable and the conductors; reducing them therefore relieves the strain.

6.6.3.2 Accuracy classes

Measuring accuracy is defined by standardized accuracy classes. These are described in the standard DIN EN 60051-1 (VDE 0411-51-1) which sets the maximum expected deviation of a measured value from the true value of the physical quantity being measured. The accuracy class must be known for energy management, since it is reflected in the possible evaluations. In practice, all devices on the market offer sufficient accuracy, as long as the measured values are not used for billing. Calibrated meters must be used for this.

6.6.3.3 User of old meters

For reasons of transparency it is recommended that old meters be kept in a measurement point register but also that the respective accuracy and the history of the meter (standardized, calibrated or unused) be given. Meters used for documenting energy efficiency measures and for acquiring performance indicators must be sufficiently accurate.

6.6.3.4 Reliability of data

The accuracy and reproducibility of data are important. Documentation must be provided of the measurement calibration and the accuracy and reproducibility of the overall system. The data should be plausibility-checked. Action should be taken on non-plausible data.

6.6.3.5 Other energy-related media

Other energy-related media are often recorded in addition to electric energy consumption. The details are not specified here.

6.6.3.6 Connection/data exchange

There are many protocols for the connection of measurement equipment and for data exchange. The vendor-independent protocol in the DIN EN 61850-X standard series has proven useful for high and medium voltage distribution data connections. At the low voltage level, there are many ways to connect the measurement devices, including ProfiBus, ProfiNet, OPC and SQL, depending on whether they are directly available to the energy management or through an existing level of automation. The protocols generally have no impact on the transparency.

6.6.4 Energy data management system

Energy data management systems are software for capturing, saving and evaluating the energy-related data. There are many systems, all with different functionalities. It should generally be ensured that specific performance indicators can be analyzed based on relevant factors. Therefore it should be possible to link the energy data with product and production data (industry) or other relevant variables (number of employees, building size, ambient temperature, etc.). Only then can the performance indicators (EnPIs, energy performance indicators) be compared and statements made about the energy efficiency of production. Data acquisition in short time intervals (e.g. in seconds or 10 second units) allows timely evaluation and, if necessary, energetic recommendations to be made.

Performance indicators and characteristics can be illustrated using the example of a melting process (see illustrations below). The energy required for melting the batch is compared to the amount produced. This yields the relative ratio of specific consumption in kWh/t. Under similar production conditions, this value is useful as it allows a quantitative comparison to be made. However, if the feedstock mix (for example) varies, this results in different typical specific consumption figures. The more cold feedstock there is to be melted down, the more energy is required. The greater the amount of hot feedstock, the lower the energy requirement. The produced batches can now be grouped by feedstock mix and plotted on the X-axis. Different limits apply for each feedstock mix. To evaluate the current situation, the present feedstock mix is defined and the corresponding limits used to represent the result. The yellow dot shows an outlier that is just above the desired limit for the given feedstock and is thus represented by the yellow range on the speedometer. The same specific consumption for pure cold feedstock would still be within the limits and would have been represented by the green range. This shows how important it is to include the production conditions in order to obtain a reliable assessment of the energy situation.

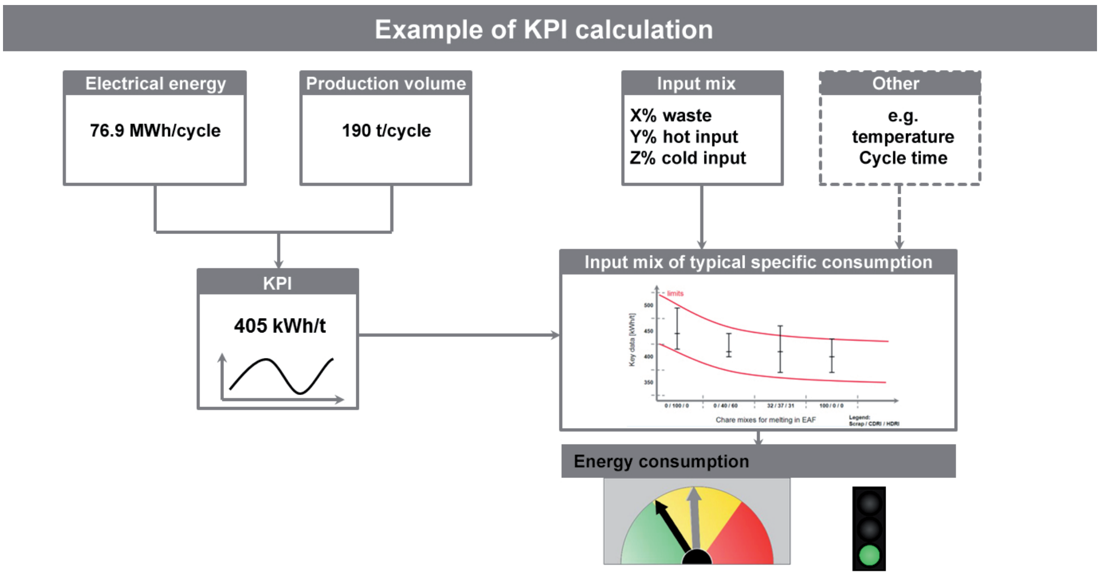


Figure 42a – Sample KPI calculation [16]

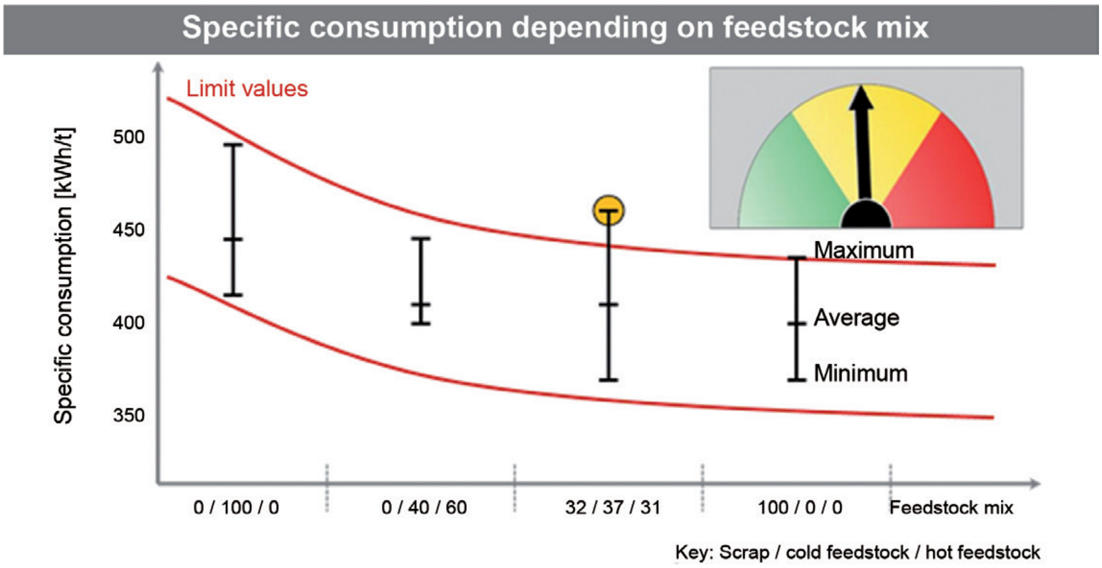


Figure 42b – Specific consumption depending on the feedstock mix [16]

6.6.5 Energy management system

The organizational aspects as well as the processes for increasing energy efficiency are described in DIN ISO 50001. Mirroring quality and environmental management, the key aspects include

- The energy manager (with overall responsibility) and his energy team,
- Documentation,
- Reporting,
- Ongoing improvement process,
- Internal and external audits.

The introduction of an energy management system according to DIN ISO 50001 is supported by various programmes and is mandatory for the reduced EEG reallocation charge in the energy-intensive industries. The criteria that companies must fulfil during certification or auditing are becoming ever stricter.

They are based on the PDCA cycle as used in the DIN EN ISO 9000 standard: Plan, Do, Check, Act (see figure 43).

Data presentation and interpretation possibilities are also described under the heading "Energy controlling" in VDI 2166 Part 1.

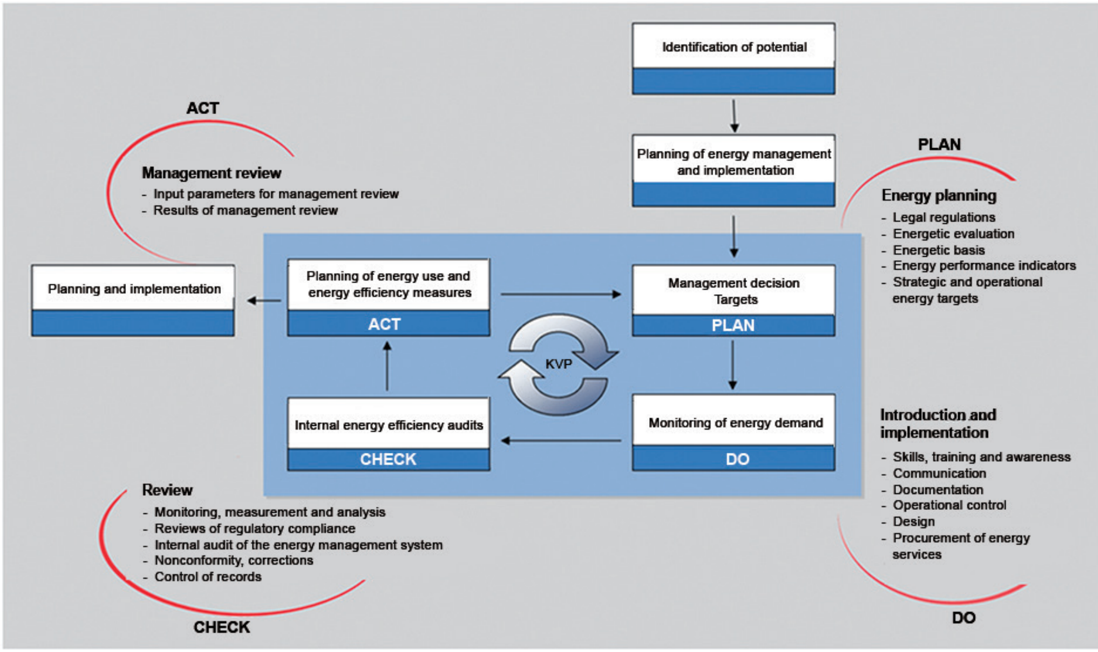


Figure 43 – Energy management system [16]

6.7 New network concepts

New network concepts

Radial systems are commonly used today in low-voltage networks. The necessary system protection devices (overload, short circuit, selectivity) and their design are universally available.

The ring and meshed network structures commonly used in medium-voltage networks are now to be used in the low voltage system, too. The necessary low-voltage protection devices are not currently suitable for these networks. They must also provide distance and differential protection functions.

Micro grids

Independent power supplied by photovoltaic systems, combined heat and power plants, wind power plants is increasing, as is the use of batteries. Consumers are becoming prosumers. If this development is taken to its logical conclusion, this will result in isolated networks disconnected from the smart grid (micro grids). This creates new problems such as the earthing system, frequency control and compliance with the standard voltage which must then be re-evaluated. IEC 60364-8-2 and VDE 0100-802, which are currently being developed, set out the requirements of such systems.

DC networks

DC networks are increasingly seen as an alternative to AC networks. Various indoor applications (e.g. lighting) already exist. How these are used in industry is part of the current research. Large consumers (e. g. welding systems) produce large current surges in the DC network. Using electronics to supply the DC network cannot compensate for the voltage fluctuations, as the required short-circuit power is lacking.

Comparable system structures to AC voltage are not (yet) feasible. The same applies for system protection products.

Material migration in long-term operation and its effects have not yet been sufficiently studied.

Electric vehicles and charging stations

The move away from fossil fuels is one of the problems we will need to face in the future. The future of transportation lies in the electrification of cars and HGVs. Batteries are currently the focus of discussion as energy storage solutions. However, this will only make sense if the proportion of renewable power generation continues to grow.

The charging station infrastructure is currently under construction. In most cases, the existing electricity networks are not designed to cope with the additional power required by the charging stations. They need to be expanded accordingly.

Installation is also being hindered by legal hurdles. At present, all parties must agree to the installation of charging stations in underground garages beneath blocks of flats. No decisions have yet been made regarding the creation of an infrastructure for inner city roadside parking.

The charging stations are electronic loads. They constitute a capacitive load and have a high harmonic content. Rapid charging stations drain a large amount of power over a short period of time from the distribution network. The charge capacities in each case are:
- Wall box 3 – 22 kW,
- Charging column 22 – 150 kW,
- Rapid charging stations up to 600 kW.

The harmonic component can constitute up to 50 % of the current. e-car charging stations cannot be integrated in the low-voltage grid without precise analysis of the network. This is because EN 50160 limits the harmonic component of the voltage to 8 %.

The charging infrastructure of car parks or parking places should have its own medium-voltage supply. It needs to be checked whether the infrastructure of the distribution grid operator can deliver this. The new regulations for the connection of installations (VDE-AR-N 4110/4100/4105) describe the general terms and conditions.

Tenant electricity model

The adoption of the tenant electricity law on 25 July 2017 created new opportunities which enable tenants to participate in the energy transition.

The wide range of technical and legal challenges involved can only be surmounted successfully if there is close cooperation between owners, network operators, planners, skilled tradesmen and service providers. Further developments are necessary to the existing billing and associated metering systems. To obtain a satisfactory solution for all parties, it makes sense to offer new and interesting business models which include heating and mobility. Successful transformer-to-socket planning involves making the network capacity thus released available for electric mobility. An example of such a project can be found in Oldenburg: www.hennehaus.de

Further projects have been implemented by Stadtwerke Konstanz and form a basis for incorporating integrated energy in the planning of housing associations or rental properties in need of redevelopment.

Double busbar

Advantages
- Inexpensive meter technology
- Clear separation of tenant electricity customers and third-party tenants

Disadvantages
- Cost of 2nd busbar
- Costs for change processes
- No temporal resolution of electricity use
- Only netted billing (not EnWG-compliant)

Conventional totalizer model*

Advantages
- Inexpensive meter technology
- More flexibility when changing supplier compared to double busbar
- Common model
- Disadvantage:

Disadvantages
- effort in change processes (manual reading)
- No temporal resolution of electricity use
- Only netted billing (not EnWG-compliant)

Smart totalizer model*

Advantages
- Due date exact consumption during change processes
- Time-resolved generation and use of electricity based on 15-minute values
- EnWG-compliant billing (identification of direct and residual electricity, network charges and concession fees)

Disadvantages
- Higher costs for measuring and communication technology
- Complex calculation system for the determination of direct and residual current

* with virtual point of delivery

Figure 44 – Metrological concepts of tenant electricity models [16a]

6.8 Summaries and recommendations

Extensive efficiency improvement measures for low-voltage systems in electricity distribution networks are already included in the scope of DIN VDE 0100-801 (VDE 0100-801) which contains additional requirements, measures and recommendations for the planning, construction and inspection of all types of low voltage systems, including the local generation and storage of energy, to optimize the overall efficient use of electricity.

The standard assumes the availability of annual energy values for each application. These are not normally available during the planning process. For this reason, reference values are to be drawn up and made available for planning. It would be preferable if this were extended to synthetic load profiles, which are independent of the voltage level.

A key method for improving energy efficiency in energy supply plants is to optimize the selection of resources and support systems. This includes choosing equipment with the highest energy rating and also consideration of the overall concept. This applies e.g. to transformers, motors and inverters which are often run in partial load operation, and energy conversion efficiency of which depends to a large extent on the operating mode. To obtain the optimum design for such equipment, the necessary load profiles and the mode need to be analyzed and the concept designed accordingly.

An energy efficient system also requires demand-side control of equipment. The energy consumption must be determined for this, and load profiles drawn up in order to operate systems optimally. As more and more electronic applications are being used, monitoring of the power factor and of the harmonics is becoming increasingly important.

Aggregate units, systems, automation and management systems can also be planned without functional limitations in terms of energy efficiency, e.g. in the form of adapted dimensioning, processor power and cooling.

In order to optimize the power distribution, sub-distributions should be set up as close as possible to the load centres. Where there are considerable load fluctuations, it may be useful to share the supply across several transformers or inverter systems that are operated in parallel.

Furthermore, electricity distribution networks should also be specifically checked for the extent to which the FNN "Recommendations for the design, reconstruction, expansion and operation of grid stations" can be optimized in terms of energy efficiency measures.

The application of DIN VDE 0100-801 (VDE 0100-801) should also become much more widely known in the market as a means of putting many of the above requirements into practice. DIN VDE 0100-801 (VDE 0100-801) covers the erection of electrical installations and also operating aspects to increase electrical energy efficiency.

Overall, various approaches to electrical energy efficiency exist:
- At the application level, the focus is on energy efficiency in terms of lower consumption;
- Within distribution, efficiency is regarded from the viewpoints of investment and lower operating costs;
- At the point of transition from the consumer to the supplier, efficiency is purely a commercial issue.

7 Energy generation and storage

Reliable and economical energy supply

Mastering the transition to a new energy landscape – producing and providing energy in a climate-friendly, economical and reliable way

Energy is the lifeblood of the modern world. This applies both to the world of work as well as to our private lives. Apartments, industrial plants, office buildings, transport – everything depends on a reliable supply of energy.

The energy market is changing significantly with the increasing use of renewable energy, particularly for electricity production. Innovative technologies and new business models are driving this change.

