Efficient systems and renewable energies

Technology and Energy Panel

BDH
Federal Industrial Association of Germany
House, Energy and Environmental Technology

ISH

Foreword

Under the auspices of the BDH and Frankfurt Trade Fair, the Technology and Energy Panel will be held at the ISH 2013 in Frankfurt for the fifth time. ASUE, BWP, DEPV, DVGW, FGK, HEA, HKI and IWO will support this central event of the international trade fair ISH. The Alliance for Building Energy Efficiency, geea which promotes greater efficiency in buildings across the entire industry, as well as the German Energy Agency, dena and the Standards Committee Heiz- und Raumlufttechnik (heating and air conditioning systems) in DIN e.V. will be the new entrants as sponsors for the first time.

Again, the Technology and Energy Panel of ISH will be held under the auspices of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU). With the acquisition of patronage, the policy clearly underscores the importance of modern technology for the ambitious European and national goals for climate protection and conservation of resources. With an area of 450 m^2, the Panel showcases the state of the art worldwide. With the support of partners from the energy industry, the exhibition shows the potential of efficient use of fossil fuels and the growing importance of renewable energies in the heat market. The partners of the Technology and Energy Panel and the Ministry rely on the dual strategy of efficiency and renewable energies. This allows exploitation of the huge energy savings and CO_2 reduction potential ranging up to 50 % in the buildings sector. Advanced German technologies make the central contribution to this.

The international trade fair ISH with its 200,000 expert visitors forms the information platform for European and, increasingly, non-European decision makers as well. Again, the Technology and Energy Panel's main focus is on the visitors who want to be informed briefly and neutrally about the state of the art, innovations and modernisation concepts. Therefore, this central brochure will be published in German, English, Italian, Spanish, French, Russian and Chinese. All the photos and the lectures will be presented in English and German.

Iris Jeglitza-Moshage
Senior Vice President,
Messe Frankfurt Exhibition

Andreas Lücke M.A.
Managing Director BDH

Table of contents

EU Framework Conditions

Strong alliance for efficiency and renewable

The partner organisations of the Technology and Energy Panel have a common core matter of concern: Efficiency and development of renewable energies. The fossil fuels will continue to play a key role in the provision of energy in the heating and cooling market around the world. There is consensus among the partners that the role of renewable energies in the heat market and the air-conditioning sector will grow strongly and successively.

The Technology and Energy Panel foresees strong interdependence between all forms of energy – be it fossil or renewable – and an efficient system technology that enables an energy-related optimum in the use of these types of energy. The partner organisations and their roles in detail:

www.asue.de

for the gas industry

BDH – Federal Industrial Association of Germany House, Energy and Environmental Technology

for efficiency and renewable energies

bwp – German Heat Pump Association

for heat pumps

dena – German Energy Agency

for energy efficiency, renewable energies and smart energy systems

DEPV – Deutscher Energieholz- und Pellet-Verband e.V.

for wood and pellets, as well as the corresponding technology

DIN NHRS

for standardisation

DVGW

for the gas industry and the standardisation body

Fachverband Gebäude-Klima e. V.

for air-conditioning technology and ventilation systems

geea – Die Allianz für Gebäude-Energie-Effizienz

for building energy efficiency

HEA – Fachgemeinschaft für effiziente Energieanwendung e. V.

for the electricity industry

HKI

for efficient single room furnaces

iwo – Institut für Wärme und Oeltechnik

for the heating oil industry

BDH
2012

102 companies
2 associations

Market shares:	90 % in Germany 60 % in the EU
Turnover:	12.7 billion euros worldwide
Employees:	67,400 worldwide
R & D:	508 million euros worldwide

Products and Systems:	Gas, oil and wood boilers Heat pumps Solar thermal systems and photovoltaics Heat distribution and emission systems Ventilation systems Air-conditioning Flue systems CHP systems Storage tanks and tank systems Large boilers and burners up to 36 MW

The Technology and Energy Panel is under the aegis of BDH and Frankfurt Trade Fair. The patronage is taken over by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

BDH: Association for Efficiency and Renewable Energies

The BDH organises 104 companies that produce efficient systems and /or components for heating, domestic hot water heating and ventilation in buildings and integrate renewable energies in the process. The members of BDH assume an internationally leading position for systems from 4 kW to 36 MW.

They represent approximately 60 % of the European market in the field of heat supply to buildings and the industrial heat sector.

They generate a turnover of EUR 12.7 billion worldwide and employ approximately 67,400 people.

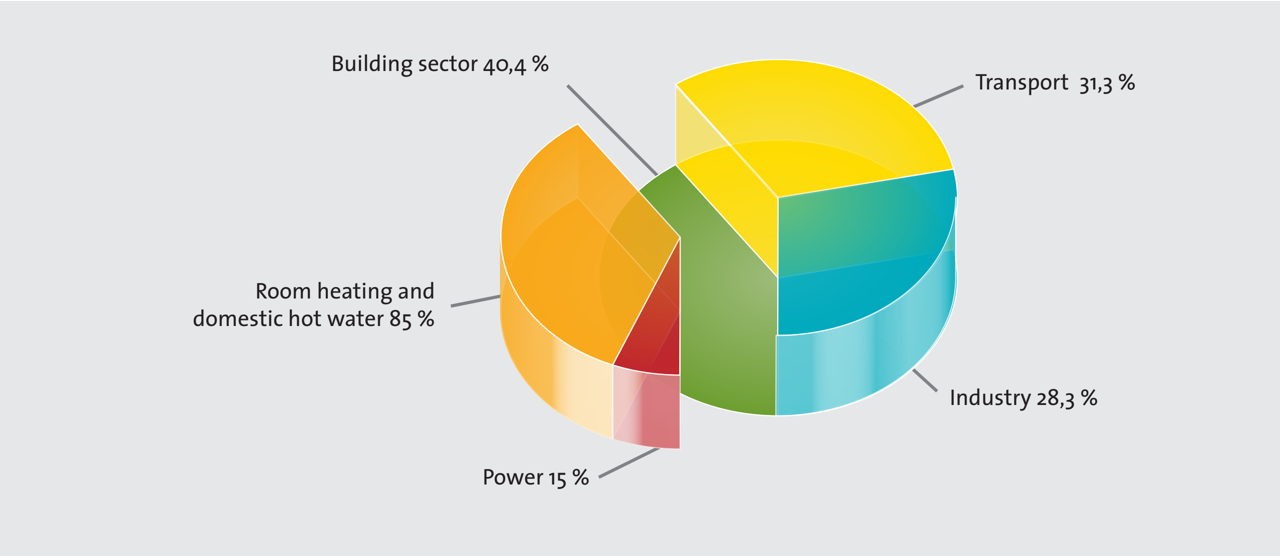


Fig. 1: Final energy consumption by sectors within the EU

Europe's largest energy consumption sector in focus

According to the EU Green Paper, the heat market accounts for 40 % of final energy consumption in Europe. The heating of buildings and domestic hot water account for approximately 85 % thereof.
This corresponds to 33 % of final energy consumption.
According to the Green Paper, the energy efficiency of buildings in Europe is very low. If the energy efficiency could be doubled through technical measures or energy improvement of the building envelope, about 20 % of energy consumption in Europe could be saved. No other energy consumption sector in Europe has such high savings potential.
A key part of the solution lies in the system technology sector. The enormous challenges in the field of energy-related modernisation of outdated heating technology in Europe are apparent here.

18 million tonnes of CO_2 can be saved in the range of up to 36 MW in the industrial heat sector alone in Germany. The ISH offers the central information and advice platform also for these important technological approaches and solutions.

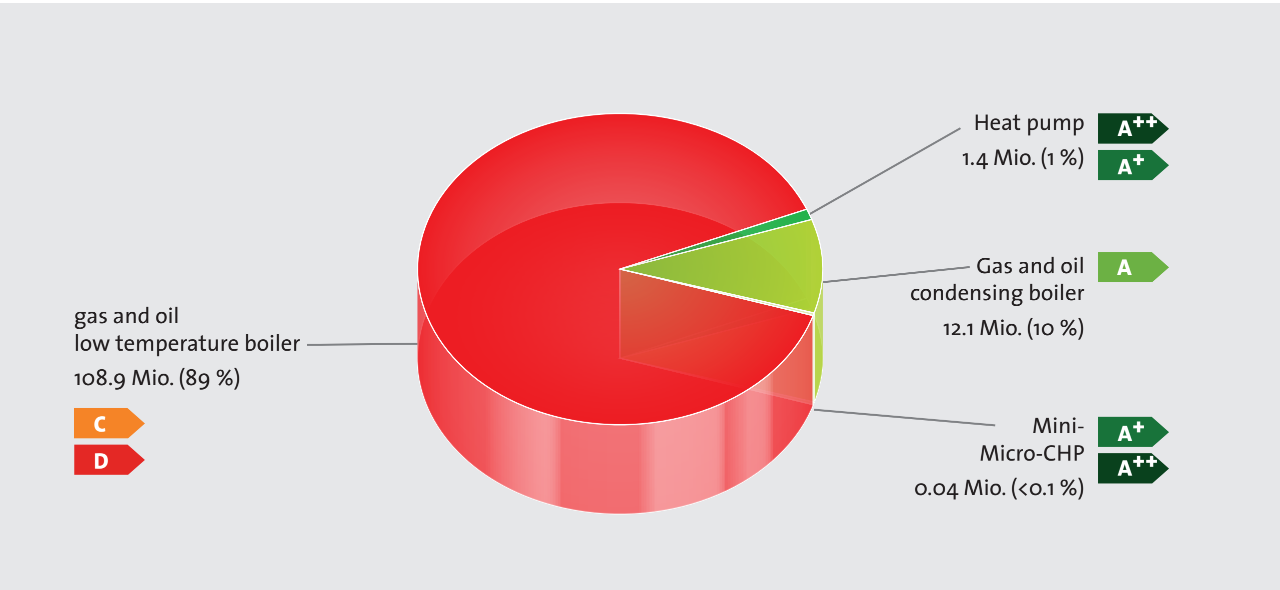


Fig. 2: Number of existing systems in Europe, about 122.4 million.