Power generation

The electricity sector is leading the transformation in the global use of energy. Electricity is the fastest growing form of final energy. Yet the electricity sector is doing more than any other to reduce the proportion of fossil fuels in the global energy mix.

To keep pace with the growing demand for electricity, a total of about 7,200 gigawatts (GW) of generation capacity need to be built by 2040 (also because of the need to replace existing power plants which have come to the end of their useful life: about 40 % of current plants). The strong growth of renewable energy in many countries means that it will account for one third of global electricity generation by 2040.

Appropriate price signals are needed in order to ensure timely investment in new thermal generation capacities and renewable energy – and to maintain a reliable electricity supply. In some cases this will make market or pricing reforms necessary.

The shift towards more capital-intensive technologies and high prices for fossil fuels will result in an increase in average power costs and consumer prices in most countries of the world. However, efficiency gains in consumption will help to reduce the proportion of household income spent on electricity.

Renewable energy is an important element of the low-carbon pillar of the global energy supply and is quickly gaining ground – not least through USD 120 billion of subsidies worldwide in 2013.

Through rapid cost savings and ongoing support, renewable energy will account for almost half the increase in total electricity generation by 2040, with the use of biofuels more than tripling to 4.6 million barrels per day and the use of renewable energy for heat production more than doubling.

At 37 %, the share of electricity generation contributed by renewable energy will increase most in the OECD countries, and its growth will correspond to the total net increase in power supply within the OECD. However, the growth in the amount of electricity produced from renewable energy is twice as high in the non-OECD countries, particularly China, India, Latin America and Africa.

Worldwide, wind power accounts for the largest share of the growth in power generation from renewable energy (34 %), followed by hydropower (30 %) and solar energy (18 %).

The proportion of wind and photovoltaic energy has quadrupled in the global energy mix, meaning that their integration is presenting more and more challenges both from a technical and market perspective. In the European Union wind power accounts for 20 % of total production, while in Japan photovoltaic energy meets 37 % of peak demand in the summer.

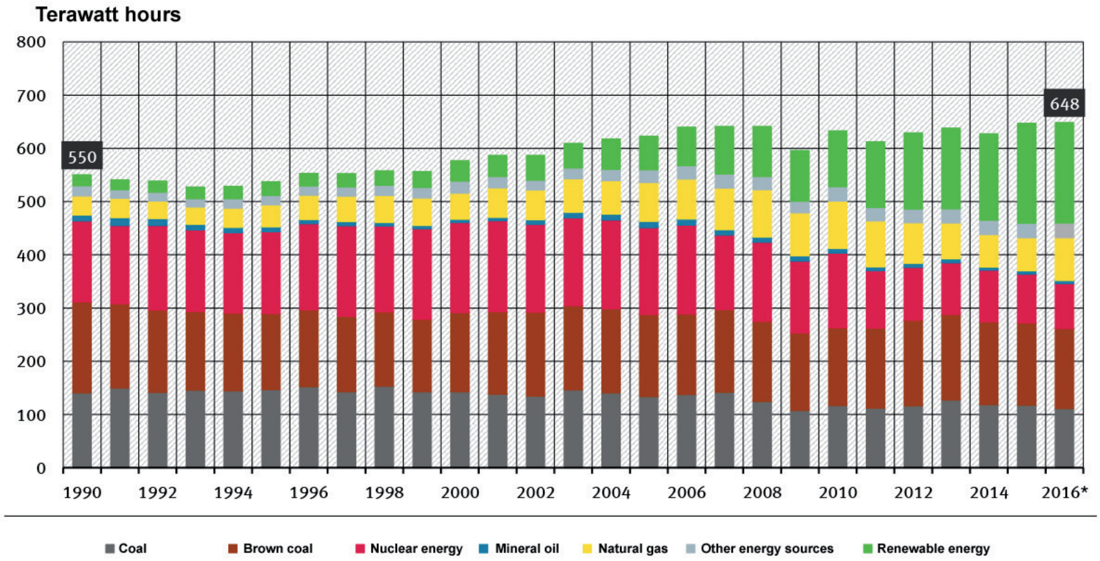


Figure 45 – Gross electricity generation in Germany, by energy source [17]

Storage

Energy storage is assuming ever increasing importance as a result of the energy transition. The DKE is reflecting this by developing the German Energy Storage Standardization Roadmap. In September 2014 the DIN organization joined forces with the DKE to hold a workshop on the topic of energy storage, dividing the field into the following areas:

- Thermal storage (commercial/industrial applications),
- Thermal storage (domestic applications),
- Electrochemical storage (e.g. battery storage, redox flow batteries),
- Chemical storage (e.g. power to gas, power to liquid),
- Mechanical storage (e.g. pumped storage power plants, gravitational potential energy storage),
- Storage.

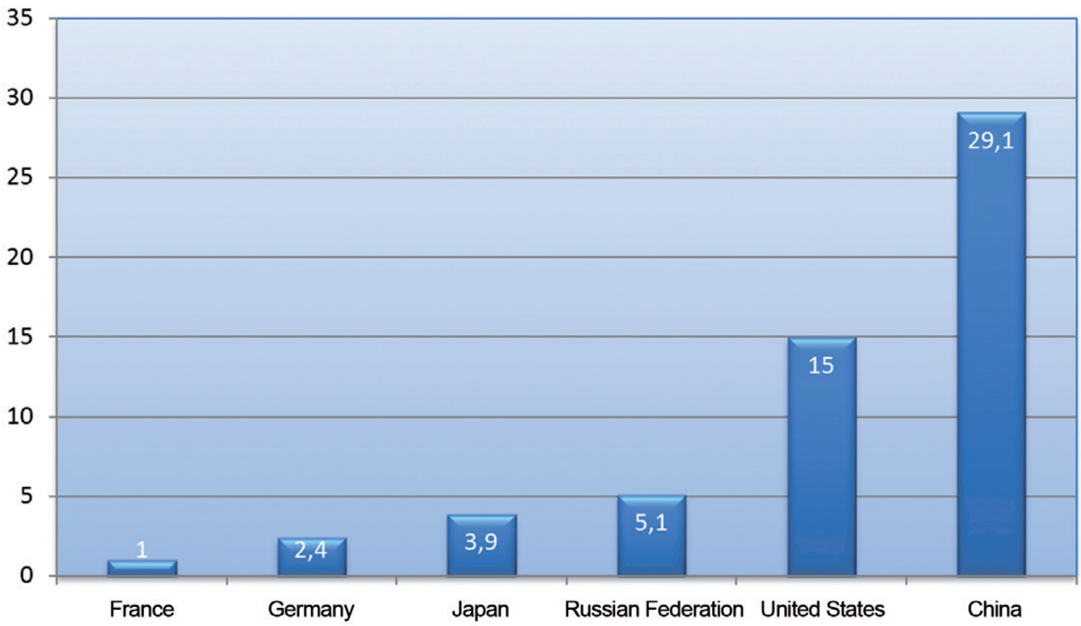


Figure 46 – Carbon dioxide emissions 2013/Global shares (%) [18]

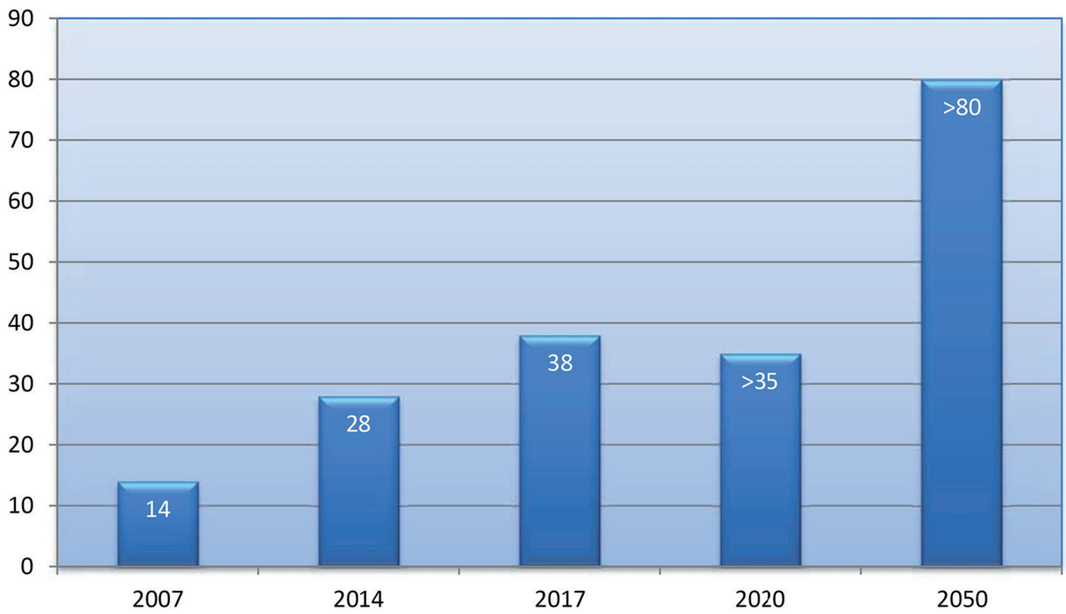


Figure 47 – Share of electricity produced from renewable energy sources in Germany (partly forecast) (%) [19]

7.1 Renewable energy

Renewable energy at a glance

The contribution of renewable energy to the energy supply in Germany is growing steadily. Its rising importance is largely due to the Renewable Energy Act (EEG) which came into force on 1 April 2000, and its amendment in 2014.

Following its introduction, the share of renewable energy sources in gross electricity consumption rose from 6 % in 2000 to 38 % in 2017.

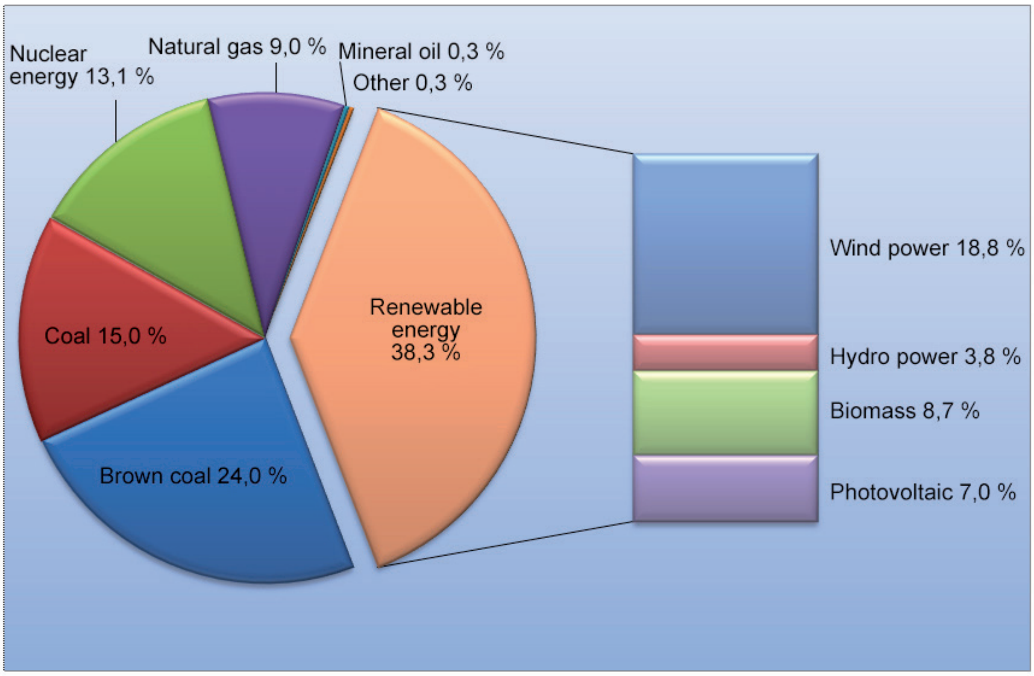


Figure 48 – Electricity generation in Germany in 2017, percentages [20]

Sun, wind etc.

Solar and wind energy are the major renewable sources in the energy transition. Both belong to the ca tegory of fluctuating energy sources, i.e. they are only available when the sun shines or the wind blows. Biomass, hydropower and geothermal energy also make a valuable contribution to the sustainable energy supply. Solar energy can be harnessed directly in a variety of ways. Solar cells in photovoltaic systems, solar concentrator plants and solar panels use solar radiation directly and convert the energy into electricity or heat.

Sun and wind are the main renewable energy sources in the energy transition.

Wind energy now accounts for more than 18 % of German electricity generation. Wind as an energy source plays an important role in the development of renewable energy and an economically viable and climate-friendly energy supply. In 2017 around 5,300 megawatts came online, meaning that the wind energy capacity of onshore and offshore wind farms around Germany amounted to 55,389 megawatts by the end of the year.

Biomass is used for electricity and heat generation (e.g. in cogeneration plants), and for the production of bio-fuels in solid, liquid and gaseous form. Approximately 9 % of the total electrical energy came from biomass in 2017.

7.2 Conventional energies

In the energy mix of the future, renewable energy will provide the lion's share and make Germany less dependent on energy imports. However, conventional energy sources will still play a major role.

Coal

The fossil fuel coal (lignite and coal) plays an important role in the current energy mix of the Federal Republic. Almost 25 % of primary energy consumption is based on coal and lignite. Coal's share of gross electricity generation is over 40 %.

Coal is mainly used in Germany in power plants and the steel industry. Coal mining in Germany (including the number of mines and employees) has been steadily declining for decades. About 90 % of the demand for coal and coal products is therefore now covered by imports.

Lignite, the most important indigenous fossil energy resource is plentiful and, in contrast to German coal, can be extracted without subsidies. The Federal Republic of Germany is the world's largest lignite mining country, ahead of China, Russia and the US. Lignite mining in Germany at present occupies approx. 176,490 hectares of land, around 69 % of which is now being recultivated.

Roughly 90 % of lignite is used for electricity production and district heating in public and industrial power plants and provides approximately 24 % of power generation in Germany.

579 g of CO_2 were emitted on average in 2013 to generate a kilowatt hour of electricity from the combustion of fossil fuels. Based on data from the BMWi, extrapolated figures for 2015 show 535 g/kWh and thus 226 g or roughly 29 % less than in 1990.

Natural gas

Accounting for 21 % of primary energy consumption (9 % of power generation), natural gas plays an important role in the energy supply in Germany.

Compared to other fossil fuels, natural gas causes lower CO_2 emissions and is therefore more climate-friendly.

Natural gas power plants can play an important role in compensating power from renewable energy sources, the production of which can fluctuate considerably depending on the weather and season.

If renewable electricity is converted into hydrogen or methane (power to gas) and fed into the natural gas grid in the future, this could provide considerable storage for several billion kilowatt hours (kWh) of energy.

Mineral oil

Accounting for roughly 34 % of primary energy consumption in 2015, oil remains the most important primary energy source in Germany. Mineral oil provides about 1 % of the generated power. Since the 1970s, when oil accounted for more than half of the primary energy consumption, its share has fallen primarily due to the increased use of natural gas for heating.

The Federal Government has set itself the goal of reducing primary energy consumption by 20 % from 2008 to 2020 and by 50 % by 2050. In order to achieve this, it will be necessary to use petroleum products and other energy sources much more efficiently.

Mineral oil accounts for over 90 % of final energy consumption in traffic and transport. Because the transport sector is also to contribute to reducing greenhouse gas emissions, the Federal Government aims to lower final energy consumption by 10 % by 2020, and by 40 % by 2050 compared with 2005 – in part by expanding electromobility.

Nuclear power

Following the accident at the Fukushima nuclear power plant in Japan, the role of nuclear power‘s bridging function (until renewable energy and the corresponding energy infrastructure are reliable and economically viable) has been reconsidered. The reactor accident made it necessary to re-evaluate the residual risks of nuclear power for society.

Against this background the Federal Government decided in the summer of 2011 to accelerate the energy transition and gradually phase out electricity generation from German nuclear power plants completely by the end of 2022. There are currently 8 nuclear power plants in Germany delivering about 11,000 MW of electrical power when in operation.

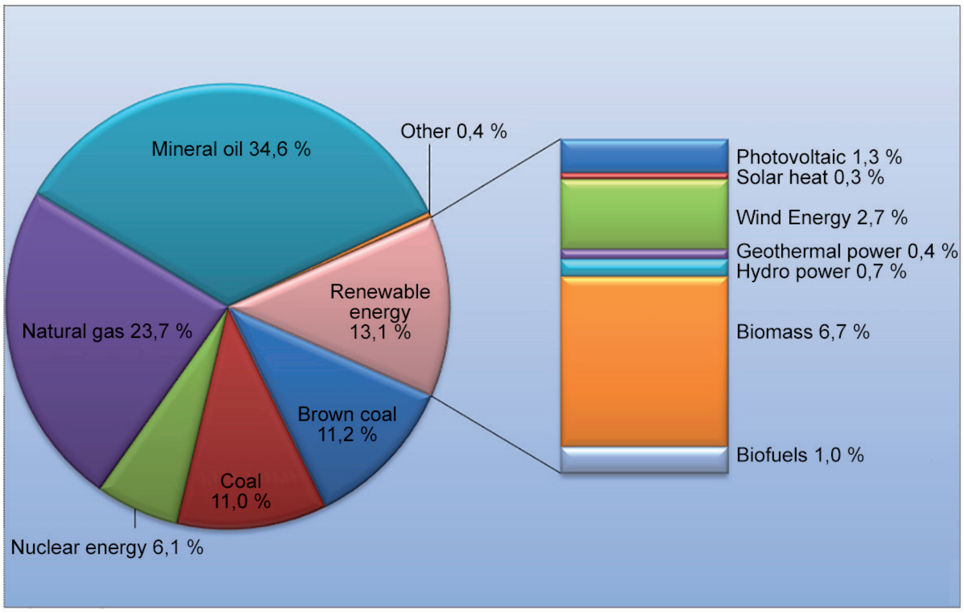


Figure 49 – Primary energy consumption in Germany in 2017, percentages [20]

7.3 Self-supply and energy storage systems

Self-supply

To produce electrical energy and heat yourself and thus become independent, plays an increasingly important role. New technical systems and cheaper systems support this trend.

Electrical energy can be drawn from and fed into the power grid. The availability of the power grid is a necessary prerequisite for this. The demand profile of a single consumer has a negligible effect on the overall electrical power supply system. Thermal energy is supplied regionally because of the high conduction losses.

Storage units are used for buffering the heat, refrigeration and electrical energy and form the basis of energy self-supply.

Renewable energy sources are preferable for charging thermal storage systems. Thermal solar panels in conjunction with building storage units are now standard. In future, however, electric heating rods will also be used for charging. This has the advantage that self-generated electricity which is not used by the owner is fed into the heat supply.

Cold storage units are normally charged by electrically powered chillers. If absorption chillers are used, cold is obtained from heat using electricity.

Electrical energy storage units are used to buffer the self-generated energy (e.g. PV system) which exceeds a prosumer‘s own consumption.

Cogeneration will achieve greater importance in the future. Electrical energy is generated alongside thermal energy. In centralized conventional power generation, 30–40 % of the primary energy is used for power generation, the predominant proportion is discharged as waste heat to the environment (cooling towers, river water). Combined heat and power plants (CHPs – also including mini and micro-power stations) are installed locally to ensure that the generated heat is usable. The energy conversion efficiency of CHP plants is over 90 %.

Where self-sufficiency is implemented, control of the storage management and the dimensioning of the storage (electrical, thermal) needs to be coordinated. The thermal and electrical load profiles of the consumer are the basis for this.

The H0 load profiles common in households today do not assume self-supply. The greater the focus on self-supply, the less effective is a forecast of demand for electric power based on the H0 profile. This applies similarly to all other standard load profiles.

Energy storage systems

Electrical energy efficiency measures for electrical and electrochemical energy storage systems can in principle be implemented independent of e.g. the size or voltage level of the energy storage systems. Such energy storage technologies include:

- Lead batteries,
- Li-ion batteries,
- Redox flow batteries,
- Capacitors,
- Superconducting magnetic energy storage units.

Associated controls, regulators (e. g. battery management system, charging control) and inverters are often included as components of the energy storage system. These can be stationary and connected to the electricity supply network, or mobile (e. g. in electric vehicles).

Stationary energy storage systems can be connected to the electricity supply network in different voltage levels (see figure 50. Low voltage photovoltaic systems coupled with batteries, for example, can serve to optimize the local load profile in buildings. Powerful energy storage systems, however, can also be used in up to high voltage levels to provide control power for the electricity grid when needed.

Energy storage systems can optimize load profiles and provide control power

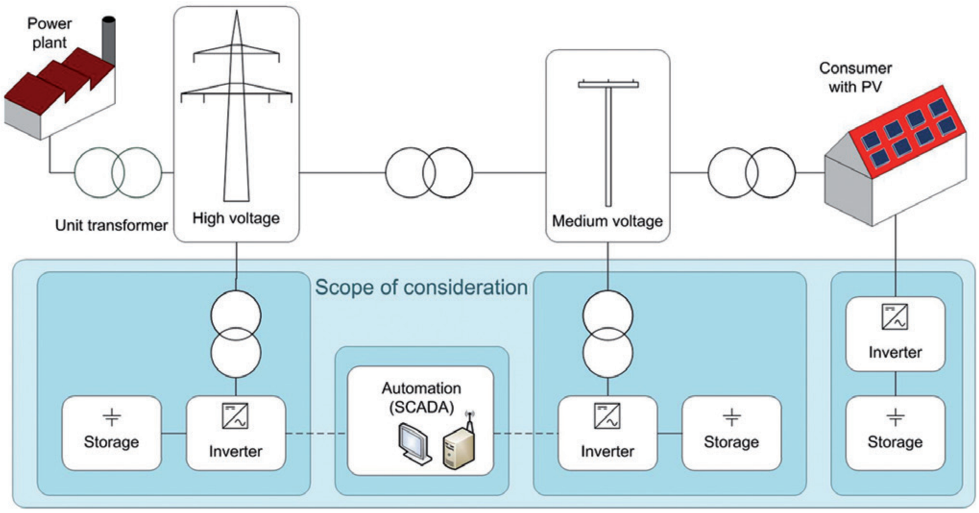


Figure 50 – Scope of consideration of stationary energy storage systems (simplified) [14]

Summary/Recommendations

Efficiency measures for electrical energy storage systems are currently covered mainly by DIN VDE 0100-801 (VDE 0100-801). This contains additional requirements, measures and recommendations for the planning, construction and inspection of all types of low voltage equipment, including the local generation and storage of energy, to optimize the overall efficient use of electricity.

Electrical energy management in a low-voltage system provides a systematic approach to the optimization of energy efficiency, including the availability and integration of local storage possibilities of electric power. If the energy comes from a local energy storage unit (e.g. battery), the user must assess the economic effects of the maximum available power, the amount of energy available and the variable price of energy.

The development of standards is desirable especially for (grid-linked) PV systems with inverters and battery storage to ensure a holistic view of systemic measures for electrical energy efficiency.

8 Energy procurement and provision

Minimizing energy consumption and optimizing costs are the key factors in achieving electrical energy efficiency. Time-based provision, i.e. providing power at the times when applications require it, will gain in importance in the future. Renewable sources of energy, such as solar and wind power, depend on the weather and are not continuously available. Even if the amount of energy does cover the demand, the requested power might still not be available, meaning that the supply cannot be guaranteed.

A good example of this is rapid-charge e-car stations. Here, the battery is charged at high power levels for a short period. Following the rapid charging process, the amount of power required drops more or less to zero until the next charge. This type of use, only drawing on the power when it is actually needed (and no longer), characterizes effective automation systems and equipment. High demand peaks are therefore a negative side-effect of energy efficiency.

Solar energy systems exhibit similar behaviour. The amount of power generated can change quickly in cloudy weather.

If production and consumption are not balanced at all times this can result in network problems. The smaller the scope of the network, the more serious the effects will be. Short-circuit power represents a characteristic value for the stability and quality of a network. Generators based on a rapidly rotating mass create this; solar and wind power systems are intrinsically not able to provide high levels of short-circuit power.

From a network stability point of view (load balance and short circuit power), it is not possible to increase the proportion of renewable energy producers infinitely.

The energy transition alters not only the energy sources, but also the methods of producing electricity – away from a small number of large power plants to many small producers: wind and solar parks, combined heat and power plants (CHPs), heat pumps, and bio-gas plants feed electricity into the public grid. A homeowner with a photovoltaic system thus becomes a "prosumer": he uses and produces energy.

From the perspective of the network operator

The network operator is responsible for the quality of the electrical energy (voltage, frequency, power factor, maximum harmonic content). From the network operator‘s point of view, the great challenge is to control the many micro-plants to create a uniform current flow – a prerequisite for a stable supply. Unlike a coal-fired plant for example, the output of a wind farm depends on the weather: in strong winds, it produces more energy than the distribution network can absorb. When the wind drops, however, electricity production stops. The energy demand varies, too: very high or very low levels of power can be consumed depending on the weather, lighting conditions and time of day.

To compensate for fluctuations in production and in consumption, software solutions have been developed which allow energy to be merged from various decentralized and predominantly renewable sources and storage and to be regulated centrally. The result is a virtual power plant which always provides power when it is needed.

From the perspective of the consumer

From the consumer‘s perspective, regulation of prosumer behaviour by the network operator is inacceptable. He wants to exploit the benefits of liberalization for himself. This is based on forecasts of his energetic behaviour (consumption and return feed) – and compliance with these.

For the consumer the electrical energy price will be geared in the future more and more to the latest prices on the electricity exchange. The prices reflect the relationship between supply (production) and demand (consumption). Currently, the smallest trading unit for energy is a period of one hour for the subsequent hour. In the future it will also be possible to trade ¼-hour energy units (0.1 MWh). However, trading can only function if appropriately reliable forecasts for production and consumption are available.

The more decentralized and compartmentalized the energy production market is, the more communication is required between the participants for the production forecast. The system is further complicated by the support given to prosumers to use their own electrical energy (e.g. PV plant plus battery). Standard load profiles, such as those commonly used today in forecasts for consumers of < 100,000 kWh/a, are no longer applicable here. Energy forecasting (purchase and delivery) is also essential for these prosumers.
Smart meters assume the measurement and communication functions at the interface between the electrical energy market and the consumers.

Once the energy forecasts have been communicated, the energy supplier responds by setting the prices accordingly. The consumer can now adjust his own consumption forecast by modifying his consumption behaviour to the current price structure.

The better this interplay between forecast and consumption works, the lower the reserve power required for control power. This in turn reduces the proportion of the reserve power costs in the energy price.

In many cases there is no basis for a forecast.

Consumers: The consumption behaviour of many applications in industry, in the infrastructure and in buildings is opaque. The dependencies between use and energy demand have to be identified (e.g. shutdowns, incident light, parts of production processes).
Energy self-generation: The energy forecasts depend on environmental variables such as wind speed, temperature, solar radiation.
Storage: Storage systems are defined by their storage capacity and C-rate, in operation by their charge/discharge status.

The electrical demand profile is created from the interaction of consumption, self-generation and storage.

If the connections between the energy flows are transparent and known, automating the control of the electrical power supply allows the forecasts to be optimized – leading to cost-effective energy procurement. One of the main conditions for a successful energy transition therefore lies in bringing together all the different factors in a suitable automation system.

Summary/Recommendations

Energy procurement by consumers and its provision by energy suppliers are determined to a large extent by the costs involved. These are based on accurate consumption demand forecasts.

Consumers and energy suppliers communicate automatically via standardized communication channels; a great deal of attention needs to be paid to data protection here. Block chaining lends itself for dynamic contract drafting as well as the related transactions.

9 ANNEXES

Annex 1 Norms, standards and committees

The following lists contain currently valid norms, standards and committees with a direct reference to the electrical efficiency.

Annex 1.1 Norms, standards and committees "energy efficiency"

Norms and standards "energy efficiency"

DIN EN ISO/IEC 13273-1	**NA 172-00-09 AA**	**ISO/IEC JPC 2**
Energieeffizienz und erneuerbare Energiequellen – Gemeinsame internationale Terminologie – Teil 1: Energieeffizienz (ISO/IEC 13273-1:2015); Deutsche Fassung EN ISO/IEC 13273-1:2016 Energy efficiency and renewable energy sources – Common international terminology – Part 1: Energy efficiency (ISO/IEC 13273-1:2015); German version EN ISO/IEC 13273-1:2016		
DIN EN ISO 16103	**NA 115-01-06 AA**	**ISO TC 122**
Verpackung – Verpackungen zur Beförderung gefährlicher Güter – Recycling-Kunststoffe (ISO 16103:2005); Deutsche Fassung EN ISO 16103:2005 Packaging – Transport packaging for dangerous goods – Recycled plastics material (ISO 16103:2005); German version EN ISO 16103:2005		
DIN EN ISO 50001	**NA 172-00-09 AA**	**ISO TC 242**
Energiemanagementsysteme – Anforderungen mit Anleitung zur Anwendung (ISO 50001:2011); Deutsche Fassung EN ISO 50001:2011 Energy management systems – Requirements with guidance for use (ISO 50001:2011); German version EN ISO 50001:2011		
DIN SPEC 4701-10/A1	**NA 041-05-01 AA**	
Energetische Bewertung heiz- und raumlufttechnischer Anlagen – Teil 10: Heizung, Trinkwassererwärmung, Lüftung; Änderung A1 Energy efficiency of heating and ventilation systems in buildings – Part 10: Heating, domestic hot water supply, ventilation; Amendment A1		
DIN V 18599-1	**NA 005-56-20 GA**	
Energetische Bewertung von Gebäuden – Berechnung des Nutz-, End- und Primärenergiebedarfs für Heizung, Kühlung, Lüftung, Trinkwarmwasser und Beleuchtung – Teil 1: Allgemeine Bilanzierungsverfahren, Begriffe, Zonierung und Bewertung der Energieträger Energy efficiency of buildings – Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting – Part 1: General balancing procedures, terms and definitions, zoning and evaluation of energy sources		

Committees "energy efficiency"

COMMITTEE	TITLE
DKE/TBINK.EEE	Energieeffizienz
DKE/TBINK.EEE_AK_NR	Normungs-Roadmap Elektrische Energieeffizienz
NA 005-56-20 GA	Energetische Bewertung von Gebäuden
NA 041-05-01 AA	Energetische Bewertung gebäudetechnischer Anlagen (SpA ISO/TC 205 "Umweltgerechte Gebäudeplanung")
NA 115-01-06 AA	Gefahrgutverpackungen
NA 172-00-09 AA	Energieeffizienz und Energiemanagement

Annex 1.2 Norms, standards and committees "local consumption"

Norms and standards "household”

DIN EN 50193-1 (VDE 0705-193-1)	**DKE/UK 513.3**
Elektro-Durchfluss-Wassererwärmer – Teil 1: Allgemeine Anforderungen; Deutsche Fassung EN 50193-1:2013 Electric instantaneous water heaters – Part 1: General requirements; German version EN 50193-1:2013	
DIN EN 50229	**DKE/UK 513.1**
Elektrische Wasch-Trockner für den Hausgebrauch – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften; Deutsche Fassung EN 50229:2007 Electric clothes washer-dryers for household use – Methods of measuring the performance; German version EN 50229:2007	
DIN EN 50242/DIN EN 60436 (VDE 0705-436)	**DKE/UK 513.5 IEC/SC 59A**
Elektrische Geschirrspüler für den Hausgebrauch – Messverfahren für Gebrauchseigenschaften (IEC 60436:2004, modifiziert + A1:2009, modifiziert + A2:2012, modifiziert); Deutsche Fassung EN 50242/EN 60436:2008 + EN 50242:2008/A11:2012 Electric dishwashers for household use – Methods for measuring the performance (IEC 60436:2004, modified + A1:2009, modified + A2:2012, modified); German version EN 50242/EN 60436:2008 + EN 50242:2008/A11:20122	
DIN EN 50350	**DKE/UK 513.4**
Aufladesteuerungen für elektrische Speicherheizungen für den Hausgebrauch – Verfahren zur Messung der Gebrauchseigenschaften; Deutsche Fassung EN 50350:2004 Charging control systems for household electric room heating of the storage type – Methods for measuring performance; German version EN 50350:2004	

DIN EN 50523-1	DKE/K 513
Geräte für den Hausgebrauch – Interworking – Teil 1: Funktionsspezifikation; Deutsche Fassung EN 50523-1:2009 Household appliances interworking – Part 1: Functional specification; German version EN 50523-1:2009	
DIN EN 50523-2	**DKE/K 513**
Geräte für den Hausgebrauch – Interworking – Teil 2: Datenstrukturen; Deutsche Fassung EN 50523-2:2009 Household appliances interworking – Part 2: Data structures; German version EN 50523-2:2009	
DIN EN 50559 (VDE 0705-559)	**DKE/UK 513.4**
Elektrische Raumheizung, Fußbodenheizung, Charakteristika der Gebrauchstauglichkeit – Definitionen, Prüfverfahren, Dimensionierung und Formelzeichen; Deutsche Fassung EN 50559:2013 Electric room heating, underfloor heating, characteristics of performance – Definitions, method of testing, sizing and formula symbols; German version EN 50559:2013	
DIN EN 50563 (VDE 0806-563)	
Externe AC/DC- und AC/AC-Netzteile – Bestimmung von Nulllast und durchschnittlicher Effizienz im Betrieb; Deutsche Fassung EN 50563:2011 + A1:2013 External a.c. – d.c. and a.c. – a.c. power supplies – Determination of no-load power and average efficiency of active modes; German version EN 50563:2011 + A1:2013	
DIN EN 50564 (VDE 0705-2301))	**DKE/K 513**
Elektrische und elektronische Haushalts- und Bürogeräte – Messung niedriger Leistungsaufnahmen (IEC 62301:2011, modifiziert); Deutsche Fassung EN 50564:2011 Electrical and electronic household and office equipment – Measurement of low power consumption (IEC 62301:2011, modified); German version EN 50564:2011	
DIN EN 60311	**DKE/UK 513.10**
Elektrische Bügeleisen für Haushalt und ähnliche Zwecke – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60311:2002 + A1:2005 + A2:2009); Deutsche Fassung EN 60311:2003 + A1:2006 + A2:2009 Electric irons for household or similar use – Methods for measuring performance (IEC 60311:2002 + A1:2005 + A2:2009); German version EN 60311:2003 + A1:2006 + A2:2009	
DIN EN 60312-1 (VDE 0705-312-1)	**DKE/UK 513.7 IEC/TC 59**
Staubsauger für den Hausgebrauch – Teil 1: Trockensauger – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften (IEC 60312-1:2010, modifiziert + A1:2011, modifiziert); Deutsche Fassung EN 60312-1:2013 Vacuum cleaners for household use – Part 1: Dry vacuum cleaners – Methods for measuring the performance (IEC 60312-1:2010, modified + A1:2011, modified); German version EN 60312-1:2013	