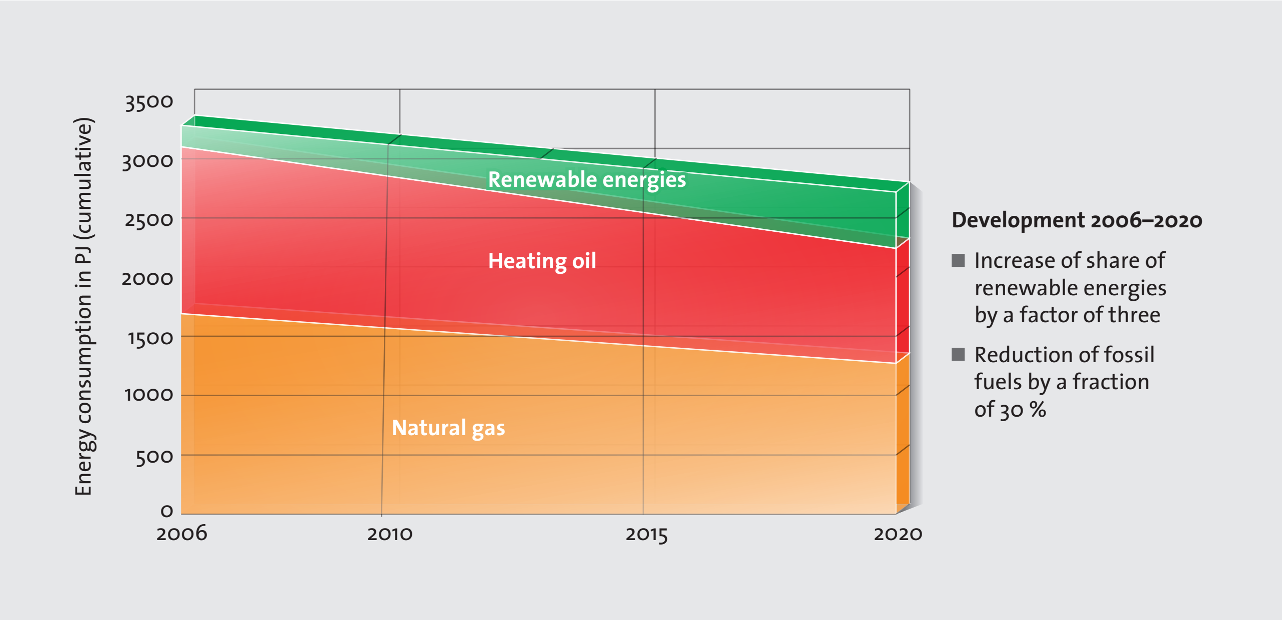


Fig. 3: Heat by energy source (BDH forecast)

Figure 3 shows the objective in natural gas, heating oil and renewable energies with Germany as an example (BDH forecast). The consumption of fossil fuels goes down considerably due to the gains in efficiency.
The renewable energies gain great significance through increased application of solar heat, environmental and geothermal energy, as well as the increased use of biomass.

The dual strategy of efficiency and renewable energies, and the associated accelerated technological modernisation offer tangible economic benefits and are also the key to achieving the energy and climate protection goals.

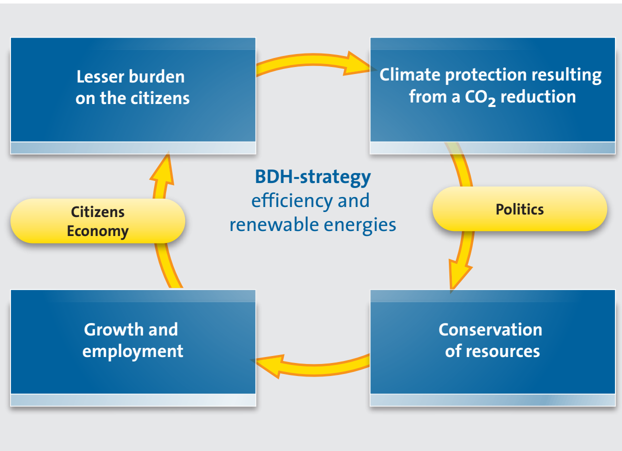


Fig. 4: Win-win situation through accelerated modernisation until 2020

The use of efficient systems and renewable energies in existing building stocks, and the optimisation of systems for industrial heating have a positive effect on the economy through growth and additional employment in crafts, industry and trade. Citizens will be relieved from costs for heating and domestic hot water by the energy savings.
Savings of up to 100 million tonnes of CO_2 per year will help protect the climate. 18 % of Germany's energy consumption makes the greatest possible contribution to the strategic protection of resources.

Technological progress for more efficiency and renewable energies

In the past 30 years, efficiency improvement potential of over 30 % could be achieved in heat generators, as well as in the field of air conditioning and ventilation through intense research and development effort of the German industry. If renewable energies are coupled, the efficiency gains are up to 40 %.

Thus, the utilisation ratios in the use of condensing technology have now reached their physical limit. Besides efficient utilisation of the required current, a large proportion of renewable energies is used while using geothermal energy and environmental heat. Modern low-emission wood boilers and decentralised CHP systems complete the product portfolio.

This leads to an excellent energy balance. The additional use of solar thermal energy in practically all the available systems allows substitution of up to 20 % of fossil fuels.

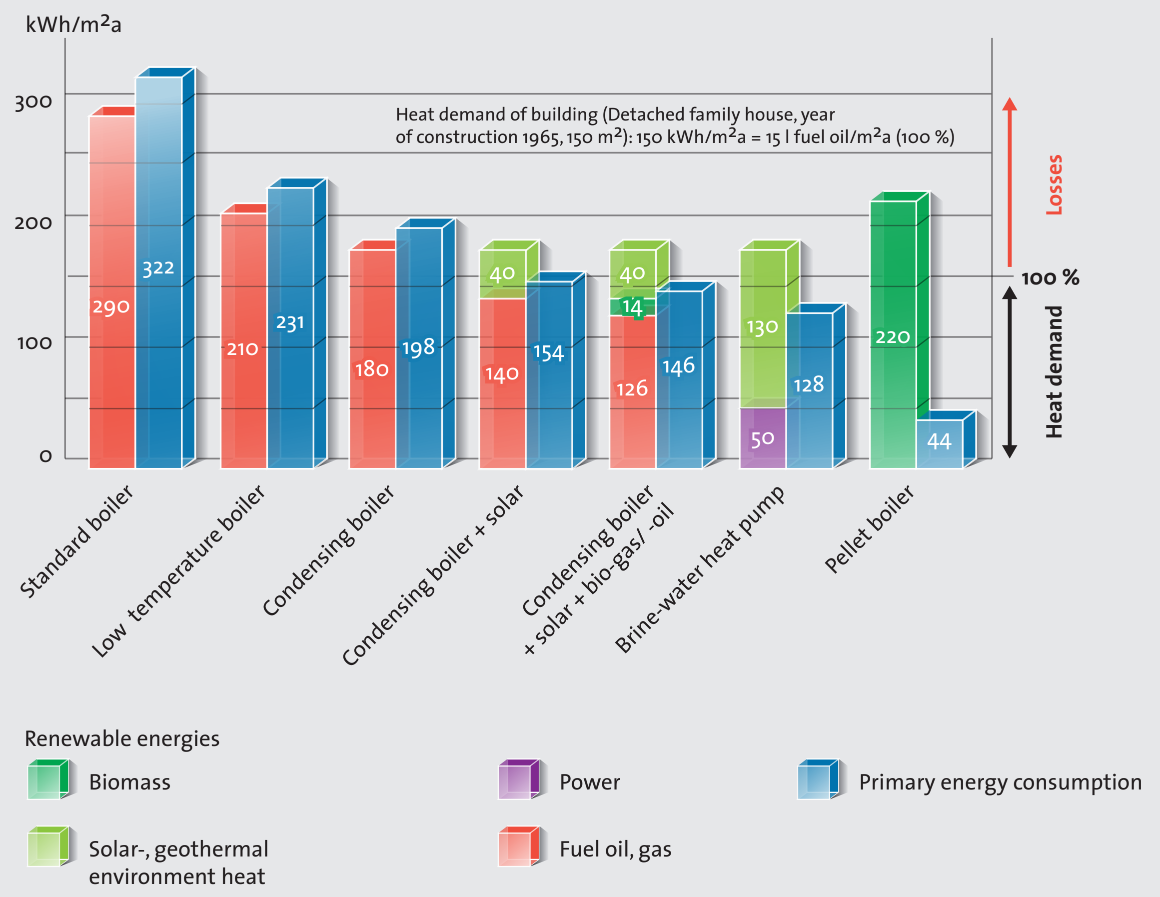


Fig. 5: Final energy and primary energy demand in typical existing buildings

The sector analyzed:

- The backlog of deferred modernization torpedoes resource- and climate protection
- Tenants and landlords can save up to 50 % energy costs
- General political conditions are currently inadequate

The sector recommends:

- Doubling of the modernization speed
- Increasing the proportion of renewable energies in the heating market
- Optimization of the general political conditions
- Increasing and stabilization of promotion
- Use of bio-oil and biogas in the heating market

Europe pro efficiency and renewable energies

As early as 2007, the European Union set itself ambitious energy and environmental policy goals:

- Reduction of greenhouse gases by 20 % by 2020 (increased to 30 % in 2010) compared to 1990
- Increasing the share of renewable energies in energy consumption to 20 % by 2020
- Increase in energy efficiency by 20 % by 2020

For all energy-related areas, namely transport, industry, energy industry and the building sector, the EU has been developing strategies since 2007. Relevant EU Directives and Regulations have to be implemented or applied at the national level.