DIN EN 60350-1 (VDE 0705-350-1)	DKE/UK 513.2 CLC/TC 59X
Elektrische Kochgeräte für den Hausgebrauch – Teil 1: Herde, Backöfen, Dampfgarer und Grills – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60350-1:2011, modifiziert + corrigendum Feb. 2012); Deutsche Fassung EN 60350-1:2013 + A11:2014, mit CD-ROM Household electric cooking appliances – Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring performance (IEC 60350-1:2011, modified + corrigendum Feb. 2012); German version EN 60350-1:2013 + A11:2014, with CD-ROM	
DIN EN 60350-2 (VDE 0705-350-2)	**DKE/UK 513.2 CLC/TC 59X**
Elektrische Kochgeräte für den Hausgebrauch – Teil 2: Kochfelder – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60350-2:2011, modifiziert); Deutsche Fassung EN 60350-2:2013 + A11:2014, mit CD-ROM Household electric cooking appliances – Part 2: Hobs – Methods for measuring performance (IEC 60350-2:2011, modified); German version EN 60350-2:2013 + A11:2014, with CD-ROM	
DIN EN 60379	**DKE/UK 513.3**
Verfahren zum Messen der Gebrauchseigenschaften von elektrischen Warmwasserspeichern für den Hausgebrauch (IEC 60379:1987, modifiziert); Deutsche Fassung EN 60379:2004 Methods for measuring the performance of electric storage water-heaters for household purposes (IEC 60379:1987, modified); German version EN 60379:2004	
DIN EN 60442	**DKE/UK 513.10**
Elektrische Haushalt-Brotröster – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60442:1998 + A1:2003); Deutsche Fassung EN 60442:1998 + A1:2003 Electric toasters for household and similar purposes – Methods for measuring the performance; (IEC 60442:1998 + A1:2003); German version EN 60442:1998 + A1:2003	
DIN EN 60456 (VDE 0705-456)	**DKE/UK 513.1**
Waschmaschinen für den Hausgebrauch – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60456:2010, modifiziert); Deutsche Fassung EN 60456:2011 + AC:2011 Clothes washing machines for household use – Methods for measuring the performance (IEC 60456:2010, modified); German version EN 60456:2011 + AC:2011	
DIN EN 60531	**DKE/UK 513.4**
Elektrische Raumheizgeräte für den Hausgebrauch – Verfahren zur Messung der Gebrauchseigenschaften (IEC 60531:1999, modifiziert); Deutsche Fassung EN 60531:2000	
DIN EN 60661 (VDE 0705-661)	**DKE/UK 513.10 IEC/SC 59L**
Verfahren zur Messung der Gebrauchseigenschaften elektrischer Haushalt-Kaffeebereiter (IEC 60661:1999, modifiziert + A1:2003, modifiziert + A2:2005, modifiziert); Deutsche Fassung EN 60661:2014 Methods for measuring the performance of electric household coffee makers (IEC 60661:1999, modified + A1:2003, modified + A2:2005, modified); German version EN 60661:2014	

DIN EN 60705 (VDE 0705-705)	DKE/UK 513.2 IEC/SC 59K
Mikrowellengeräte für den Hausgebrauch und ähnliche Zwecke – Verfahren zur Messung der Gebrauchstauglichkeit (IEC 60705:2010 + A1:2014); Deutsche Fassung EN 60705:2015, mit CD-ROM Household microwave ovens – Methods for measuring performance (IEC 60705:2010 + A1:2014); German version EN 60705:2015, with CD-ROM	
DIN EN 61121 (VDE 0705-1121)	**DKE/UK 513.1**
Wäschetrockner für den Hausgebrauch – Verfahren zur Messung der Gebrauchseigenschaften (IEC 61121:2012, modifiziert); Deutsche Fassung EN 61121:2013 Tumble dryers for household use – Methods for measuring the performance (IEC 61121:2012, modified); German version EN 61121:2013	
DIN EN 61591 (VDE 0705-1591)	**DKE/UK 513.2**
Haushalt-Dunstabzugshauben und andere Absauger für Kochdünste – Verfahren zur Messung der Gebrauchseigenschaft (IEC 61591:1997 + A1:2005 + A2:2010); Deutsche Fassung EN 61591:1997 + A1:2006 + A2:2011 + A11:2014 Household range hoods and other cooking fume extractors – Methods for measuring performance (IEC 61591:1997 + A1:2005 + A2:2010); German version EN 61591:1997 + A1:2006 + A2:2011 + A11:2014	
DIN EN 62552 (VDE 0705-2552)	**DKE/GUK 513.6**
Haushalt-Kühl-/Gefriergeräte – Eigenschaften und Prüfverfahren (IEC 62552:2007, modifiziert + corrigendum Mar. 2008); Deutsche Fassung EN 62552:2013 Household refrigerating appliances – Characteristics and test methods (IEC 62552:2007, modified + corrigendum Mar. 2008); German version EN 62552:2013)	
DIN EN 62623 (VDE 0806-2623)	**DKE/K 742**
Desktop- und Notebook-Computer – Messung des Energieverbrauchs (IEC 62623:2012); Deutsche Fassung EN 62623:2013 Desktop and notebook computers – Measurement of energy consumption (IEC 62623:2012); German version EN 62623:2013	
DIN EN 62885-3 (VDE 0705-2885-3)	**DKE/UK 513.7**
Geräte zur Oberflächenreinigung – Teil 3: Nassreinigungsgeräte für Teppiche – Verfahren zur Messung der Gebrauchseigenschaften (IEC 62885-3:2014); Deutsche Fassung EN 62885-3:2015 Surface cleaning appliances – Part 3: Wet carpet cleaning appliances – Methods for measuring the performance (IEC 62885-3:2014); German version EN 62885-3:2015	
DIN EN 62929 (VDE 0705-2929)	**DKE/UK 513.7**
Reinigungsroboter für den Hausgebrauch – Trockenreinigung: Verfahren zur Messung der Gebrauchseigenschaften (IEC 62929:2014); Deutsche Fassung EN 62929:2014 Cleaning robots for household use – Dry cleaning: Methods for measuring performance (IEC 62929:2014); German version EN 62929:2014	

DIN EN 50193-2-1 (VDE 0705-193-2-1)	DKE/UK 513.3	CLC/TC 59X
Elektro-Durchfluss-Wassererwärmer – Teil 2-1: Verfahren zur Messung der Gebrauchseigenschaften – Multifunktionelle Elektro-Durchfluss-Wassererwärmer; Deutsche Fassung 50193-2-1:2014 Electric instantaneous water heaters – Part 2-1: Methods for measuring the performance – Multifunctional electric instantaneous water heaters; German version 50193-2-1:2014		
DIN EN 50193-2-2 (VDE 0705-193-2-2)	**DKE/UK 513.3**	**CLC/TC 59X**
Elektro-Durchfluss-Wassererwärmer – Teil 2-2: Anforderungen an die Gebrauchseigenschaften – Durchfluss-Wassererwärmer für eine einzelne Zapfstelle – Effizienz; Deutsche Fassung 50193-2-2:2013 Electric instantaneous water heaters – Part 2-2: Performance requirements – Single point of use electric instantaneous showers – Efficiency; German version 50193-2-2:2013		
DIN EN 50229 (VDE 0705-229)	**DKE/UK 513.1**	**CLC/TC 59X**
Elektrische Wasch-Trockner für den Hausgebrauch – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften; Deutsche Fassung EN 50229:2015 + AC:2016 Electric clothes washer-dryers for household use – Methods of measuring the performance; German version EN 50229:2015 + AC:2016		
DIN EN 50440 (VDE 0705-379)		**DKE/UK 513.3**
Effizienz von elektrischen Warmwasserspeichern für den Hausgebrauch; Deutsche Fassung EN 50440:2015 Efficiency of domestic electrical storage water heaters and testing methods; German version EN 50440:2015		
E DIN EN 60311/A3 (VDE 0705-311/A3)	**DKE/UK 513.10**	**IEC/SC 59L**
Elektrische Bügeleisen für Haushalt und ähnliche Zwecke – Verfahren zur Messung der Gebrauchseigenschaften (IEC 59L/116/CDV:2015); Deutsche Fassung EN 60311:2003/FprA3:2015 Electric irons for household or similar use – Methods for measuring performance (IEC 59L/116/CDV:2015); German version EN 60311:2003/FprA3:2015		
E DIN EN 60312-1-1 (VDE 0705-312-1-1)	**DKE/UK 513.7**	**IEC/SC 59F**
Staubsauger für den Hausgebrauch – Teil 1-1: Schnurlose Trockensauger – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften (IEC 59F/234A/CD:2013) Vacuum cleaners for household use – Part 1-1: Cordless dry vacuum cleaners – Methods for measuring the performance (IEC 59F/234A/CD:2013)		

E DIN EN 60350-1/A100 (VDE 0705-350-1/A100)	DKE/UK 513.2	CLC/TC 59X
Elektrische Kochgeräte für den Hausgebrauch – Teil 1: Herde, Backöfen, Dampfgarer und Grills – Verfahren zur Messung der Gebrauchseigenschaften; Deutsche Fassung FprEN 60350-1:2015/FprAA:2015 Household electric cooking appliances – Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring performance; German version FprEN 60350-1:2015/FprAA:2015		
E DIN EN 60350-1/AA (VDE 0705-350-1/AA)	**DKE/UK 513.2**	**CLC/TC 59X**
Elektrische Kochgeräte für den Hausgebrauch – Teil 1: Herde, Backöfen, Dampfgarer und Grills – Verfahren zur Messung der Gebrauchseigenschaften; Deutsche Fassung EN 60350-1:2013/FprAA:2014, mit CD-ROM Household electric cooking appliances – Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring performance; German version EN 60350-1:2013/FprAA:2014, with CD-ROM		
E DIN EN 60436 (VDE 0705-436)	**DKE/UK 513.5**	**IEC/SC 59A**
Elektrische Geschirrspüler für den Hausgebrauch – Messverfahren für Gebrauchseigenschaften Electric dishwashers for household use – Methods for measuring the performance		
E DIN EN 60436/A100 (VDE 0705-436/A100)	**DKE/UK 513.5**	**IEC/SC 59A**
Elektrische Geschirrspüler für den Hausgebrauch – Messverfahren für Gebrauchseigenschaften Electric dishwashers for household use – Methods for measuring the performance		
E DIN EN 61591/AA (VDE 0705-1591/AA)	**DKE/UK 513.2**	**CLC/TC 59X**
Haushalt-Dunstabzugshauben und andere Absauger für Kochdünste – Verfahren zur Messung der Gebrauchseigenschaft; Deutsche Fassung EN 61591:1997/FprAA:2014 Household range hoods and other cooking fume extractors – Methods for measuring performance; German version EN 61591:1997/FprAA:2014		
E DIN EN 62512 (VDE 0705-2512)	**DKE/UK 513.1**	**IEC/SC 59D**
Elektrische Wasch-Trockner für den Hausgebrauch – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften (IEC 59D/390/CDV:2011); Deutsche Fassung FprEN 62512:2011 Electric clothes washer-dryers for household use – Methods of measuring the performance (IEC 59D/390/CDV:2011); German version FprEN 62512:2011		
E DIN EN 62552-1 (VDE 0705-2552-1)	**DKE/GUK 513.6**	**IEC/SC 59M WG 1**
Haushaltskühlgeräte – Eigenschaften und Prüfverfahren – Teil 1: Allgemeine Anforderungen (IEC 59M/33/CD:2012) Household refrigerating appliances – Characteristics and test methods – Part 1: General Requirements (IEC 59M/33/CD:2012)		

E DIN EN 62552-2 (VDE 0705-2552-2)	DKE/GUK 513.6 IEC/SC 59M
Haushaltskühlgeräte – Eigenschaften und Prüfverfahren – Teil 2: Leistungsanforderungen (IEC 59M/34/CD:2012) Household refrigerating appliances – Characteristics and test methods – Part 2: Performance Requirements (IEC 59M/34/CD:2012)	
E DIN EN 62552-3 (VDE 0705-2552-3)	**DKE/GUK 513.6 IEC/SC 59M**
Haushaltskühlgeräte – Eigenschaften und Prüfverfahren – Teil 3: Energieverbrauch und Rauminhalt (IEC 59M/35/CD:2012) Household refrigerating appliances – Characteristics and test methods – Part 3: Energy Consumption and Volume (IEC 59M/35/CD:2012)	
E DIN EN 62849 (VDE 0705-2849)	**DKE/K 513 IEC/TC 59**
Verfahren zur Bewertung der Leistungsfähigkeit von Haushaltrobotern (IEC 59/623/CD:2014) Performance evaluation method of household robot (IEC 59/623/CD:2014)	
E DIN EN 62885-2 (VDE 0705-2885-2)	**DKE/UK 513.7 IEC/SC 59F**
Oberflächenreinigungsgeräte – Teil 2: Trockensauger für den Hausgebrauch und ähnliche Anwendungen – Prüfverfahren zur Bestimmung der Gebrauchseigenschaften (IEC 59F/276/CDV:2015); Deutsche Fassung FprEN 62885-2:2015 Surface cleaning appliances – Part 2: Dry vacuum cleaners for household and similar use – Methods for measuring the performance (IEC 59F/276/CDV:2015); German version FprEN 62885-2:2015	
E DIN EN 62999 (VDE 0705-2999)	**DKE/UK 513.4 IEC/SC 59C**
Elektrische Raumheizung, Fußbodenheizung, Charakteristika der Gebrauchstauglichkeit – Definitionen, Prüfverfahren, Dimensionierung und Formelzeichen (IEC 59C/193/CDV:2015) Electric room heating, underfloor heating, characteristics of performance – Definitions, method of testing, sizing and formula symbols (IEC 59C/193/CDV:2015)	
DIN EN 61508-1 (VDE 0803-1)	**DKE/GK 914**
Funktionale Sicherheit sicherheitsbezogener elektrischer/elektronischer/programmierbarer elektronischer Systeme – Teil 1: Allgemeine Anforderungen (IEC 61508-1:2010); Deutsche Fassung EN 61508-1:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements (IEC 61508-1:2010); German version EN 61508-1:2010	
DIN EN 62442-1 (VDE 0712-28)	**DKE/UK 513.4**
Energieeffizienz von Lampenbetriebsgeräten – Teil 1: Betriebsgeräte für Leuchtstofflampen – Messverfahren zur Bestimmung der Gesamteingangsleistung von Betriebsgeräteschaltungen und des Wirkungsgrades von Betriebsgeräten (IEC 62442-1:2011); Deutsche Fassung EN 62442-1:2011 + AC:2012 Energy performance of lamp controlgear – Part 1: Controlgear for fluorescent lamps – Method of measurement to determine the total input power of controlgear circuits and the efficiency of the controlgear (IEC 62442-1:2011); German version EN 62442-1:2011 + AC:2012	

Committees

COMMITTEE	TITLE
DKE/K 513	Hausgeräte, Gebrauchseigenschaften
DKE/UK 513.1	Wäschepflegegeräte
DKE/UK 513.2	Herde, Mikrowellengeräte und Dunstabzugshauben
DKE/UK 513.3	Wassererwärmer
DKE/UK 513.4	Heiz- und Wärmegeräte
DKE/UK 513.5	Geschirrspülmaschinen
DKE/GUK 513.6	Kühl- und Gefriergeräte
DKE/UK 513.7	Bodenbehandlungsgeräte
DKE/UK 513.10	Kleingeräte
DKE/K 742	Audio-, Video- und Multimediasysteme, -geräte und –komponenten
DKE/GK 914	Funktionale Sicherheit elektrischer, elektronischer und programmierbarer elektronischer Systeme (E, E, PES) zum Schutz von Personen und Umwelt

Norms and standards "smart metering"

DIN EN 50491-11 (VDE 0849-11)	DKE/K 716 CLC/TC 205
Allgemeine Anforderungen an die Elektrische Systemtechnik für Heim und Gebäude (ESHG) und an Systeme der Gebäudeautomation (GA) – Teil 11: Smart Metering – Applikationsbeschreibung – Einfache externe Verbrauchsanzeige; Deutsche Fassung EN 50491-11:2015 General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) – Part 11: Smart Metering – Application Specifications – Simple External Consumer Display; German version EN 50491-11:2015	

Norms and standards "commerce, trade, services”

ISO/IEC 30134 series
Information technology – Data Centres – Key performance Indicators
ISO/IEC 15067-3
Informationstechnik – Anwendungsmodell für Heim-Elektronik-Systeme (HES) – Teil 3: Modell eines Energielastmanagementsystems für HES Information technology – Home Electronic System (HES) application model – Part 3: Model of a demand-response energy management system for HES

CLC/TR 50600-99-1

Information technology – Data centre facilities and infrastructures – Part 99-1: Recommended practices for energy management

DIN EN 62018 (VDE 0806-2018) DKE/UK 712.1 IEC/TC 108

Energieverbrauch von Einrichtungen der Informationstechnik – Messverfahren (IEC 62018:2003); Deutsche Fassung EN 62018:2003

Power consumption of information technology equipment – Measurement methods (IEC 62018:2003); German version EN 62018:2003

Norms and standards "industry"

DIN EN 50598-1 (VDE 0160-201) DKE/K 226 CLC/TC 22X

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 1: Allgemeine Anforderungen zur Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) mit semianalytischen Modellen (SAM); Deutsche Fassung EN 50598-1:2014

Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM); German version EN 50598-1:2014

DIN EN 50598-2 (VDE 0160-202) DKE/K 226 CLC/TC 22X

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern; Deutsche Fassung EN 50598-2:2014

Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters; German version EN 50598-2:2014

DIN EN 50598-3 (VDE 0160-203) DKE/K 226 CLC/TC 22X

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 3: Quantitativer Ökodesign-Ansatz mittels Ökobilanz einschließlich Produktkategorieregeln und des Inhaltes von Umweltdeklarationen; Deutsche Fassung EN 50598-3:2015

Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations; German version EN 50598-3:2015

DIN EN 50600-1 (VDE 0801-600-1) DKE/GUK 715.5 CLC/TC 215

Informationstechnik – Einrichtungen und Infrastrukturen von Rechenzentren – Teil 1: Allgemeine Konzepte; Deutsche Fassung EN 50600-1:2012

Information technology – Data centre facilities and infrastructures – Part 1: General concepts; German version EN 50600-1:2012

DIN EN 60204-1 (VDE 0113-1)	DKE/K 225	IEC/TC 44
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 1: Allgemeine Anforderungen (IEC 60204-1:2005, modifiziert); Deutsche Fassung EN 60204-1:2006 Safety of machinery – Electrical equipment of machines – Part 1: General requirements (IEC 60204-1:2005, modified); German version EN 60204-1:2006		
DIN EN 60204-11 (VDE 0113-11)	**DKE/K 225**	**IEC/TC 44**
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 11: Anforderungen an Hochspannungsausrüstung für Spannungen über 1000 V Wechselspannung oder 1500 V Gleichspannung, aber nicht über 36 kV (IEC 60204-11:2000); Deutsche Fassung EN 60204-11:2000		
DIN EN 60204-31 (VDE 0113-31)	**DKE/K 225**	**IEC/TC 44**
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 31: Besondere Sicherheits- und EMV-Anforderungen an Nähmaschinen, Näheinheiten und Nähanlagen (IEC 60204-31:2013); Deutsche Fassung EN 60204-31:2013 Safety of machinery – Electrical equipment of machines – Part 31: Particular safety and EMC requirements for sewing machines, units and systems (IEC 60204-31:2013); German version EN 60204-31:2013		
DIN EN 60204-32 (VDE 0113-32)	**DKE/K 225**	**IEC/TC 44**
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 32: Anforderungen für Hebezeuge (IEC 60204-32:2008); Deutsche Fassung EN 60204-32:2008 Safety of machinery – Electrical equipment of machines – Part 32: Requirements for hoisting machines (IEC 60204-32:2008); German version EN 60204-32:2008		
DIN EN 60204-33 (VDE 0113-33)	**DKE/K 225**	**IEC/TC 44**
Sicherheit von Maschinen – Elektrische Ausrüstungen von Maschinen – Teil 33: Anforderungen an Fertigungseinrichtungen für Halbleiter (IEC 60204-33:2009, modifiziert); Deutsche Fassung EN 60204-33:2011 Safety of machinery – Electrical equipment of machines – Part 33: Requirements for semiconductor fabrication equipment (IEC 60204-33:2009, modified); German version EN 60204-33:2011		
DIN EN 62061 (VDE 0113-50)	**DKE/K 225**	**IEC/TC 44**
Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme (IEC 62061:2005 + A1:2012); Deutsche Fassung EN 62061:2005 + A1:2013 Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005 + A1:2012); German version EN 62061:2005 + A1:2013		
DIN EN 62623 (VDE 0806-2623)	**DKE/K 742**	**IEC/TC 108**
Desktop- und Notebook-Computer – Messung des Energieverbrauchs (IEC 62623:2012); Deutsche Fassung EN 62623:2013 Desktop and notebook computers – Measurement of energy consumption (IEC 62623:2012); German version EN 62623:2013		

DIN EN ISO 12100	DKE/K 225
Sicherheit von Maschinen – Allgemeine Gestaltungsleitsätze – Risikobeurteilung und Risikominderung (ISO 12100:2010); Deutsche Fassung EN ISO 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction (ISO 12100:2010); German version EN ISO 12100:2010	
DIN EN ISO 14119	**DKE/K 225**
Sicherheit von Maschinen – Verriegelungseinrichtungen in Verbindung mit trennenden Schutzeinrichtungen – Leitsätze für Gestaltung und Auswahl (ISO 14119:2013); Deutsche Fassung EN ISO 14119:2013 Safety of machinery – Interlocking devices associated with guards – Principles for design and selection (ISO 14119:2013); German version EN ISO 14119:2013	
E DIN EN 60204-1 (VDE 0113-1)	**DKE/K 225 IEC/TC 44**
Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 1: Allgemeine Anforderungen (IEC 44/709/CDV:2014); Deutsche Fassung FprEN 60204-1:2014 Safety of machinery – Electrical equipment of machines – Part 1: General requirements (IEC 44/709/CDV:2014); German version FprEN 60204-1:2014	
E DIN EN 61800-9-1 (VDE 0160-109-1)	**DKE/K 226 IEC/SC 22G**
Drehzahlveränderbare elektrische Antriebe – Teil 9-1: Energieeffizienz für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Allgemeine Anforderungen für die Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) und semi-analytischen Modellen (SAM) (IEC 22G/300/CDV:2015); Deutsche Fassung FprEN 61800-9-1:2015 Adjustable speed electrical power drive systems – Part 9-1: Energy efficiency of power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the Extended Product Approach (EPA) and semi analytic model (SAM) (IEC 22G/300/CDV:2015); German version FprEN 61800-9-1:2015	
E DIN EN 61800-9-2 (VDE 0160-109-2)	**DKE/K 226 IEC/SC 22G**
Drehzahlveränderbare elektrische Antriebe – Teil 9-2: Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern (IEC 22G/301/CDV:2015); Deutsche Fassung FprEN 61800-9-2:2015 Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Energy efficiency indicators for power drive systems and motor starters (IEC 22G/301/CDV:2015); German version FprEN 61800-9-2:2015	

E DIN EN 62745 (VDE 0113-1-1)	DKE/K 225 IEC/TC 44
Sicherheit von Maschinen – Anforderungen für die Verbindung von kabellosen Steuerungen an Maschinen (IEC 44/686A/CD:2013) Safety of machinery – Requirements for the interfacing of cableless controllers to machinery (IEC 44/686A/CD:2013)	
IEC TR 62837	
Energy efficiency through automation systems	

Norms and standards "traffic and transport"

IEC 62888
Railway applications – Energy measurement on board trains

Norms and standards "machine tools"

DIN EN ISO 4413	NA 060-36-90 AA ISO/TC 131
Fluidtechnik – Allgemeine Regeln und sicherheitstechnische Anforderungen an Hydraulikanlagen und deren Bauteile (ISO 4413:2010); Deutsche Fassung EN ISO 4413:2010 Hydraulic fluid power – General rules and safety requirements for systems and their components (ISO 4413:2010); German version EN ISO 4413:2010	
DIN EN ISO 4414	**NA 060-36-21-05 ISO/TC 131**
Fluidtechnik – Allgemeine Regeln und sicherheitstechnische Anforderungen an Pneumatikanlagen und deren Bauteile (ISO 4414:2010); Deutsche Fassung EN ISO 4414:2010 Pneumatic fluid power – General rules and safety requirements for systems and their components (ISO 4414:2010); German version EN ISO 4414:2010	
DIN EN ISO 14414	**NA 060-01-01 AA ISO/TC 115**
Energetische Bewertung von Pumpensystemen (ISO/ASME 14414:2015); Deutsche Fassung EN ISO 14414:2015 Pump system energy assessment (ISO/ASME 14414:2015); German version EN ISO 14414:2015	
DIN EN 16231	**NA 172-00-09 AA CEN/CENELEC/JWG 3**
Energieeffizienz-Benchmarking-Methodik; Deutsche Fassung EN 16231:2012 Energy efficiency benchmarking methodology; German version EN 16231:2012	
DIN EN 16297-1	**NA 060-11-01 AA CEN/TC 197**
Pumpen – Kreiselpumpen – Umwälzpumpen in Nassläuferbauart – Teil 1: Allgemeine Anforderungen und Verfahren zur Prüfung und Berechnung des Energieeffizienzindexes (EEI); Deutsche Fassung EN 16297-1:2012 Pumps – Rotodynamic pumps – Glandless circulators – Part 1: General requirements and procedures for testing and calculation of energy efficiency index (EEI); German version EN 16297-1:2012	

DIN EN ISO 50001	NA 172-00-09 AA ISO/TC 242
Energiemanagementsysteme – Anforderungen mit Anleitung zur Anwendung (ISO 50001:2011); Deutsche Fassung EN ISO 50001:2011 Energy management systems – Requirements with guidance for use (ISO 50001:2011); German version EN ISO 50001:2011	
ISO 13579	**ISO/TC 244**
Industrieöfen und zugehörige Prozesseinrichtungen – Methoden zur Messung der Energiebilanz und Berechnung der Effizienz Industrial furnaces and associated processing equipment – Method of measuring energy balance and calculating efficiency	
ISO 14955	**ISO/TC 39**
Machine tools. Environmental evaluation of machine tools. Design methodology for energy-efficient machine tools	
ISO 20140	**ISO/TC 184**
Automatisierungssysteme und Integration – Bewertung der Energieeffizienz und anderer Faktoren von Fertigungssystemen, die die Umwelt beeinflussen Automation systems and integration – Evaluating energy efficiency and other factors of manufacturing systems that influence the environment	

Guidelines "machine tools

VDMA 24262
Energieeffiziente Pumpensysteme – Leitfaden zur Erkennung und Bewertung vorhandener Schwachstellen und korrekter Erfassung des Energieeinsparpotentials Energy-efficient pump systems – Guide for the detection and evaluation of weak points and the correct capture of the energy savings potential
VDMA 24474
Kunststoff- und Gummimaschinen – Energieeffizienz von Extrudern Plastics and rubber machinery – Energy efficiency of extruders
VDMA 24580
Fluidtechnik – Anwendungshinweise zur Optimierung der Energieeffizienz von Hydraulikanlagen Fluid power – Application notes for the optimization of the energy efficiency of hydraulic systems
VDMA 24581
Fluidtechnik – Anwendungshinweise zur Optimierung der Energieeffizienz von Pneumatikanlagen Pneumatic fluid power – Application notes for the optimization of the energy efficiency of pneumatic systems

VDMA 34179
Messvorschrift zur Bestimmung des Energie- und Medienbedarfs von Werkzeugmaschinen in der Serienfertigung Measurement instruction to determine the energy- and resource demand of machine tools for mass production

Committees "machine tools"

COMMITTEE	TITLE
DKE/K 225	Elektrotechnische Ausrüstung und Sicherheit von Maschinen und maschinellen Anlagen
DKE/K 226	Ausrüstung von Starkstromgeräten und -anlagen mit elektronischen Betriebsmitteln
DKE/GUK 715.5	Rechenzentren
DKE/K 742	Audio-, Video- und Multimediasysteme, -geräte und -komponenten

Norms and standards with relevance for the determination of the machine losses, the machine efficiency and the specification of limit values for the efficiencies IE1 to IE4

DIN EN 60034-2-1 (VDE 0530-2-1)	DKE K311	IEC/TC 2
Drehende elektrische Maschinen – Teil 2-1: Standardverfahren zur Bestimmung der Verluste und des Wirkungsgrades (ausgenommen Maschinen für Schienen- und Straßenfahrzeuge) Deutsche Fassung EN 60034-2-1:2014 Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)		

DIN EN 60034-2-2 (VDE 0530-2-2)	DKE K311	IEC/TC 2
Drehende elektrische Maschinen – Teil 2-2: Besondere Verfahren zur Bestimmung der Einzelverluste großer Elektrischer Maschinen aus Prüfungen – Ergänzung zu IEC 60034-2-1: Deutsche Fassung EN 60034-2-2:2010 Rotating electrical machines – Part 2-2: Specific methods for determining separate losses of large machines from tests – Supplement to IEC 60034-2-1		

E DIN IEC 60034-2-3 (VDE 0530-2-3)	IEC/TC 2
Drehende Elektrische Maschinen – Teil 2-3: Besondere Verfahren zur Bestimmung der Verluste und des Wirkungsgrades von umrichtergespeisten Wechselstrommaschinen (IEC 2/1570/CD:2009) Rotating electrical machines – Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors (IEC 2/1570/CD:2009)	

DIN EN 60034-25 (VDE 0530-25)	DKE K311	IEC/TC 2
Drehende elektrische Maschinen – Teil 25: Wechselstrommaschinen zur Verwendung in Antriebssystemen – Anwendungsleitfaden (IEC 2/1689/CD:2012) Rotating electrical machines – Part 25: AC machines when used in power drive systems – Application guide (IEC 2/1689/CD:2012)		
DIN EN 60034-30-1 (VDE 0530-30-1)	**DKE K311**	**IEC/TC 2**
Drehende elektrische Maschinen – Teil 30-1: Wirkungsgrad-Klassifizierung von netzgespeisten Drehstrommotoren (IE-Code) (IEC 60034-30-1:2014); Deutsche Fassung EN 60034-30-1:2014 Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code) (IEC 60034-30-1:2014); German version EN 60034-30-1:2014		
DIN IEC/TS 60034-30-2 (VDE V 0530-30-2)	**DKE K311**	**IEC/TC 2**
Drehende elektrische Maschinen – Teil 30-2: Wirkungsgrad-Klassifizierung von Wechselstrommotoren mit variabler Drehzahl (IE-Code) (IEC 2/1741/CD:2014) Rotating electrical machines – Part 30-2: Efficiency classes of variable speed AC motors (IE-code) (IEC 2/1741/CD:2014)		
DIN CLC/TS 60034-31 (VDE V 0530-31)	**DKE K311**	**IEC/TC 2**
Drehende elektrische Maschinen – Teil 31: Auswahl von Energiesparmotoren einschließlich Drehzahlstellantrieben – Anwendungsleitfaden (IEC/TS 60034-31:2010); Deutsche Fassung CLC/TS 60034-31:2011 Rotating electrical machines – Part 31: Selection of energy-efficient motors including variable speed applications – Application guide (IEC/TS 60034-31:2010); German version CLC/TS 60034-31:2011		

Norms and standrads with relevance for the determination of losses and the efficiency of electrical machines for railway and road vehicles.

DIN EN 60349-1 (VDE 0115-400-1)	DKE UK 351.1	IEC/TC 9
Elektrische Zugförderung – Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge – Teil 1: Elektrische Maschinen ausgenommen umrichtergespeiste Wechselstrommotoren (IEC 60349-1:2010); Deutsche Fassung EN 60349-1:2010 Electric traction – Rotating electrical machines for rail and road vehicles – Part 1: Machines other than electronic converter-fed alternating current motors (IEC 60349-1:2010); German version EN 60349-1:2010		
DIN EN 60349-2 (VDE 0115-400-2)	**DKE UK 351.1**	**IEC/TC 9**
Elektrische Zugförderung – Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge – Teil 2: Umrichtergespeiste Wechselstrommotoren (IEC 60349-2:2010); Deutsche Fassung EN 60349-2:2010 Electric traction – Rotating electrical machines for rail and road vehicles – Part 2: Electronic converterfed alternating current motors (IEC 60349-2:2010); German version EN 60349-2:2010		

DIN IEC/TS 60349-3 (VDE V 0115-400-3)	DKE UK 351.1	IEC/TC 9
Elektrische Zugförderung – Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge – Teil 3: Bestimmung der Gesamtverluste von umrichtergespeisten Wechselstrommotoren mit dem Einzelverlustverfahren (IEC/TS 60349-3:2010) Electric traction – Rotating electrical machines for rail and road vehicles – Part 3: Determination of the total losses of converter-fed alternating current motors by summation of the component losses (IEC/TS 60349-3:2010)		
DIN EN 60349-4 (VDE 0115-400-4)	**DKE UK 351.1**	**IEC/TC 9**
Elektrische Zugförderung – Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge – Teil 4: Umrichtergespeiste Synchronmaschinen mit Permanentmagneterregung (IEC 60349-4:2012); Deutsche Fassung EN 60349-4:2013 Electric traction – Rotating electrical machines for rail and road vehicles – Part 4: Permanent magnet synchronous electrical machines connected to an electronic converter (IEC 60349-4:2012); German version EN 60349-4:2013		

Norms and standards "ecodesign for propulsion systems".