Four Directives apply to the largest energy consumption sector in Europe, the buildings sector.

EU directives and their relevance for the heat market

The Energy Performance of Buildings Directive, implemented in Germany through the Energy Conservation Regulation (EnEV) includes establishment of minimum standards on the energy quality and / or the primary energy consumption of buildings.

It sets the prerequisite of an energy performance certificate for buildings as well as regular inspection of the facilities.

Energy Efficiency Directive

By implementing the Directive, the utility providers (natural gas, oil, electricity) should achieve energy savings for their customers in the private and public sectors, each with different percentage points per year.

Directive on Ecodesign requirements for Energy relevant Products, ErP, and Labelling Directive

As part of the so-called lots, all heat generators should meet the Ecodesign criteria and will receive a Consumer Energy Label analogous to white goods on the basis of energy efficiency criteria. This applies to both the building heating and for domestic hot water heating in the building. This instrument will have a strong impact on the market development and efficiency technologies.

The state of the art should be at least marked with an A and systems that additionally use renewable energies with an A+ or A++.
By using the so-called package label, providers (from the trade and industry) and technicians can configure heating systems, for example, consisting of condensing technology and solar, as a package label with appropriate markings. These can reach up to A+++.

The coming months and years will create one of the biggest challenges for trade and industry in this sector. For the instrument to produce a positive impact, product and installer labels must be brought to the market as soon as possible by the expert groups.

With proper design and application of the labelling system, the efficiency technologies and renewable energy technologies described in the brochure will benefit fully.

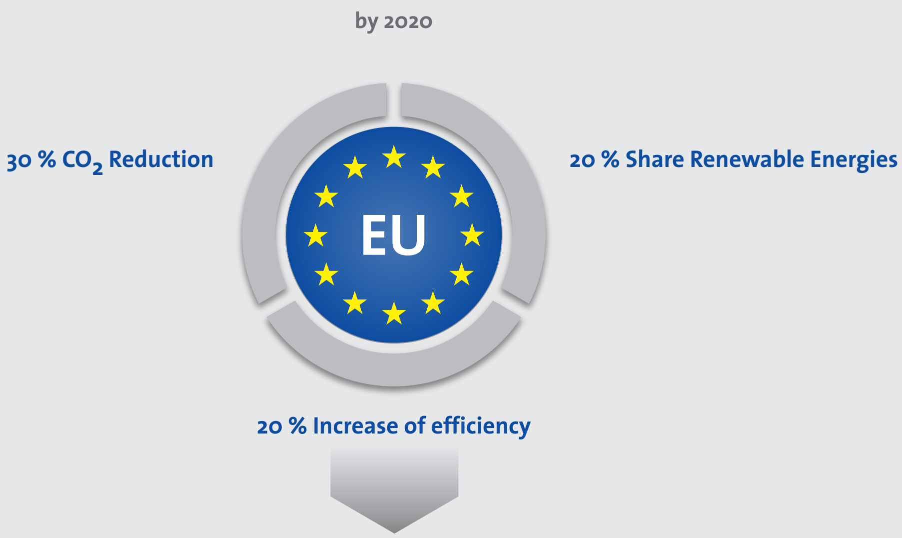
The perspectives of the European market

Europe has a legal framework such as ErP / Labelling Directive and EPBD, which give clear advantages to efficient systems in contrast to inefficient technology. Thus, for example, in southern Europe in recent years, substantial proportions of condensing technology could be achieved (between 20 and 30 % compared to almost 0 % five years ago).

The air-water and brine-water heat pumps also recorded successful growth continuously for years, particularly in central and northern Europe. The use of solar thermal energy remains on a growth course with focus on Germany. The centralised heating boilers for solid biomass gain in importance, especially in Germany, Austria, Switzerland and Italy.
All in all, the course of the EU towards greater efficiency in the existing building stock is irreversible. Nevertheless, the big modernisation backlog existing in all countries hinders achievement of the objectives of the European Commission by 2020. Therefore, the industry calls for a more attractive policy of incentives to induce investors to the long-overdue modernisation projects in agreement with, for example, the German government.

Non-European markets with high growth

Especially Russia and China record high growth rates in the buildings sector. The European heating industry with its efficiency technologies for new construction and renovation profits from this dynamism in particular.



Relevance for Buildings and Products

Energy Performance of Buildings Directive, EPBD

The EPBD sets a general European framework for the definition of minimum energy performance standards in the buildings of the member countries. Minimum standards and computation methods are defined by the countries individually. It obliges the Member States to introduce energy performance certificates.

Directive on Ecodesign requirements for Energy relevant Products, ErP-/Labelling-Directive

The ErP defines the minimum requirements via the ecological properties of energy consuming and energy-relevant products. These include heat boilers, water heaters, pumps, fans as well as air-conditioning and ventilation systems. The guideline is often linked to the introduction of an energy efficiency label for the concerned products.

Directive on the Promotion of the Use of Energy from Renewable Energy Sources, RES

The RES aims at increasing the proportion of renewable energy sources in the EU substantially. It obliges the member countries to initiate measures by virtue of which the proportion of renewable energies in the EU can increase by at least 20 % on average.

Energy Efficiency Directive

The Energy Efficiency Directive defines obligations for the member states. Public sector buildings are required to reduce energy by 3 % per year, private buildings by 1.5 %.

Fig. 6: Framework conditions for the EU heat market

Biogas from biomass

Biogas is produced when organic material, the so-called biomass, decomposes anaerobically. Anaerobic bacteria, which can live without oxygen, are responsible for it. Biomass also includes fermentable waste material containing biomass, such as sewage sludge, biowaste, manure or plant parts. Biogas consists mainly of methane and carbon dioxide.

Bio-natural gas can be fed to the gas grid and increases the use of renewable energies

But only methane is valuable for energy generation: The higher its proportion, the more energy-rich is the biogas. However, carbon dioxide and water vapour are not usable. Biogas is produced in large fermenter systems, in which micro-organisms convert biomass, so as to develop biogas as a metabolite. In order to use this gas for heating purposes or power generation, it is dried, filtered, and desulphurised. It is also purified to remove trace gases.

Closed material cycle

The treatment of biogas comprises primarily the reduction of CO_2 and O_2 content. A common treatment method is gas scrubbing with which CO_2 is separated, so that the proportion of methane in the raw material increases. The gas scrubbing process is based on an absorption process with water or special detergents. Pressure change adsorption – an adsorption process with activated carbon – represents another cleaning process. There are also other methods, such as cryogenic gas separation, which is carried out using cryoenergy. Gas separation through a membrane to make biogas usable for various applications is currently being developed.

Before being fed into the natural gas grid, biogas should be compressed to the appropriate operating pressure and processed to grid quality. High compression is necessary also for use as fuel. If the biogas is to be used as fuel, both hydrogen sulphide and ammonia should be removed before the combustion process, so as to prevent damage to the gas engines. The biomass leftover from the fermentation is highly suitable as an organic fertilizer, hence a closed material cycle is present here.

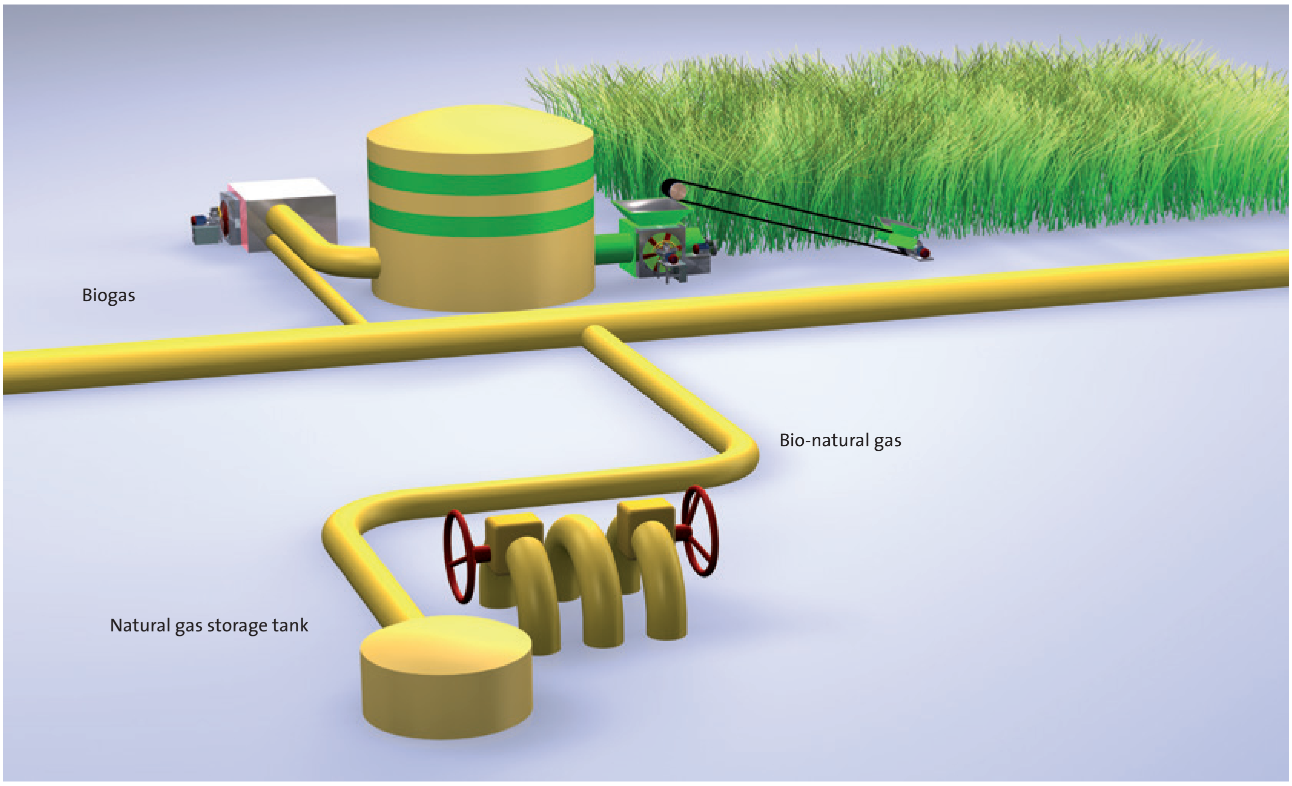


Fig. 7: Production and transport routes of biogas/bio-natural gas

Using existing structures

Since 2007, biogas is mixed with conventional natural gas and fed into the natural gas grid. It is spoken about bio-natural gas in this case. It passes through the existing infrastructure to the users. Because bio-natural gas has the same quality criteria as natural gas, it can also be used flexibly, e.g. in gas-fired condensing boilers, cogeneration of heat and power systems or as fuel in natural gas vehicles. Bio-natural gas reduces the CO_2 emission significantly by up to 65 % in a natural gas car.

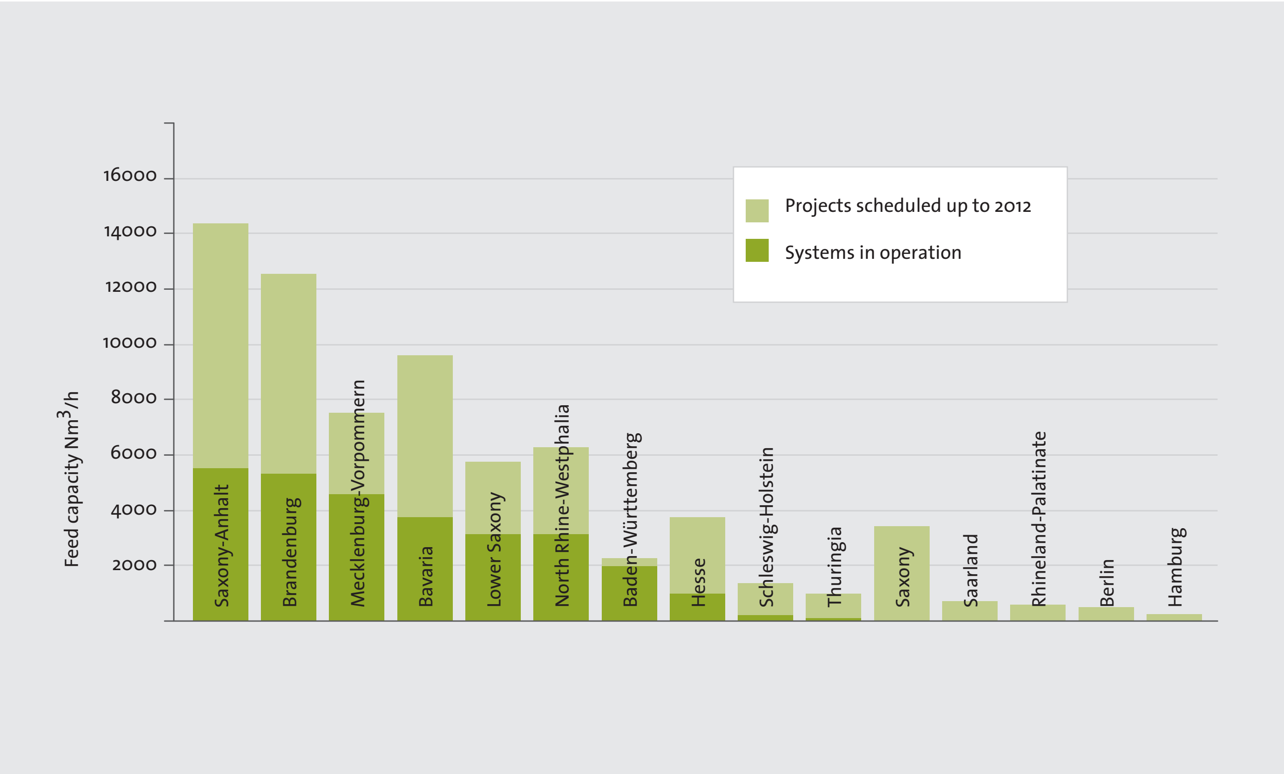
Through the increased supply of biogas, natural gas consumers switchover gradually to renewable energies. By 2030, up to 100 billion kWh bio-natural gas could be produced per year, which corresponds to approximately one tenth of the natural gas consumption in 2005.

Energy mix of the future

Biogas has a high area efficiency. Biogas can be produced continuously throughout the year and can be stored as simple as natural gas.

Due to the non-dependence on wind or sunlight, biogas will play a key role in the energy mix of the future.

Biogas is also carbon dioxide neutral: During combustion only as much carbon dioxide as that removed by the biomass from the atmosphere is released. Biogas simultaneously reduces dependence on imports of fossil fuels and contributes to the local economy. By 2020 the German gas industry sees itself obliged to mix around 20 % bio-natural gas with the natural gas used as fuel.



Source: German Energy Agency (dena)

Fig. 8: Bio-natural gas feed systems in Germany, Version: November 2010

Liquid fuel can be extracted from plants

Many energy-rich and oleaginous plants, such as rapeseed or sunflower can be used for energy purposes, i.e. for electricity, heat and fuel production. Therefore, liquid fuels from biomass are already added to conventional energy sources regularly.

Bio-heating Oil Contributes to Reduction in the Demand of Heating Oil

One example is the so-called “bio-heating oil”, which has been on the market for a few years now. Bio-heating oil is a low-sulphur heating oil, to which at least three percent by volume of a liquid fuel from renewable resources is mixed – currently, it is bio-diesel in most cases.

High efficiency and sustainability

Bio-heating oil can significantly help to reduce the demand for mineral oil, reduce greenhouse gas emissions and conserve resources. However, sustainable cultivation of raw materials and the most efficient use of the fuel are prerequisites for such benefits.

In the process, increasing the efficiency has priority over the proliferation of bio-heating oil in the heating market as before. This is because the ambitious climate protection goals can be achieved only with a mix of highly efficient heating technologies and renewable energies. In addition, the renewable resources do not have unlimited availability – and therefore, they should not be wasted in inefficient heating systems.

The petroleum industry has expressed its commitment to the goals of sustainability regulation: Bio-components must have been produced and certified in accordance with recognised social and environmental standards. Two aspects are important here: On the one hand, the production of energy crops should not compete with the production of food – our bio-fuel should not be responsible for a rise in prices of basic food products for people in the producing countries. And secondly, the use of bio-components must actually lead to reduction in greenhouse gas emissions at the end of the production process.

FAME as bio-components in heating oil

There are several ways to produce liquid fuels from biomass. Thus, one uses today vegetable oils and esterified vegetable oils (known as fatty acid methyl ester, in short “FAME”) as the “first generation bio-fuels”. Cracked and hydrogenated vegetable oils and animal fats (so-called hydrogenated Vegetable Oils, in short “HVO”) and synthetic oils from biomass (so-called biomass-to-liquids, in short “BTL”) are “bio-fuels of the second generation”. Currently, FAME is mainly used as a bio-component in bio-heating oil – better known as “bio-diesel” to consumers. Here, the oily ingredients are squeezed out, melted or extracted from plants, such as rapeseed or sunflower, using solvents and finally refined.