DIN EN 50598-1 (VDE 0160-201)	DKE K 226	CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 1: Allgemeine Anforderungen zur Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) mit semi-analytischen Modellen (SAM); Deutsche Fassung EN 50598-1:2014 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM); German version EN 50598-1:2014		
DIN EN 50598-2 (VDE 0160-202)	**DKE K 226**	**CLC/TC 22X**
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern; Deutsche Fassung EN 50598-2:2014 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters; German version EN 50598-2:2014		

DIN EN 50598-3 (VDE 0160-203)	DKE K 226	CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 3: Quantitativer Ökodesign-Ansatz mittels Ökobilanz einschließlich Produktkategorieregeln und des Inhaltes von Umweltdeklarationen; Deutsche Fassung EN 50598-3:2015 Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations; German version EN 50598-3:2015		

Norms and standards "energy performance of buildings"

DIN EN 15316-4-2 (2008-09-00)		CEN/TC 228
Heizungsanlagen in Gebäuden – Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen – Teil 4-2: Wärmeerzeugung für die Raumheizung, Wärmepumpensysteme; Deutsche Fassung DIN EN 15316-4-2:2008-09 Heating systems in buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-2: Space heating generation systems, heat pump systems; Deutsche Fassung DIN EN 15316-4-2:2008-09		
CEN/TR 15316-6-5	**NA 041-05-01 AA**	**CEN/TC 288/WG4**
Heizungsanlagen und Wasserbasierte Kühlanlagen in Gebäuden – Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen – Teil 6-9: Begleitende TR zur EN 15316-4-2 (Wärmeerzeugung für die Raumheizung, Wärmepumpensysteme;) Heating systems and water based cooling systems in buildings – Method for calculation of system energy requirements and system efficiencies – Part 6-5: Accompanying TR to EN 15316-4-2 (Space heating generation systems, heat pump systems)		
CEN/TR 153616-6-5		
Heizungsanlagen und Wasserbasierte Kühlanlagen in Gebäuden – Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen – Teil 6-6: Begleitende TR zur EN 15316-4-3 (Wärmeerzeugungssysteme, thermische Solar- und Photovoltaikanlagen) Heating systems and water based cooling systems in buildings – Method for calculation of system energy requirements and system efficiencies – Part 6-6: Accompanying TR to EN 15316-4-3 (Heat generation systems, thermal solar and photovoltaic systems)		
DIN EN 15316-4-3		
Heizungsanlagen und wasserbasierte Kühlanlagen in Gebäuden – Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen – Teil 4-3: Wärmeerzeugungssysteme, thermische Solaranlagen und Photovoltaikanlagen; Deutsche Fassung prEN 15316-4-3:2014 Heating systems and water based cooling systems in buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-3: Heat generation systems, thermal solar and photovoltaic systems; German version prEN 15316-4-3:2014		

DIN EN 16798-9	
Energieeffizienz von Gebäuden – Teil 9: Lüftung von Gebäuden – Modul M4-1 – Berechnungsmethoden für energetische Anforderungen von Kühlsystemen – Allgemeine Anforderungen; Deutsche Fassung prEN 16798-9:2014 Energy performanceof buildings – Part 9: Ventilation for buildings – Module M4-1 – Calculation methods for energyrequirements Calculation methods for energy requirements of cooling systems – general; German version prEN 16798-9:2014	
CEN/TR 16798-10	**NA 041-05-02 AA**
Energieeffizienz von Gebäuden – Teil 10: Lüftung von Gebäuden – Modul 4-1 – Berechnungsmethoden für energetische Anforderungen von Kühlsystemen – Allgemeine Festlegungen – Technischer Report zur Interpretation der Festlegungen in EN XXXXX-9 Energy performance of buildings – Part 10 : Ventilation for buildings – Module M4-1 – Calculation methods for energy requirements of cooling systems – general – Technical report – interpretation of the requirements in EN 16798 – 9	
DIN EN 16798-11	
Energieeffizienz von Gebäuden – Teil 11: Modul M4-3 – Berechnung der Norm-Kühllast; Deutsche und Englische Fassung prEN 16798-11:2015 Energyperformance of buildings – Part 11 : Module M4-3 – Calculation of the design cooling load; German and English version prEN 16798-11:2015	
CEN/TR 16798-12	
Energieeffizienz von Gebäuden – Teil 11: Modul M4-3 – Berechnung der Norm-Kühllast; Technischer Report zur Interpretation der Festlegungen in DIN EN 16798-11 Energy performance of buildings – Part 14: Module M4- 3 – Calculation of the design cooling load – Technical report – interpretation of the requirements in EN 16798 – 11	
DIN EN 16798-3	
Energieeffizienz von Gebäuden – Teil 3: Lüftung von Nichtwohngebäuden – Anforderungen an die Leistung von Lüftungs- und Klimaanlagen und Raumkühlsystemen; (Überarbeitung EN 13779); Deutsche Fassung prEN 16798-3:2014 Energy performance of buildings – Part 3: Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems; (revision of EN 13779); German version prEN 16798-3:2014	
CEN/TR 16798-4	
Energieeffizienz von Gebäuden – Teil 3: Lüftung von Nichtwohngebäuden – Anforderungen an die Leistung von Lüftungs- und Klimaanlagen und Raumkühlsystemen: Technischer Report zur Interpretation der Festlegungen in DIN EN 16798-3 Energy performance of buildings – Part 4: Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems – Technical report – interpretation of the requirements in EN 16798 – 3	

DIN EN 16798-7
Energieeffizienz von Gebäuden – Teil 7: Modul M5-1, M 5-5, M 5-6, M 5-8 – Berechnungsmethoden zur Bestimmung der Luftvolumenströme in Gebäuden inklusive Infiltration; Deutsche Fassung prEN 16798-7:2014 Energy performance of buildings – Part 7: Ventilation for buildings – Modules M5-1, M5-5, M5-6, M5-8 – Calculation methods for the determination of air flow rates inbuildings including infiltration; German version prEN 16798-7:2014
DIN EN 16798-8
Energieeffizienz von Gebäuden – Teil 7: Modul M5-1, M 5-5, M 5-6, M 5-8 – Berechnungsmethoden zur Bestimmung der Luftvolumenströme in Gebäuden inklusive Infiltration; Technischer Report zur Interpretation der Festlegungen in DIN EN 16798-7 Energy performance of buildings – Part 7: Ventilation for buildings – Modules M5-1, M5-5, M5-6, M5-8 – Calculation methods for the determination of air flow rates inbuildings including infiltration-Technical report – interpretation of the requirements in EN 16798 -7
DIN EN 15193-1
Energetische Bewertung von Gebäuden – Modul M9 – Energetische Anforderungen an die Beleuchtung – Teil 1: Spezifikationen; Deutsche Fassung prEN 15193-1:2014 Energy performance of buildings – Modul M9 – Energy requirements for lighting – Part 1: Specifications; German version prEN 15193-1:2014
CEN/TR 15193-2
Energetische Bewertung von Gebäuden – Modul M9 – Energetische Anforderungen an die Beleuchtung – Teil 1: Spezifikationen; Technischer Report zur Interpretation der Festlegungen in DIN EN 15193-1 Energy performance of buildings — Module M9-1 :Energy requirement for lighting Technical report – interpretation of the requirements in EN 15193-1
ISO 10916
Berechnung der Auswirkung von Tageslichtnutzung auf den Netto- und Endenergiebedarf für Licht Calculation of the impact of daylight utilization on the net and final energy demand for lighting
DIN EN 15232
Energieeffizienz von Gebäuden – Einfluss von Gebäudeautomation und Gebäudemanagement; Deutsche Fassung EN 15232:2012 Energy performance of buildings – Impact of Building Automation, Controls and Building Management; German version EN 15232:2012
DIN EN 12098-3
Mess-, Steuer- und Regeleinrichtungen für Heizungen – Teil 3: Regeleinrichtungen für Elektroheizungen; Deutsche Fassung EN 12098-3:2013 Controls for heating systems – Part 3: Control equipment for electrical heating systems; German version EN 12098-3:2013

DIN EN 15193
Energetische Bewertung von Gebäuden – Energetische Anforderungen an die Beleuchtung; Deutsche Fassung EN 15193:2007 Energy performance of buildings – Energy requirements for lighting; German version EN 15193:2007

Committees

COMMITTEE	TITLE
DKE/K544	Elektrische Einrichtungen für energieeffiziente Gebäudetechnik

Norms and standards "heat pumps"

DIN EN 14511-2
Luftkonditionierer, Flüssigkeitskühlsätze und Wärmepumpen mit elektrisch angetriebenen Verdichtern für die Raumbeheizung und –kühlung Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling – Part 2: Test conditions

Norms and standards "electromobility"

DIN EN 50598-1 (VDE 0160-201)	DKE/K 226	CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 1: Allgemeine Anforderungen zur Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) mit semi-analytischen Modellen (SAM); Deutsche Fassung EN 50598-1:2014 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM); German version EN 50598-1:2014		
DIN EN 50598-2 (VDE 0160-202)	**DKE/K 226**	**CLC/TC 22X**
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern; Deutsche Fassung EN 50598-2:2014 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters; German version EN 50598-2:2014		

DIN EN 50598-3 (VDE 0160-203)	DKE/K 226 CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 3: Quantitativer Ökodesign-Ansatz mittels Ökobilanz einschließlich Produktkategorieregeln und des Inhaltes von Umweltdeklarationen; Deutsche Fassung EN 50598-3:2015 Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations; German version EN 50598-3:2015	
E DIN EN 61800-9-1 (VDE 0160-109-1)	**DKE/K 226**
Drehzahlveränderbare elektrische Antriebe – Teil 9-1: Energieeffizienz für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Allgemeine Anforderungen für die Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) und semi-analytischen Modellen (SAM) (IEC 22G/300/CDV:2015); Deutsche Fassung FprEN 61800-9-1:2015 Adjustable speed electrical power drive systems – Part 9-1: Energy efficiency of power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the Extended Product Approach (EPA) and semi analytic model (SAM) (IEC 22G/300/CDV:2015); German version FprEN 61800-9-1:2015	
E DIN EN 61800-9-2 (VDE 0160-109-2)	**DKE/K 226 IEC/SC 22G**
Drehzahlveränderbare elektrische Antriebe – Teil 9-2: Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern (IEC 22G/301/CDV:2015); Deutsche Fassung FprEN 61800-9-2:2015 Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Energy efficiency indicators for power drive systems and motor starters (IEC 22G/301/CDV:2015); German version FprEN 61800-9-2:2015	
DIN EN 62660-1 (VDE 0510-33)	**DKE/K 371 IEC/TC 21**
Lithium-Ionen-Sekundärzellen für den Antrieb von Elektrostraßenfahrzeugen – Teil 1: Prüfung des Leistungsverhaltens (IEC 62660-1:2010); Deutsche Fassung EN 62660-1:2011	
DIN EN 62660-2 (VDE 0510-34)	**DKE/K 371 IEC/TC 21**
Lithium-Ionen-Sekundärzellen für den Antrieb von Elektrostraßenfahrzeugen – Teil 2: Zuverlässigkeits- und Missbrauchsprüfung (IEC 62660-2:2010); Deutsche Fassung EN 62660-2:2011	

Committees

COMMITTEE	TITLE
DKE/K 371	Akkumulatoren
DKE/K 226	Ausrüstung von Starkstromgeräten und -anlagen mit elektronischen Betriebsmitteln
DKE/K EMOBILITY	Lenkungskreis eMobility von DKE und NAAutomobil
DKE/AK EMOBILITY.30	Normungs-Roadmap E-Mobility
DKE/GAK EMOBILITY.50	Fokusgruppe Batterien
DKE/AK EMOBILITY.60	Ladeinfrastruktur Elektromobilität

Annex 1.3 Norms, standards and committees "transmission and distribution"

Norms and standards "energy systems in elecricity supply networks"

DIN EN 15900	NA 172-00-09 AA	CEN/CENELEC/JWG 3
Energieeffizienz-Dienstleistungen – Definitionen und Anforderungen; Deutsche Fassung EN 15900:2010 Energy efficiency services – Definitions and requirements; German version EN 15900:2010		
DIN EN 16212	**NA 172-00-09 AA**	**CEN/CENELEC/JWG 4**
Energieeffizienz- und -einsparberechnung – Top-Down- und Bottom-Up-Methoden; Deutsche Fassung EN 16212:2012 Energy efficiency and savings calculation – Top-down and Bottom-up methods; German version EN 16212:2012		
DIN EN 16231	**NA 172-00-09 AA**	**CEN/CENELEC/JWG 3**
Energieeffizienz-Benchmarking-Methodik; Deutsche Fassung EN 16231:2012 Energy efficiency benchmarking methodology; German version EN 16231:2012		
DIN EN 16247 (Normenreihe)	**NA 172-00-09 AA**	**CEN/CENELEC/JWG 1**
Energieaudits; Deutsche Fassung EN 16247 (Normenreihe) Energy audits; German version EN 16247 (series of standards)		
DIN EN 50629	**DKE/UK 321.2**	**CLC/TC 14**
Energiekennwerte von Großleistungstransformatoren (Um > 36 kV oder Sr >= 40 MVA); Deutsche Fassung EN 50629:2015 Energy performance of large power transformers (Um > 36 kV or Sr >= 40 MVA); German version EN 50629:2015		

E DIN EN 60076-20 (VDE 0532-76-20)	DKE/K 321	IEC/TC 14
Leistungstransformatoren – Teil 20: Energieeffizienz (IEC 14/778/CD:2013) Power transformers – Part 20: Energy efficiency (IEC 14/778/CD:2013)		
DIN EN 60947-1 (VDE 0660-100)	**DKE/K 431**	**IEC/SC 121A**
Niederspannungsschaltgeräte – Teil 1: Allgemeine Festlegungen (IEC 60947-1:2007 + A1:2010 + A2:2014); Deutsche Fassung EN 60947-1:2007 + A1:2011 + A2:2014 Low-voltage switchgear and controlgear – Part 1: General rules (IEC 60947-1:2007 + A1:2010 + A2:2014); German version EN 60947-1:2007 + A1:2011 + A2:2014		
DIN EN 61558-2-26 (VDE 0570-2-26)	**DKE/K 323**	**IEC/TC 96**
Sicherheit von Transformatoren, Drosseln, Netzgeräten und deren Kombinationen – Teil 2-26: Besondere Anforderungen und Prüfungen für Transformatoren und Netzgeräte zur Energieeinsparung sowie für andere Zwecke (IEC 61558-2-26:2013); Deutsche Fassung EN 61558-2-26:2013 Safety of transformers, reactors, power supply units and combinations thereof – Part 2-26: Particular requirements and tests for transformers and power supply units for saving energy and other purposes (IEC 61558-2-26:2013); German version EN 61558-2-26:2013		
DIN EN 62786 (VDE 0175-786)	**DKE/K 261**	**IEC/TC 8**
Smart Grid Benutzerschnittstelle – Anbindung von nachfrageseitigen Energiequellen an das Stromnetz (IEC 8/1366/CD:2014) Smart Grid User Interface – Demand Side Energy Resources Interconnection with the Grid (IEC 8/1366/CD:2014)		
E DIN EN 62974-1 (VDE 0415-974-1)	**DKE/UK 964.2**	**IEC/TC 85**
Erfassungs- und Messsysteme zur Datenerfassung, -Übertragung und –Analyse – Teil 1: Anforderungen an die Geräte (IEC 85/511/CD:2015) Monitoring and measuring systems used for data collection, gathering and analysis – Part 1: Device Requirements (IEC 85/511/CD:2015)		
VDE-AR-E 2055-1 (VDE-AR-E 2055-1)		**DKE/UK 542.4**
Berechnung der Steigerung der elektrischen Energieeffizienz durch den Einsatz von elektrischen Energiereglern nach dem Prinzip der Spannungsabsenkung Calculation of the increase in electrical energy efficiency achieved by means of electrical energy regulators taking advantage of the principle of voltage depression		

Guidelines "energy transmission and distribution”

VDI 4602 Blatt 2	VDI-GEU
Energiemanagement – Beispiele Energy management – Examples	

Committees

COMMITTEE	TITLE
NA 172-00-02-01 AK	Materialflusskostenrechnung
NA 172-00-09 AA	Energieeffizienz und Energiemanagement
DKE/FB.STD	Standardisierung
DKE/UK 221.5	Zukunftsfähige Elektroinstallationen
DKE/K 261	Systemaspekte der elektrischen Energieversorgung
DKE/K 321	Transformatoren
DKE/UK 321.2	Transformatoren, Leistungen und Abmessungen
DKE/K 323	Transformatoren, Drosseln, Netzgeräte und entsprechende Kombinationen
DKE/K 431	Niederspannungsschaltgeräte und -kombinationen
DKE/ K 461	Elektrizitätszähler
DKE/UK 964.2	Einrichtungen zum Messen/Überwachen der Netzqualität in elektrischen Energieverteilungsnetzen
FNN Projektgruppe	Anforderungen an künftige Zählerplätze
	GEFMA e. V. Deutscher Verband für Facility Management
VDI-Richtlinienausschuss 4602	Energiemanagement

Norms and standards "electrical transmission"

DIN EN 50598-1 (VDE 0160-201) — **DKE/K 226** — **CLC/TC 22X**

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 1: Allgemeine Anforderungen zur Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) mit semi-analytischen Modellen (SAM); Deutsche Fassung EN 50598-1:2014

Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM); German version EN 50598-1:2014

DIN EN 50598-2 (VDE 0160-202) — **DKE/K 226** — **CLC/TC 22X**

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern; Deutsche Fassung EN 50598-2:2014

Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters; German version EN 50598-2:2014

DIN EN 50598-3 (VDE 0160-203)	DKE/K 226 CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 3: Quantitativer Ökodesign-Ansatz mittels Ökobilanz einschließlich Produktkategorieregeln und des Inhaltes von Umweltdeklarationen; Deutsche Fassung EN 50598-3:2015 Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations; German version EN 50598-3:2015	
E DIN EN 61800-9-1 (VDE 0160-109-1)	**DKE/K 226**
Drehzahlveränderbare elektrische Antriebe – Teil 9-1: Energieeffizienz für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Allgemeine Anforderungen für die Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) und semi-analytischen Modellen (SAM) (IEC 22G/300/CDV:2015); Deutsche Fassung FprEN 61800-9-1:2015 Adjustable speed electrical power drive systems – Part 9-1: Energy efficiency of power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the Extended Product Approach (EPA) and semi analytic model (SAM) (IEC 22G/300/CDV:2015); German version FprEN 61800-9-1:2015	
E DIN EN 61800-9-2 (VDE 0160-109-2)	**DKE/K 226 IEC/SC 22G**
Drehzahlveränderbare elektrische Antriebe – Teil 9-2: Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern (IEC 22G/301/CDV:2015); Deutsche Fassung FprEN 61800-9-2:2015 Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Energy efficiency indicators for power drive systems and motor starters (IEC 22G/301/CDV:2015); German version FprEN 61800-9-2:2015	
EN 50160	
Merkmale der Spannung in öffentlichen Elektrizitätsversorgungsnetzen; Deutsche Fassung EN 50160:2010 + Cor. :2010 Voltage characteristics of electricity supplied by public distribution networks; German version EN 50160:2010 + Cor. :2010	
IEC 60364-8-1 (VDE 0100-801)	**DKE/UK 221.5 IEC/TC 64**
Errichten von Niederspannungsanlagen – Teil 8-1: Energieeffizienz (IEC 60364-8-1:2014, modifiziert); Deutsche Übernahme HD 60364-8-1:2015 Low-voltage electrical installations – Part 8-1: Energy efficiency (IEC 60364-8-1:2014, modified); German implementation HD 60364-8-1:2015	

DIN EN 60034-30-1 (VDE 0530-30-1)	DKE/K 311 IEC/TC 2
Drehende elektrische Maschinen – Teil 30-1: Wirkungsgrad-Klassifizierung von netzgespeisten Drehstrommotoren (IE-Code) (IEC 60034-30-1:2014); Deutsche Fassung EN 60034-30-1:2014 Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code) (IEC 60034-30-1:2014); German version EN 60034-30-1:2014	
DIN ISO 50006	
Energiemanagementsysteme – Messung der energiebezogenen Leistung unter Nutzung von energetischen Ausgangsbasen (EnB) und Energieleistungskennzahlen (EnPI) – Allgemeine Grundsätze und Leitlinien (ISO 50006:2014); Energy management systems – Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) – General principles and guidance (ISO 50006:2014)	

Guidelines "electrical transmission”

VDI 3807	VDI-GBG
Verbrauchskennwerte für Gebäude Characteristic consumption values for buildings	
VDI 2166 Blatt 1	**VDI-GBG**
Planung elektrischer Anlagen in Gebäuden – Grundlagen des Energiecontrollings Planning of electrical installations in buildings – Fundamentals of energy controlling	

Norms und standards "transparency"

DIN EN ISO 50001
Energiemanagementsysteme – Anforderungen mit Anleitung zur Anwendung (ISO 50001:2011); Deutsche Fassung EN ISO 50001:2011 Energy management systems – Requirements with guidance for use (ISO 50001:2011); German version EN ISO 50001:2011
ISO 50002
Energieaudits – Anforderungen mit Anleitung zur Anwendung Energy audits – Requirements with guidance for use
DIN ISO 50003
Energiemanagementsysteme – Anforderungen an Stellen, die Energiemanagementsysteme auditieren und zertifizieren (ISO 50003:2014) Energy management systems – Requirements for bodies providing audit and certification of energy management systems (ISO 50003:2014)

DIN ISO 50006	
Energiemanagementsysteme – Messung der energiebezogenen Leistung unter Nutzung von energetischen Ausgangsbasen (EnB) und Energieleistungskennzahlen (EnPI) – Allgemeine Grundsätze und Leitlinien (ISO 50006:2014) Energy management systems – Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) – General principles and guidance (ISO 50006:2014)	
ISO 50004	
Energiemanagementsysteme – Anleitung zur Einführung, Aufrechterhaltung und Verbesserung eines Energiemanagementsystems Energy management systems – Guidance for the implementation, maintenance and improvement of an energy management system	
TS ISO 50015	
Energy management systems -- Measurement and verification of energy performance of organizations -- General principles and guidance	
ISO/DIS 50007	
Tätigkeiten im Zusammenhang mit Energiedienstleistungen – Leitlinien für die Bewertung und Verbesserung des Service für Nutzer Activities relating to energy services – Guidelines for the assessment and improvement of the service to users	
DIN EN 16247 (Teile 1-5)	
Energieaudits Energy audits	
ISO 22400-2	
Automation systems and integration – Key performance indicators (KPIs) for manufacturing operations management – Part 2: Definitions and descriptions	
DIN EN 16212	**NA 172-00-09 AA CEN/CLC/JWG 4**
Energieeffizienz- und -einsparberechnung – Top-Down- und Bottom-Up-Methoden; Deutsche Fassung EN 16212:2012 Energy efficiency and savings calculation – Top-down and Bottom-up methods; German version EN 16212:2012	
ISO 17741	
Allgemeine technische Regeln für Messung, Berechnung und Verfizierung von Energieeinsparungen von Projekten General technical rules for measurement, calculation and verification of energy savings of projects	

DIN VDE 0100-520 (VDE 0100-520)	DKE/UK 221.2
Errichten von Niederspannungsanlagen – Teil 5-52: Auswahl und Errichtung elektrischer Betriebsmittel – Kabel- und Leitungsanlagen (IEC 60364-5-52:2009, modifiziert + Corrigendum Feb. 2011); Deutsche Übernahme HD 60364-5-52:2011 Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems (IEC 60364-5-52:2009, modified + Corrigendum Feb. 2011); German implementation HD 60364-5-52:2011	

E DIN EN 60051-1 (VDE 0411-51-1)	DKE/K 964	IEC/TC 85
Direkt anzeigende analoge elektrische Messgeräte und ihr Zubehör – Teil 1: Definitionen und allgemeine Anforderungen für alle Teile (IEC 85/472/CD:2014) Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts (IEC 85/472/CD:2014)		

DIN EN 61850-X
Kommunikationsnetze und -systeme für die Automatisierung in der elektrischen Energieversorgung Communication networks and systems for power utility automation

DIN EN ISO 9000
Qualitätsmanagementsysteme – Grundlagen und Begriffe (ISO 9000:2015); Deutsche und Englische Fassung EN ISO 9000:2015 Quality management systems – Fundamentals and vocabulary (ISO 9000:2015); German and English version EN ISO 9000:2015

Annex 1.4 Norms, standards and committees "energy generation and storage"

Norms and standards "energy generation and storage"

DIN EN 50598-1 (VDE 0160-201)	DKE/K 226	CLC/TC 22X
Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 1: Allgemeine Anforderungen zur Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) mit semi-analytischen Modellen (SAM); Deutsche Fassung EN 50598-1:2014 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM); German version EN 50598-1:2014		

DIN EN 50598-2 (VDE 0160-202)	DKE/K 226 CLC/TC 22X

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern; Deutsche Fassung EN 50598-2:2014

Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters; German version EN 50598-2:2014

DIN EN 50598-3 (VDE 0160-203)	DKE/K 226 CLC/TC 22X

Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Teil 3: Quantitativer Ökodesign-Ansatz mittels Ökobilanz einschließlich Produktkategorieregeln und des Inhaltes von Umweltdeklarationen; Deutsche Fassung EN 50598-3:2015

Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations; German version EN 50598-3:2015

E DIN EN 61800-9-1 (VDE 0160-109-1)	DKE/K 226

Drehzahlveränderbare elektrische Antriebe – Teil 9-1: Energieeffizienz für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Allgemeine Anforderungen für die Erstellung von Normen zur Energieeffizienz von Ausrüstungen mit Elektroantrieb nach dem erweiterten Produktansatz (EPA) und semi-analytischen Modellen (SAM) (IEC 22G/300/CDV:2015); Deutsche Fassung FprEN 61800-9-1:2015

Adjustable speed electrical power drive systems – Part 9-1: Energy efficiency of power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the Extended Product Approach (EPA) and semi analytic model (SAM) (IEC 22G/300/CDV:2015); German version FprEN 61800-9-1:2015

E DIN EN 61800-9-2 (VDE 0160-109-2)	DKE/K 226 IEC/SC 22G

Drehzahlveränderbare elektrische Antriebe – Teil 9-2: Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen – Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern (IEC 22G/301/CDV:2015); Deutsche Fassung FprEN 61800-9-2:2015

Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Energy efficiency indicators for power drive systems and motor starters (IEC 22G/301/CDV:2015); German version FprEN 61800-9-2:2015

DIN EN 62282-2 (VDE 0130-2)	DKE/K 384 IEC/TC 105

Brennstoffzellentechnologien – Teil 2: Brennstoffzellen-Module (IEC 62282-2:2012); Deutsche Fassung EN 62282-2:2012

Fuel cell technologies – Part 2: Fuel cell modules (IEC 62282-2:2012); German version EN 62282-2:2012

DIN EN 62282-3-100 (VDE 0130-3-100)	DKE/K 384	IEC/TC 105
Brennstoffzellentechnologien – Teil 3-100: Stationäre Brennstoffzellen-Energiesysteme – Sicherheit (IEC 62282-3-100:2012); Deutsche Fassung EN 62282-3-100:2012 Fuel cell technologies – Part 3-100: Stationary fuel cell power systems – Safety (IEC 62282-3-100:2012); German version EN 62282-3-100:2012		
DIN EN 62282-3-200 (VDE 0130-3-200)	**DKE/K 384**	**IEC/TC 105**
Brennstoffzellentechnologien – Teil 3-200: Stationäre Brennstoffzellen-Energiesysteme – Leistungskennwerteprüfverfahren (IEC 62282-3-200:2011); Deutsche Fassung EN 62282-3-200:2012 Fuel cell technologies – Part 3-200: Stationary fuel cell power systems – Performance test methods (IEC 105/436/CD:2013)		
DIN EN 62282-3-201 (VDE 0130-3-201)	**DKE/K 384**	**IEC/TC 105**
Brennstoffzellentechnologien – Teil 3-201: Stationäre Brennstoffzellen-Energiesysteme – Leistungskennwerteprüfverfahren für kleine Brennstoffzellen-Energiesysteme (IEC 105/564/CDV:2016); Deutsche Fassung FprEN 62282-3-201:2016 Fuel cell technologies – Part 3-201: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems (IEC 105/564/CDV:2016); German version FprEN 62282-3-201:2016		
DIN EN 62282-3-300 (VDE 0130-3-300)	**DKE/K 384**	**IEC/TC 105**
Brennstoffzellentechnologien – Teil 3-300: Stationäre Brennstoffzellen-Energiesysteme – Installation (IEC 62282-3-300:2012); Deutsche Fassung EN 62282-3-300:2012 Fuel cell technologies – Part 3-300: Stationary fuel cell power system – Installation (IEC 62282-3-300:2012); German version EN 62282-3-300:2012		
DIN EN 62282-4-101 (VDE 0130-4-101)	**DKE/K 384**	**IEC/TC 105**
Brennstoffzellen-Technologien – Teil 4-101: Antriebe mit Brennstoffzellen-Energiesystemen (mit Ausnahme von Straßenfahrzeugen und Hilfsantrieben) – Elektrisch betriebene Flurförderfahrzeuge – Sicherheit (IEC 62282-4-101:2014); Deutsche Fassung EN 62282-4-101:2014 Fuel cell technologies – Part 4-101: Fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APU) – Safety of electrically powered industrial trucks (IEC 62282-4-101:2014); German version EN 62282-4-101:2014		
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Committees

COMMITTEE	TITLE
DKE/K 226	Ausrüstung von Starkstromgeräten und -anlagen mit elektronischen Betriebsmitteln
DKE/K 384	Brennstoffzellen

Norms and standards "energy storage systems"

DIN VDE 0100-801 (VDE 0100-801)	DKE/UK 221.5	IEC/TC 64
Errichten von Niederspannungsanlagen – Teil 8-1: Energieeffizienz (IEC 60364-8-1:2014, modifiziert); Deutsche Übernahme HD 60364-8-1:2015 Low-voltage electrical installations – Part 8-1: Energy efficiency (IEC 60364-8-1:2014, modified); German implementation HD 60364-8-1:2015		
GEFMA 124-2	**GEFMA**	**--**
Energiemanagement – Methoden		
DIN EN 61936-1 (VDE 0101-1)	**DKE/K 222**	**IEC/TC 99**
Starkstromanlagen mit Nennwechselspannungen über 1 kV – Teil 1: Allgemeine Bestimmungen (IEC 61936-1:2010, modifiziert + Cor.:2011 + A1:2014); Deutsche Fassung EN 61936-1:2010 + AC:2011 + AC:2013 + A1:2014 Power installations exceeding 1 kV a.c. – Part 1: Common rules (IEC 61936-1:2010, modified + Cor.:2011 + A1:2014); German version EN 61936-1:2010 + AC:2011 + AC:2013 + A1:2014		

Committees

COMMITTEE	TITLE
NA 172-00-09 AA	Energieeffizienz und Energiemanagement
DKE/UK 221.5	Zukunftsfähige Elektroinstallationen
DKE/K 261	Systemaspekte der elektrischen Energieversorgung
GEFMA	Deutscher Verband für Facility Management, GEFMA e. V.

Annex 2 Product groups and regulations on the Ecodesign Directive

PRODUCT GROUPS (LOTS)	IMPLEMENTING MEASURES/REGULATIONS
Lot-Simple set-top boxes	Reg 107/2009, applies since 25.02.2010
Lot 1 Boiler and combi boiler	Reg 813/2013, applies since 26.09.2015
Lot 2 hot water heater	Reg 814/2013, applies since 26.09.2015
Lot 3 PCs (desktops and laptops)	Reg 617/2013, applies since 01.07.2014
Lot 3 Screens (displays)	Working document
Lot 4 Imaging devices	Self-regulation Initiative (Volunteers Agreement)
Lot 5 TV sets	Reg 642/2009 + Amd. 801/2013, applies since 07.01.2010
Lot 6 Standby and Off-mode losses	Reg 1275/2008 + Amd. 801/2013, applies since 07.01.2010
Lot 7 External power supply-units	Reg 278/2009, applies since 27.04.2010 Revision study
Lot 8 Office Lighting	Reg 245/2009 + Amd. 347/2010, applies since 13.04.2010
Lot 9 Street Lighting	Reg 245/2009 + Amd. 347/2010, applies since 13.04.2010
Lot 10 Air Conditioning units	Reg 206/2012, applies since 01.01.2013
Lot 10 Small fans	Reg 206/2012, applies since 01.01.2013
Lot 10 Vents	Reg 1253/2014, applies since 01.01.2016
Lot 11 Electric Motors	Reg 640/2009 + Amd. 4/2014, applies since Aug 12,
Lot 11 Circulating Pumps	Reg 641/2009 + Amd. 622/2012, applies since 01.01.2013
Lot 11 Fans	Reg 327/2011, applies since 01.01.2013
Lot 11 Water Pumps	Reg 547/2012, applies since 01.01.2013
Lot 12 commercial refrigeration and freezing appliances	Working document
Lot 13 household refrigeration and freezing appliances	Reg 643/2009, applies since 01.07.2010
Lot 14 Household dishwashers	Reg 1016/2010, applies since 01.12.2011
Lot 14 household washing machines	Reg 1015/2010, applies since 01.12.2011
Lot 15 Solid Fuel boilers	Reg 1189/2015, applies since 10.08.2015
Lot 16 Tumble Dryers	Reg 932/2012, applies since 01.11.2013
Lot 17 Vacuum Cleaners	Reg 666/2013, applies since 01.09.2014
Lot 18 complex set-top boxes	Self-regulation Initiative (Volunteers Agreement), applies since 01.07.2010

PRODUCT GROUPS (LOTS)	IMPLEMENTING MEASURES/REGULATIONS
Lot 19 Household lighting Part I "Not directed"	Reg 244/2009 + Amd. 859/2009, applies since 01.09.2009
Lot 19 Household lighting Part II "Reflector Lamps"	Reg 1194/2012, applies since 01.09.2013
Lot 20 solid fuel-single room heaters	Reg 1185/2015, applies since 10.08.2015
Lot 20 Single Room heaters	Reg 1188/2015, applies since 10.08.2015
Lot 21 Central heating products with use of hot air for heat distribution	Draft Regulation
Lot 22 household and commercial ovens	Reg 66/2014, applies since 20.02.2015
Lot 23 cooking fields and grills for household and commercial use	Reg 66/2014, applies since 20.02.2015
Lot 24 Professional Washing machines, Dryers and Dishwashers	Working document
Lot 25 coffee machines for non-commercial purposes	See Reg 801/2013, applies since 01.01.2015
Lot 26 networked standby losses	Reg 801/2013, applies since 01.01.2015
Lot 27 uninterruptable power supplies (UPS)	Preliminary study Completed
Lot 28 Sewage Pumps	Preliminary study Completed
Lot 29 Pure Water pumps (Larger than in Lot 11)	Preliminary study Completed
Lot 30 motors and drives (Outside the scope of regulation 640/2009)	Working document
Lot 31 Compressors	Working document
Lot 32 Window	Preliminary study
Lot 33 Smart Appliances	Preliminary study
Lot 37 Lighting Systems	Preliminary study
ENTR imaging devices in medicine	Draft Self-Regulation Initiative (Volunteers Agreement)
Lot ENTR 1 Commercial cold storage cabinets	Reg 1095/2015, applies since 01.07.2015

PRODUCT GROUPS (LOTS)	IMPLEMENTING MEASURES/REGULATIONS
Lot ENTR 2 Transformers	Reg 548/2014, applies since 01.07.2015
Lot ENTR 3 devices for sound and picture processing	Self-Regulation Initiative (Volunteers Agreement)
Lot ENTR 4 Industrial and laboratory furnaces and ovens	Working document
Lot ENTR 5 Machine tools	Draft Self-Regulation Initiative (Volunteers Agreement)
Lot ENTR 6 air conditioning and venti-lation systems	Reg 1253/2014, applies since 01.01.2016
Lot ENTR 7 Boilers	Preliminary study Completed
Lot ENTR 8 Power cables	Preliminary study Completed
Lot ENTR 9 Server	Preliminary study
JRC taps and shower heads	Preliminary study

Annex 3 Product groups and regulations on the energy label Directive

PRODUCT GROUPS (LOTS)	IMPLEMENTING MEASURES/REGULATIONS
Lot 1 Boiler and combi boiler	Reg 811/2013 + Amd. 518/2014, applies since 26.09.2013
Lot 2 hot water heater	Reg 812/2013 + Amd. 518/2014, applies since 26.09.2013
Lot 3 Screens	Working document
Lot 5 TV Sets	Reg 1062/2010 + Amd. 518/2014, applies since 30.11.2011
Lot 8 Office Lighting	Preliminary study Completed
Lot 9 Street Lighting	Preliminary study Completed
Lot 10 Air Conditioning units	Reg 626/2011 + Amd. 518/2014, applies since 01.01.2013
Lot 10 Household ventilation	Reg 1254/2014, applies since 01.01.2016
Lot 12 commercial refrigeration and freezing appliances	Reg 1094/2015, applies since 28.07.2015
Lot 13 household refrigeration and freezing appliances	Reg 1060/2010 + Amd. 518/2014, applies since 30.11.2011
Lot 14 household dishwashers	Reg 1059/2010 + Amd. 518/2014, applies since 20.12.2011
Lot 14 household washing machines	Reg 1061/2010 + Amd. 518/2014, applies since 20.12.2011
Lot 15 Solid Fuel boilers	Reg 1187/2015, applies since 10.08.2015
Lot 16 Tumble Dryers	Reg 392/2012 + Amd. 518/2014, applies since 29.05.2013
Lot 17 Vacuum Cleaners	Reg 665/2012 + Amd. 518/2014, applies since 01.09.2014

PRODUCT GROUPS (LOTS)	IMPLEMENTING MEASURES/REGULATIONS
Lot 19 Household Lighting Part I and II	Reg 874/2012 + Amd. 518/2014, applies since 01.09.2013
Lot 20 Single Room heaters	Reg 1186/2015, applies since 10.08.2015
Lot 22 household and commercial ovens	Reg 65/2014, applies since 01.01.2015
Lot 23 cooking fields and grills for household and commercial use	Reg 65/2014, applies since 01.01.2015
Lot 24 Professional Washing machines, Dryers and Dishwashers	Preliminary study Completed
Lot 25 coffee machines for non-commercial purposes	Preliminary study Completed
Lot 32 Windows	Preliminary study
Lot ENTR 1 Professional refrigeration and freezing appliances	Working document
Lot ENTR 6 Ventilation systems	Reg 1254/2014, applies since 01.01.2016
JRC taps and shower heads	Preliminary study

Last update: 28.04.2016

Annex 4 Projects

The EUREF campus in Berlin

Figure 51 – The EUREF Campus [21]

The EUREFCampus is Europe's first CO_2-neutral district.