FAME is similar to low-sulphur heating oil in its properties. A combustible mixture of a conventional, low-sulphur heating oil and a bio-component such as FAME is technically, relatively quick and easy to produce. The properties of FAME are standardised in

Product / Feedstock	Oil-seed and oil-bearing fruit (e.g. rape-seed and sunflower)	Animal fats, used cooking oil	Vegetable matter, waste and slurry
Vegetable oil			
FAME			
Hydrogenated vegetable oils (HVO)			
BtL (Biomass-to-Liquids – second generation)			

Fig. 9: Possible feedstocks for liquid biofuels

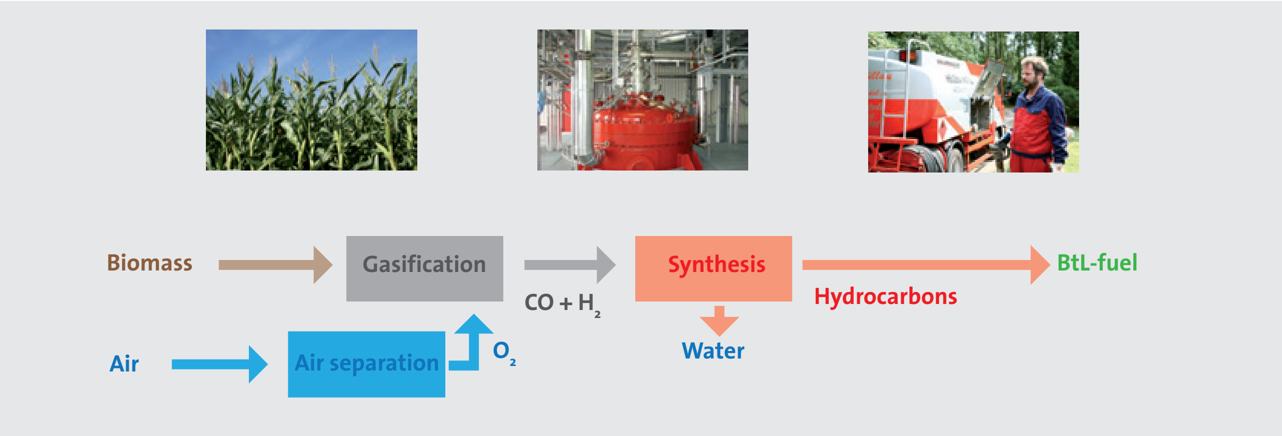


Fig. 10: Manufacture of BtL fuels

DIN EN 14214 / Nov 2012 edition. Bio-heating oils are already offered with a FAME admixture in the heating market today. The label for bio-heating oil is according to the standard "heating oil EL A Bio". "A" stands for "alternative".

Application in oil heating systems

Extensive research has been undertaken to facilitate safe use of liquid bio-fuels in the approximately six million oil heating systems in Germany. Today, with bio-heating oil, the consumer can increase its share of renewable energies in heating supplies quickly and without major investments.

Low-sulphur heating oil with up to 10.9 % by volume of fatty acid methyl esters (FAME) can be used in an oil plant without loss of operational safety, according to the heating devices industry. However, the use of low-sulphur heating oil with greater than 5 % by volume of FAME may require special measures at the oil plant due to the materials used.

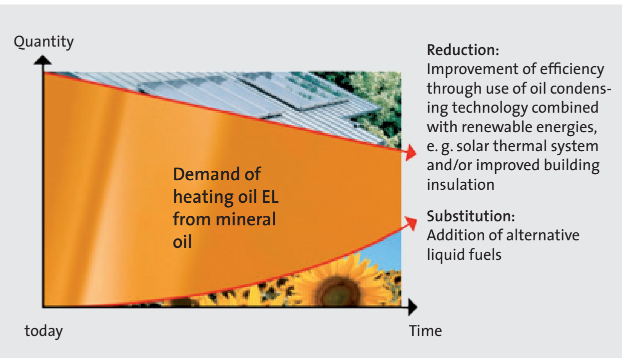


Fig. 11: Future perspective for liquid fuels

The manufacturer's specifications are decisive here. Moreover, the Institute of Heat and Oil Technology (IWO) has drafted important instructions for installation in cooperation with the heating industry.

Liquid fuels of the second generation

A new technology to produce liquid fuels from biomass is cracking and hydrogenation of vegetable oils and animal fats. The result is an ultra-pure bio-fuel free of sulphur and aromatics (so-called Hydrogenated Vegetable Oils, in short "HVO").

Another method uses not only the oils and fats, but also processes complete plants such as straw, wood residues, or the so-called energy crops to produce liquid bio-fuel synthetically (Biomass-to-Liquids, BTL). For this purpose, the biomass is converted to a synthesis gas by the gasification and then liquefied (Fischer-Tropsch process). The result is again an ultra-pure bio-fuel free of sulphur and aromatics.

This technology has a few advantages compared with the aforementioned manufacturing method: On the one hand, the total biomass can be used, and not only its oily components. In addition, the yield per hectare of energy crops increases in this way. Furthermore, specific properties can be generated during the production process, so that not only very high quality fuels are produced, but also such fuels that are adapted exactly to the subsequent application .

According to current findings, these second-generation fuels are used even in existing oil heating systems without any problem and can be easily added to conventional fuels. However, no significant production capacity for liquid bio-fuels of the second generation has been recorded so far: Its field of application is limited currently to the fuel sector, as the use of bio-components in the fuel is mandatory there.

Wood is on the rise

Wood is becoming more and more attractive as fuel: Wood has a very good life cycle assessment and a nearly constant price trend. In addition, wood is a regional renewable fuel, and thus the economy can benefit from short transport routes, local jobs and domestic value creation. So, there are good reasons to believe that nearly 20 % of households in Germany rely on wood for heat generation. A fifth of these consumers even have centralised wood-fired heating, which is also used for domestic hot water heating.

Almost 20 % of households in Germany use wood for heat generation

No wonder: Modern automated fireplaces now make operation as comfortable as never before. Wood is hardly inferior to the traditional fuels, oil or gas, in terms of its comfort.

Good for the forest – good for climate

Each year more than 380 million m³ of wood produced sustainably from European forests is on the market. 40 % thereof is now used for heat generation in Europe.

The use of wood is, on the one hand, good for forest tending and protection: Only a forest that is thinned out well is stable and resistant to environmental impacts. Thus, the increased use of wood as fuel avoids ecologically non-beneficial overageing of forests.

On the other hand, the use of wood is also good for the climate. Wood is carbon neutral as a renewable resource: When burned only the amount of CO_2 that was absorbed by the tree during its growth is released.

Pellets, split logs and wood chips

Modern heating systems use the energy carrier wood in the form of pellets, wood chips or split logs.

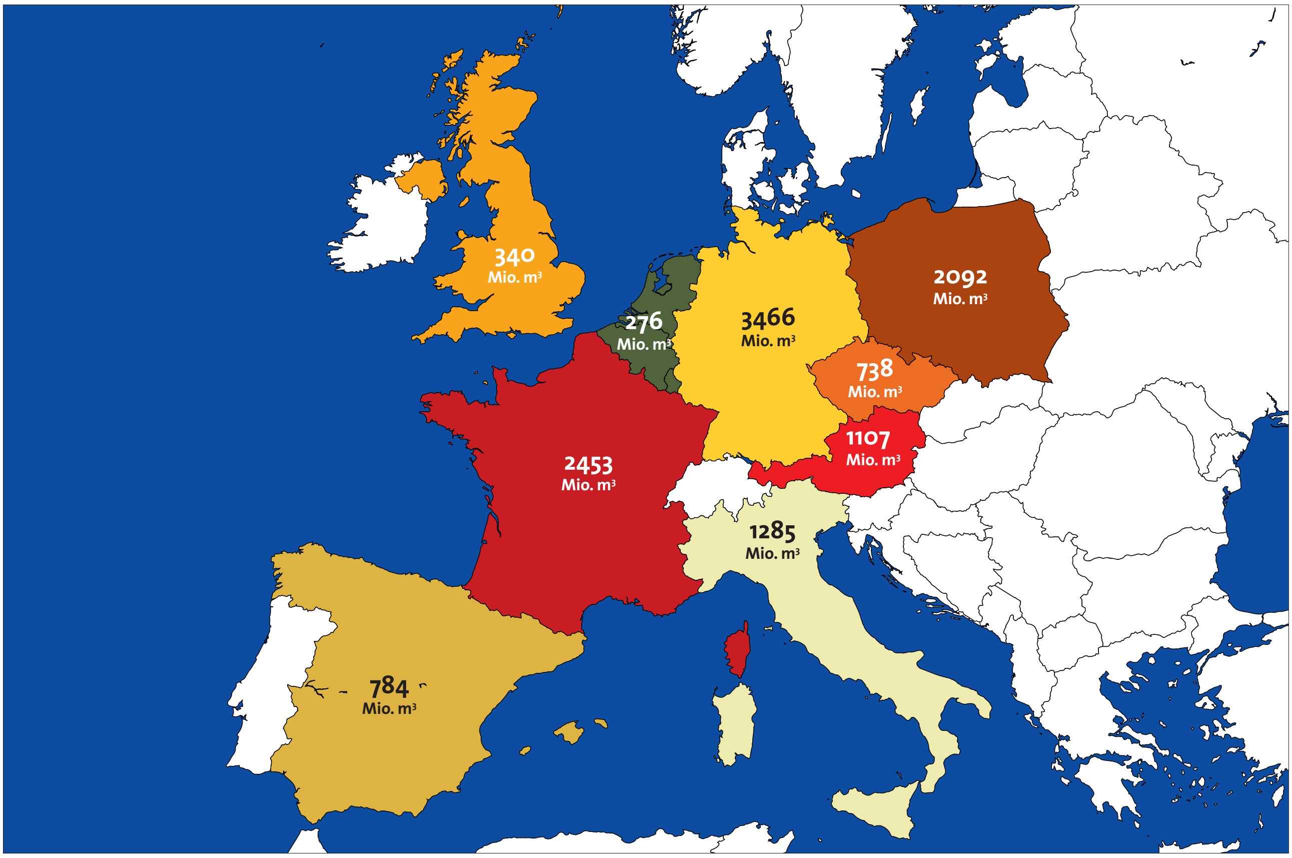


Fig. 12: Wood reserves of selected European countries in 2009. Source: Eurostat

Fig. 13: Pellets

Fig. 14: Logs

Fig. 15: Wood chips

Wood pellets are small, standardised, cylindrical pellets made from natural, untreated wood. In order to produce pellets, the wood chips occurring in the sawmill are first dried, then cleaned and pressed into pellets in matrices. The chips join naturally, owing to their own lignin.