In 2008 an energy transition innovation centre was set up on the old gasometer site; it is designed for CO_2-neutral operation and already meets the 2050 climate targets.

Small wind turbines, solar plants, a combined heat and power plant, two large batteries as a network buffer as well as a supercapacitor for frequency stabilization were installed on the EUREF campus to test the integration of renewable energy sources and electromobility in the power grid. The objective is to make maximum use of renewable energy sources and to be able to provide both positive and negative control energy when needed.

Kassel bakery

Early in 2013 a baker in Kassel decided to optimize the energy performance of his business. In 2012, the main branch (including the bakehouse) incurred an energy bill of EUR 97,208, with 97% of this being spent on electricity. That is a lot of money for a relatively small company with 65 employees.

With professional planning support, the following measures were implemented:
- Bakehouse and sales area lighting converted to LED and T5 lamps
- New, efficient ovens
- Peak load management introduced
- Heat recovery for ovens

This yielded total electrical energy savings of 54,000 kWh per year, translating into EUR 33,000 per year. Overall this represents a calculated internal return on invested capital (EUR 200,000) of around 14% with a static payback period of 6.1 years. The payback is fastest on the lighting investment. The baker's energy efficiency project is, however, still ongoing. [22]

Fashion store reduces lighting costs by up to 45%

Successful product presentation in fashion stores requires optimum illumination. Light is the key to success – but is also a large cost factor in retail.

In 2013 a fashion store in north Hesse decided that the time was right for light emitting diodes (LEDs). It then started to upgrade the lighting, with the higher energy efficiency helping it to save up to 45% of its electricity costs.

The electricity consumption in 2012 was 59,677 kWh for 2,500 square meters of retail space. That amounted to a full EUR 10,500 per year only for lighting electricity costs. After the conversion to LED technology, the power consumption is now only 32,762 kWh, representing a sizeable saving of 45%.

This is further evidence that the efficiency technologies currently available can yield great savings even in modern businesses. [22]

Photovoltaic structure to cover entire electricity demand of the Porsche Centre in Berlin

A 25-meter high steel structure fitted with photovoltaic panels is to generate up to 30,000 kWh of solar power annually. When the auto centre opens in the spring of 2017, the intention is for the solar electricity it generates to cover the entire electricity demand. Visitors will then also be able to recharge their cars for free at a charging station. [23]

ETA-Fabrik in Darmstadt

The opening of the "ETA-Fabrik" at TU Darmstadt on 2.3.16 represented a milestone in energy efficiency research. New forms of energy storage, energy use and in particular power control for the production plant of the future are being explored on an interdisciplinary basis within the framework of the BMWi-funded research project, supervised by project sponsor Jülich.

The aim of the project is to construct a model factory which combines various interdisciplinary approaches to reducing the energy consumption and CO_2 emission levels of industrial production.

Another objective of the ETA-Fabrik is to provide an independent platform where young generations of engineers and key industry decision-makers can work together to unleash wide-ranging energy efficiency potential for their companies.

The energy efficiency innovations developed in the project should also help in the transfer to industry. New avenues are being explored in the ETA-Fabrik project, both in the context of achieving climate targets through more environment-friendly production in Germany, as well as in the creation of competitive advantages through innovative manufacturing processes and efficient "Made in Germany" products.

Europe‘s first CO_2-free railway station is in Kerpen-Horrem

A regional train station has been turned into Europe‘s first CO_2-neutral station thanks to the deployment of energy-efficient environmental technology.

Various technologies allow the Kerpen-Horrem station in North Rhine-Westphalia to operate on a carbon-neutral basis. In the EUR 4.3 million project, the integrated photovoltaic system produces roughly 31,000 kilowatt hours of electricity per year, while a geothermal system provides heating and cooling for the building, and a solar heating plant delivers hot water. Rainwater is collected on the green roof and is used to supply the public toilets. A new lighting concept also combines the use of natural light with energy-saving LED technology. The combined individual measures ensure that no CO_2 is emitted in the operation of the station.

Municipalities for electromobility

The municipalities in the Hannover-Braunschweig-Göttingen-Wolfsburg metropolitan region are committed to electromobility. The Federal Ministry of Transport and Digital Infrastructure has donated EUR 1.7 million for the development and implementation of local incentives and the use of electric vehicles in the towns, cities and rural districts of the metropolitan region. Together with the Institut für Demokratieforschung at Göttingen University it has set up one of the most exciting local projects designed to showcase electromobility in Germany. It is scheduled to run until the beginning of 2016.

Municipalities are playing a prominent role in the development of electromobility. They are responsible for local public transport, take decisions on traffic regulation and deploy large numbers of vehicles in their fleets. The goal of meeting the metropolitan area‘s entire energy demand for electricity, heat and mobility from renewable energy sources by 2050 is at the heart of this venture.

The Aktion Autotausch scheme gives members of the councils and district assemblies the opportunity to use an electric car instead of their own vehicle for a number of days. The purpose is to convince them of the suitability of electric cars for everyday use and of the need to address the infrastructure requirements in their field. The findings are feeding into a trans-European exchange of knowledge as part of the ‚European Network MEElecTric: International Cooperation and Knowledge Transfer‘ project and the better transport forum.

Tumble driers with heat pump

Heat pump tumble driers need only half the energy of conventional condenser driers. A recent test of 15 driers with heat pumps published by Stiftung Warentest showed that the most economical modern driers consume about EUR 25 worth of power per year for a small family. They make more efficient use of the heated air for drying than driers without a heat pump. An efficiency class A condensation drier with heat pump technology saves about 83% of electricity costs compared to a C-rated unit per year. Over a drier‘s entire lifespan of 13 years, this results in total savings of about EUR 1,080.

Up to 75% energy savings in control cabinets

Modern control cabinet coolers enable energy savings of up to 75% to be made through their hybrid technology – a combination of passive and active cooling. Further advantages are the high control accuracy and lower thermal stress for all cabinet components. At up to 35°C the devices can function with purely passive cooling. Active cooling is only switched on above this, significantly reducing the energy consumption.

Hybrid ferry: emission-free, quiet and energy-efficient

The "Berlin", the first of two hybrid ferries, has been plying the 50 km stretch of water between Rostock in Germany and Gedser in Denmark since 23 May 2016. The ferry switches to the quiet, emission-free electric drive in the first 30 minutes after departing from and when approaching the port. Upon reaching the open sea, the diesel engine takes over. This works most effectively at 85 to 90% capacity, yet only uses 40 to 55% during a crossing. The excess energy is stored in batteries and then used when needed.

According to the shipping company, the hybrid drive system is able to save up to 15% of CO_2 emissions. As the next step, the company is aiming to make the ferry service completely emission-free on the Puttgarden-Rødby route by using 100% battery operation.

Concrete spheres for storing wind power in Lake Constance

The idea is ingenious: why not save energy in huge, hollow concrete spheres at the bottom of the sea? Whether this works or not is soon to be tested in Lake Constance. If the concrete spheres pass the test and the technology proves successful, offshore wind farms could be equipped with spheres capable of storing 20 MWh each.

Concrete spheres for storing wind farm energy: tests to start soon in Lake Constance. When electricity is required, water flows into the spheres, driving a turbine. When there is excess power, the spheres are drained again. [24]

Largest energy research programme based on real data in Europe

Largest energy research programme based on real data in Europe The "Aspern Seestadt" quarter is being created in the 22nd district of Vienna. In one of the largest city development projects in Europe in recent years, a new quarter where more than 20,000 people will live and work is being established over a period of about 20 years.

The research company Aspern Smart City Research (ASCR), in which SIEMENS is also involved, has launched a research project for sustainable and innovative energy efficiency solutions which is unique in Europe.

The secure and sustainable supply of energy is one of the most important issues for the future. The demand for energy is rising, as are global CO_2 emissions. This means that new technologies are required. Energy needs to be optimally used – involving careful coordination of its generation, distribution, storage and consumption. ASCR is using Aspern Seestadt to test new technologies in real operation for the smart city of Vienna.

Aspern represents a unique possibility for carrying out research using real data from individual users, entire buildings and energy suppliers. Residential blocks, mixed office and residential buildings, and the new education campus will participate in the research programme. These buildings are being equipped with innovative technology such as smart meters. They provide the data that make up the basis of the research. The data are analyzed by ASCR and simulations carried out based on it. The aim is to optimize the energy consumption of the buildings, and thereby reduce the energy costs.

A further objective is to predict the electrical and thermal energy demand. The scope of the project covers the installed photovoltaic systems, batteries, heat pumps and heat storage units. This information allows the operators to participate actively in the energy market and to take advantage of the resulting benefits.

Another objective is to evaluate the electrical networks on the basis of the collected variables, both inside the buildings and in the distribution grid of the Vienna municipal utility.
https://www.wien.gv.at/stadtentwicklung/projekte/aspern-seestadt/bildung-forschung/ascr.html

Intelligent gas cleaning

Gas cleaning systems are often little-noticed auxiliary units which are often not used effectively and which hold a great deal of potential for improvement. Firstly, blower speed control can help ensure that only the output which is actually required is made available. Secondly, intelligent control of the system can significantly reduce the amount of power required, as shown by a new development patented by the SMS group. The X-Pact® Gas Cleaning Assist deploys an algorithm in the gas purification controller that enables dynamic damper control of each extraction point and ensures maximum suction power without unnecessarily increasing the speed of the controllable suck-blowers.

The gas cleaning quality is increased while the energy consumption is reduced (see figure 52).

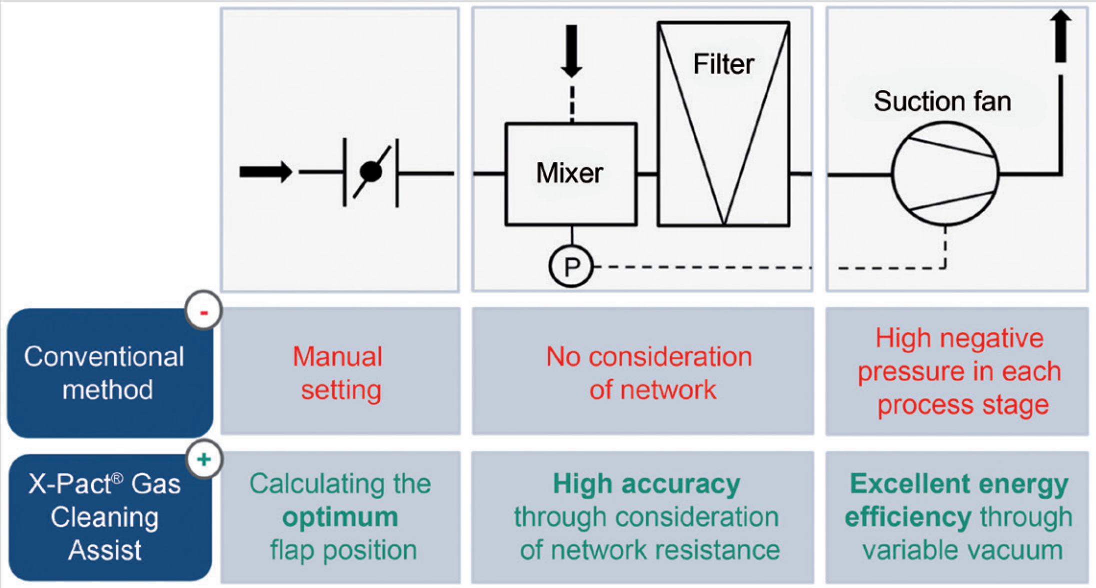

Figure 52 – Gas cleaning system [16]

To achieve this, the existing gas cleaning network is analysed, mapped in a mathematical model and fed into the Gas Cleaning Assist. This calculates the behaviour in the gas cleaning system in real time and adjusts it so that the required suction power is available on all suction points at all times – and with minimum loss of pressure. No further measurements are needed, thus avoiding costs for electromechanical components. A Gas Cleaning Assist system was retrofitted in a converter steel mill with an annual production of 1.3 million tonnes at Kardemir in Turkey. This reduced energy consumption by 21% and thus helped achieve savings of EUR 100,000 per year.

The Henne building project

Achieving almost 100 % electricity supply generated from renewable sources necessitates correctly dimensioning the PV system, micro-cogeneration unit and power storage – even in apartment buildings. The task becomes significantly more complex, however, if the entire demand for hot water and heating is to be met at the same time. The energetic modernization of an apartment building in Oldenburg is based on a solution that could serve as a model for many apartment buildings from the 60s and 70s and thus a prime example of the (building) energy transition.

The building at number 14 contains six flats of between 52 and 69 square meters. The gas consumption is 200,000 kilowatt hours per year – providing hot water and central heating in all rooms. Electricity consumption is estimated at between 16,000 and 24,000 kilowatt hours.

A photovoltaic system, two micro-CHP units and two intelligent power storage systems satisfy the power requirements during the day, at night and in the cold season. The heating is supplied by the micro CHP plants with heat-controlled Stirling engines, and in the summer by a hot water heat pump.

The electricity produced is fed directly into the local area network and consumed, or automatically cached on the AC side of the power storage systems. The resulting excess and (more-or-less) free cogenerated electricity is remunerated by the CHP bonus at 5.7 cents per kilowatt hour – although it gains significantly in value through being cached in the power storage units or in an electric car.

The modernization of the Henne building yields considerable CO_2 savings. The use of photovoltaic power instead of gas, or electricity from fossil sources, saves around 16 tonnes CO_2 per year. Power consumption of 16,000 to 24,000 kWh is assumed. 700 grams of CO_2 are saved per kWh. Further savings come from the lower energy demand arising from efficiency measures and use of the CHP plant [25].

Energy storage systems attracting attention

Energy storage solutions have to cover a wide range of needs – from the private and the commercial sectors through to extensive applications in industry and at the grid level. According to the cleantech business consultancy Navigant Research, sales of decentralized systems for storing energy are expected to rise rapidly from USD 452 million in 2014 to more than USD 16 billion in 2024. The growth is driven by the following three key factors:

- The trend towards greater sustainability.
  Accelerated reduction of CO_2 emissions caused by conventional power generation requires an increased share of renewable energies in the energy mix – and this in turn depends on options for storing the generated energy.
- Rising demand for reliability and resilience.
  Energy storage systems help to mitigate risks in the energy supply by providing greater grid stability,

allowing the operation of systems in power surges and power outages, and ensuring the functioning of critical social infrastructures even in emergency situations.

- The right of access to energy.
  More than 3 billion people use cooking, lighting and heating methods which cause pollution and are inefficient. Providing these people, as well as the 1,2 billion who currently have no access to electricity, with clean and affordable energy is made possible by converting and storing renewable energy.

According to Eaton, the usefulness of storing and controlling energy depends on the respective user. Households, for example, can reduce their electricity bills by using photovoltaic systems for their own needs, charging stations for electric vehicles and smart home networks to secure supply advantages for themselves and to avoid peak-load costs. Commercial and industrial customers can save costs if they are given the opportunity to implement load shift and peak-load avoidance systems. Yields can also be increased with the aid of demand-response programs. [25]

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