The production of pellets often takes place directly in the sawmill. 2 kg wood pellets correspond to the energy content of about 1 litre heating oil.

Split logs are also increasingly used for heating in the last few years. Basically, any tree species is suitable for this purpose. However, the wood should be dry. 2 years storage in air under rain water protection is ideal.

Wood with a water content between 15 and 20 % has an average energy value of 4 kWh/kg.

Wood obtained from the extraction of timber, as well as weak and crooked logs are cut to the desired length and split. Better drying and combustion are attained by splitting wood.

Wood chips are manufactured in various ways. Coniferous wood log pieces that occur in the saw mills and are not usable for any other processing are crushed directly. They can be used as fuel for boilers in a size of 10 to 50 mm per piece.

Another option for the production of wood chips is crushing of otherwise unusable roundwood in the forest.

Since 2012, there is a European standard (EN 14961-2) defining the product for all wood fuels. This standard has also been implemented in a separate certification for pellets (ENplus seal).

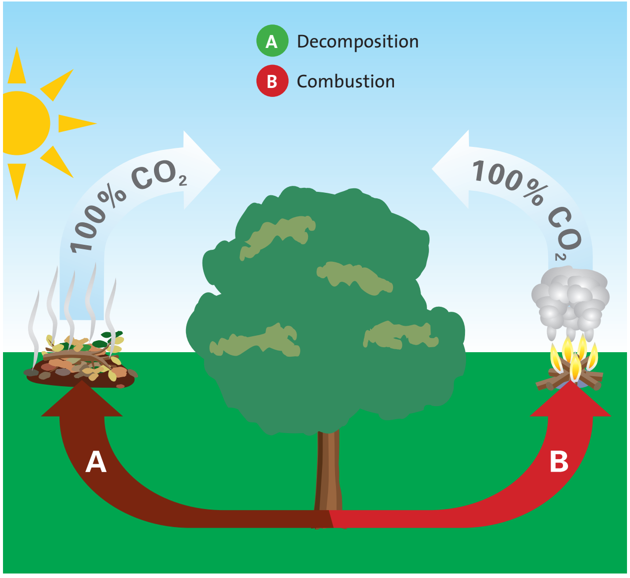


Fig. 16: The CO_2-neutral cycle

Sustainably available

Wood is also used for electricity generation in power and combined heat and power stations in some EU countries.

Since the turn of the century, the forest area in Germany has grown to about 235,000 hectare. Therefore, timber growth per hectare is over 11 m³, this results in a wood reserve of 3.6 billion m³. This puts Germany in Central Europe as a frontrunner, even ahead of the “traditional” forest countries such as Finland and Sweden. One reason is sustainable management, in which only as much wood is harvested as will grow. This economic mode of operation was first described in 1713. In Germany, it has led to a strict forest legislation.

Sustainable forest management is now firmly anchored in Europe through certification systems. The use of wood to generate heat should be increaed by 2020 in the EU on grounds of climate protection.

Petroleum remains available for the long term

Petroleum is still the "lubricant" of the world economy, its share in global primary energy consumption is about 35 percent. Fuels, plastics, chemicals, and last but not the least, the heating oils are extracted from it. The greater is the concern that this important commodity would become scarce in the foreseeable future. Luckily, it is not justified: The petroleum supply is safe in the long term – this is supported, among others, by the current data documented by the Federal Institute of Geosciences and Natural Resources (BGR).

The reserves of oil and natural gas known today will last longer than 50 years

The overall potential of the currently known oil reserves are estimated at 627 billion tonnes in accordance with BGR calculations. "Reserves" refer to oil reserves, which are clearly confirmed by drilling, and are economically recoverable using existing technology. "Resources" refer to geologically known conventional oil reserves that are not yet confirmed by drilling, as well as "unconventional resources" such as oil sands, oil shale and heavy oils, which cannot be economically extracted yet using existing technology.

Oil reserves increase since the start of mining

Confirmed oil reserves are estimated currently at 217 billion tonnes worldwide in accordance with BGR data – as high as never before! By the turn of the millennium, there were still 140 billion tonnes. Thus, the oil reserves have increased significantly within a decade, even though the oil consumption has increased. This is partly due to the discovery of new deposits, and partly to technical and scientific progress.

Thus, new techniques such as 3D seismic technology and the use of satellites enable better survey of known oil deposits and easier detection of new oil deposits. In addition, the use of new technologies lead regularly to the fact that former resources become confirmed, recoverable oil reserves. Moreover, the exploitation rate is increased continuously in the already explored oil deposits.

At the same time, offshore recovery explores new deposits: Still very large deposits are expected especially in the shelf areas of the continents. Also horizontal drilling at great depths is already controllable and successfully used. The latter, in combination with the fracking process, allows the exploration of significant shale gas and shale oil reserves in the USA.

Thanks to this development, the U.S. will probably become the largest oil and gas producer in the world as early as 2020 – and develop itself to be an energy self-sufficient net exporter by 2035.

Source: Federal Institute for Geo-Sciences and Natural Resources "Reserven, Resourcen und Verfügbarkeit von Energierohstoffen 2010", a short study. Image: IWO

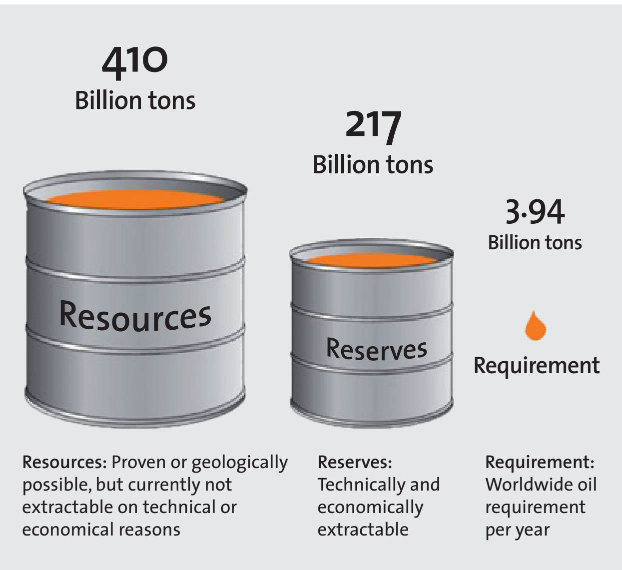


Fig. 17: Worldwide oil reserves, resources and demand 2011

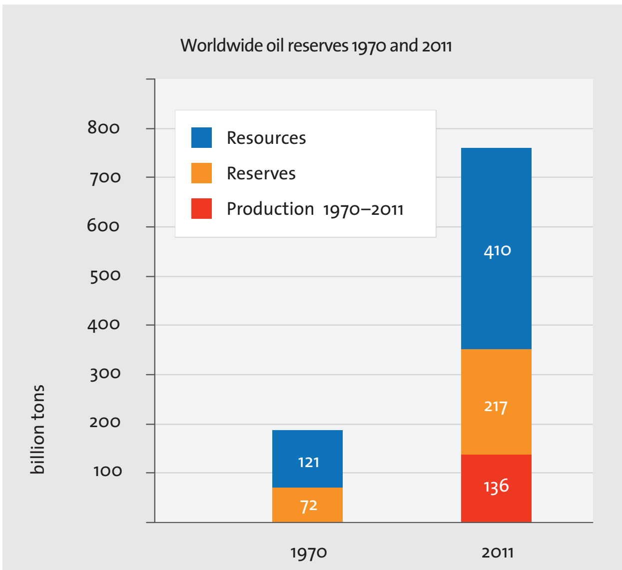
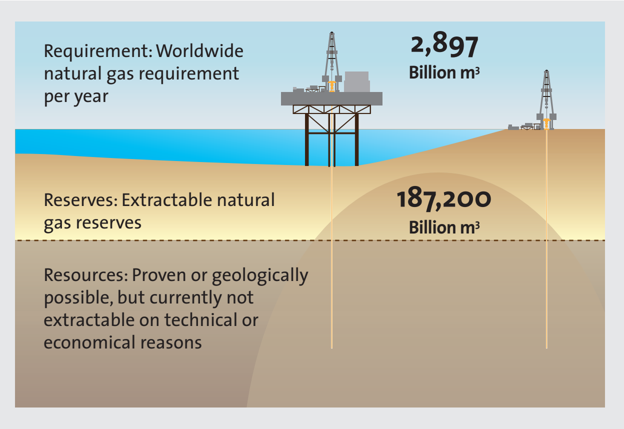


Fig. 18: Never before there were so many known oil deposits as today

Natural gas in various forms,

Natural gas is a combustible gas that is formed from dead marine micro-organisms in the absence of air, high temperature and high pressure. Natural gas can also be recovered from unconventional deposits using more sophisticated techniques, e.g. from coal seams, where it is adsorbed in the porous coal. It is released during coal mining and in the course of microbial processes. The essential component is methane (CH_4). Today, unconventional natural gas occurs primarily in the United States in large quantities as “shale gas” and is recovered. This does not include “natural gas hydrate”. Natural gas hydrate is a snow-like compound which is composed of natural gas and water and is stable up to a temperature of 20 °C. In Siberia, there are larger deposits, even on the seabed. However, there is currently no suitable technology to process these resources economically. Natural gas is transported through a pipeline or as liquefied natural gas (LNG). LNG refers to natural gas that is liquefied by cooling to -164 to -161 °C. LNG is becoming increasingly important as a medium suitable for transport.



Sources: Oil & Gas Journal 2010, E. ON Ruhrgas

Fig. 19: Worldwide reserves and extraction of natural gas

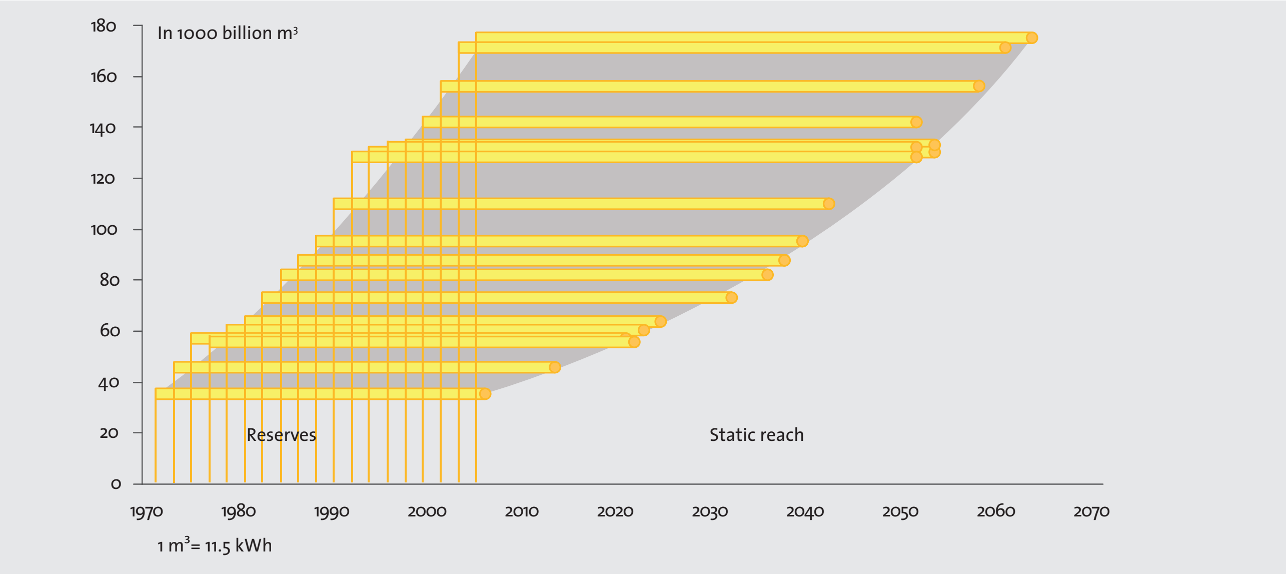
Current oil expanse is only a snapshot

The currently known crude oil reserves would last more than 50 years if one assumes the current global oil consumption to be nearly four billion tonnes per year. However, this very simple calculation represents only a snapshot and is less plausible on the whole.

In fact, the period should be significantly larger: Finally, only the deposits that are currently confirmed by drilling and are economically recoverable using the means available are considered in today’s estimate of the oil reserves.

The oil resources, whose recovery is not yet profitable using existing technology, are not included in the estimation of the oil expanse, although its potential is enormous: BGR estimates the known oil resources currently at 410 billion tonnes.

With a share of about 24 % of the global primary energy consumption, natural gas is the third largest source of energy. The findings on availability vary similar to those of petroleum. The worldwide reserves were about 187 trillion m³ at the end of 2009.



Source: E. ON Ruhrgas

Fig. 20: Never before there were so many known gas deposits as today

Examples of modernisation

Using potential, increasing efficiency

Buildings are the largest energy consumers in Germany and Europe: Residential buildings and offices as well as warehouses, hospitals and schools. Their final energy demand in Europe is around 40 % of total consumption.

About 85 % of this demand will be needed to cover the heating load and domestic hot water heating. The energy efficiency of buildings in Europe is still very low. The result: Energy consumption is twice as high as it could be in the current situation.

This is no accident: Investment in residential buildings has been low over the past few decades. Obsolete heating systems with unnecessarily high energy consumption, poorly insulated windows and doors and uninsulated buildings are still very common. This modernisation backlog of existing building stock should be resolved according to the EU.

Energy consultancy helps to increase the low energy efficiency of buildings in Europe

There is need for action: In the last ten years, energy costs have risen sharply. Those who do not invest in their building, pay extra in the long term. Therefore, European policy is keen to improve energy efficiency in the building sector fully since the beginning of the millennium. With various statutory provisions, the building sector should significantly contribute to the overall objective of the EU to achieve 20 % energy savings by 2020. State funding assists owners in energy-efficient construction and renovation.

Making energy consumption comparable

One of these rules at the EU level is the 2010/31/EU Directive (“EPBD Energy Performance of Buildings Directive”) on the total energy efficiency of buildings. It forms the basis for the widespread introduction of energy performance certificates in the Member States.

Energy performance certificates assess buildings in terms of energy demand or consumption – regardless of whether it is a residential building, a factory or an office building. During the construction, renovation, extension, sale and re-leasing of buildings, it is meanwhile mandatory to issue an energy performance certificate for the building.

Energy performance certificate is mandatory

Purchasers, tenants or also lessees of land, houses or apartments should produce an energy performance certificate when requested. In Germany, this requirement is implemented by the Energy Conservation Regulation. It also relates to public buildings such as offices or schools with an area of more than 500 m²: They must display their energy performance certificate noticeably in the building.

The energy performance certificates for new construction or renovation of buildings should be created on the basis of energy demand.

Help and advice for builders and owners

Energy performance certificates may be issued in Germany by qualified energy auditors according to Energy Conservation Regulation. Therefore, for example, by engineers and architects, who have acquired the expertise required through their activities or specialised training. However, they also include the certified “building energy consultants (HWK)” as well as other experts who can demonstrate appropriate specialised training. About 15,000 qualified energy consultants, who have the state-recognised qualification, are currently working in Germany.

How to modernise

Technical support is required for those who plan extensive modernisation measures or want to exchange their heating system. The high demands for thermal protection and energy saving in the EU Member States also make professional energy consultancy increasingly necessary.

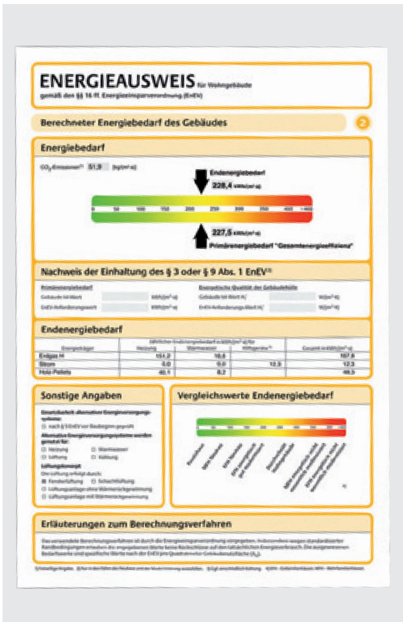
Energy consultants determine the actual energy status of the building at first. Based on this, they then come up with proposals for modernisation measures that improve the quality of the building and the heating technology, as well as increase cosiness and comfort. These measures help property owners reduce their energy consumption specifically, protect the environment, while maximising the value of the building.

Thus, energy performance certificates and consultancy give rise to new impetus to the modernisation market constantly.

Source: Bausparkasse Schwäbisch Hall

Fig. 21: Thermo-graphic image of a house

Fig. 22: Energy consulting



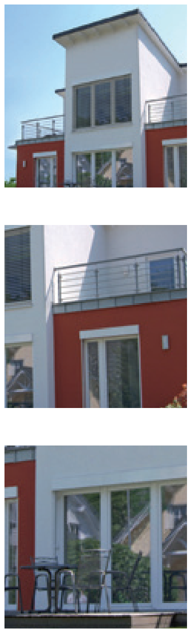


Fig. 23: Sample of energy performance certificate

Initial situation

The energy efficiency of the existing German building stock is low. This is due to outdated heating technology and inadequate insulation standards.
Only about 14 % of the approximately 20 million heating systems installed in German residential buildings correspond today to the state of the art – i. e. use fossil fuels in a highly efficient manner and couple renewable energies. In this way, energy-related (percentage) utilisation ratios of up to 98 % and continued high substitution effects can be achieved even today through the use of renewable energies.

For an efficient heating system, all components must be matched.

Even with an energy-related modernisation of the approximately 87 % technologically obsolete existing systems in Germany, the biggest part of the energy savings and CO_2 reduction potentials in the existing building stock could be achieved.
Here, technical modernisations are usually characterised by very favourable cost/benefit ratios when compared with measures at the building envelope.
Currently, the technical modernisation rate stands at just 3–4 % per year. When extrapolated, it still takes more than 30 years for the existing systems to correspond to the state of the art.

Energy efficiency and renewable energies

In new construction and renovation of old buildings, there are optimal heating technology system solutions today for all fuels. Therefore, the right system in the end always depends on the framework conditions: The heat load of the building, its purpose of use, the alignment, the lands and, of course, the preferences of investors should be especially considered here.
The systems presented in this brochure for the supply of buildings with heat, domestic hot water and apartment ventilation are internationally valid as state of the art. They convert fuels such as gas, oil and electricity very efficiently into heat and already use renewable energies during this process.

The system concept is always at the forefront

All the components of the heating system must be perfectly matched to be able to realise the energy-saving potential of modern heat generators completely. Therefore, heat generation, storage, distribution and transfer are to be considered always as a total system.

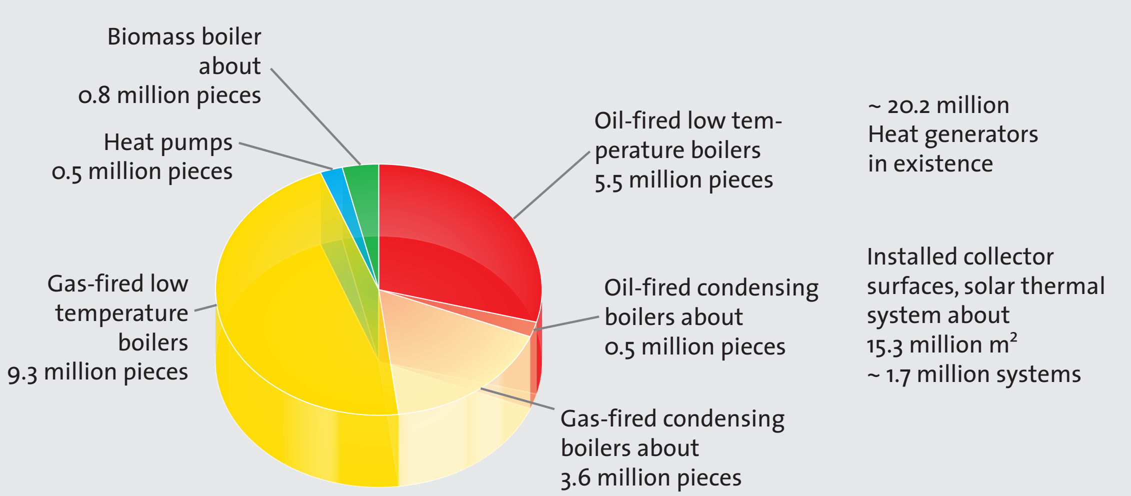


Fig. 24: Total number of centralised heat generators in Germany (2011)

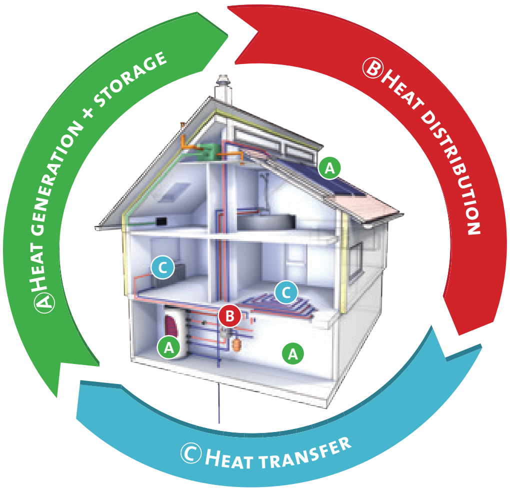


Fig. 25: The system concept is at the forefront

Heat generation and heat storage

Heat generation is the starting point for the operation of the heating system: In a centralised heat generator, the energy carriers (gas, oil, wood or electricity) used will be converted into heat. This is then used for heating and/or domestic hot water preparation. Thus, it becomes the link between the primary energy and the desired effective energy. Moreover, other energy sources such as solar thermal energy or wood in a pellet or wood burning stove with collection basin can be integrated.
Installing a storage tank is pays off as the heat provided by the heat generator is not always immediately used at 100 %. Domestic hot water storage tanks are today a central component of the heating and hot water supply system in residential and office buildings.
Thanks to their great diversity of types, they can perform different functions.

- Domestic hot water storage tanks store the heated domestic hot water which is needed for showering, bathing or cooking.
- Buffer storage tanks ensure that the heating system is securely supplied with hot water for a long time. Thus, they allow coupling of heat from renewable energies and CHP systems.
- Combination storage tanks combine both functions together.

The energy losses are kept low through minimal thermal loss and an optimised heat transfer and temperature gradient. In this way, hot water storage tanks enable the reliable supply of domestic hot water and energy at intervals of demand and supply of heat.
A special feature is shown by decentralised cogeneration of heat and power plants (CHP), which are also known as "power-generating heating systems": They produce heat and electricity simultaneously.

The scope of this technology extends from the small single-family house (micro-CHP systems, up to 2 kW_{el}) through apartment houses and medium-sized businesses (mini-CHP plants up to 50 kW_{el}) to the industrial sector. By using such systems, a primary energy efficiency of over 90 % can be achieved.

Fig. 26: Interaction between heat generation and storage

Heat distribution

The heat distribution forms the link between heat generation/storage and heat transfer. Heat distribution system includes heat circulating pumps, the forward and return flow of the hydraulic heating system and the fittings and valves. From January 2013, in accordance with the European Ecodesign requirements, the market has access only to circulating pumps with an energy efficiency index better than 0.27 – the so-called high-efficiency pumps. These are much more efficient and adapt to changing performance requirements of the system continuously. Compared to conventional pumps they use 80 % less electricity.
Optimal distribution of heat in the heating system also requires insulation of the forward and return flow as well as hydraulic balancing of the entire heating system. In order to perform the hydraulic balancing, pre-settable thermostatic valves or radiator lockshield valves on the radiators are required.
Modern thermostatic valves are characterised by presettable valve body and visually attractive thermostat sensors with high control performance. Timed controllers are worthwhile especially for professionals who are away from home almost every day.

One thing is clear: Only efficient heat distribution allows the reduction of system and indoor air temperatures and high controllability of the system.

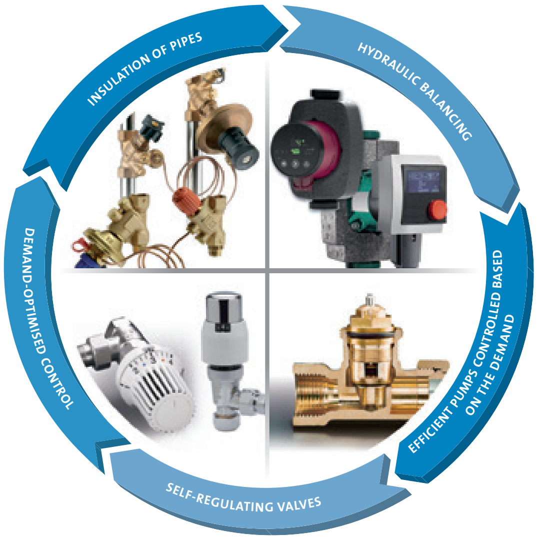


Fig. 27: Influencing factors for efficient heat distribution

Heat transfer

The heat transfer is the link between heat distribution and the consumer. Either an embedded heating system or radiator is available as a heat transfer system.
They can be installed in combination when requested.
Both systems can be combined freely with all types of heat generators of a hydraulic heating system. This makes them sustainable and future-proof.
Low system temperatures in the heating system are a prerequisite to achieve the high efficiencies of heat pumps, gas or oil-fired condensing boilers and effectively integrate solar thermal energy. Large-area and properly installed heat transfer systems ensure and increase the comfort in the room and at the same time the efficiency of the heating system.
The many variations in shape, colour and design of radiators allow the builders and planners an attractive, individual interior design and create new design freedom for the residents. Additional functions and smart accessories such as towel bars or racks, hooks or even lighting allow precise setting of feel-good accents by the radiators.
Embedded heating systems are installed permanently during the construction phase in the floor, wall or ceiling and are an integral part of the building. In addition to the “Heating” function in winter, it can also be used to cool in the summer. Thus, owners consider them as an investment for the future. The large-area installation allows uniform distribution of heat in the room and creates a comfortable indoor climate.

Fig. 28: Influencing factors for efficient heat transfer

Other components of an efficient heating system

Modern flue systems ensure safe removal of the flue gases and low flue gas temperatures. While operating an oil-fired heating system, nowadays modern oil tank systems in various variants are available to consumers.
Solar thermal energy can be used in all types of heating systems for auxiliary domestic hot water and building heating.
Regardless of the heating system, systems with controlled apartment ventilation with heat recovery are nowadays highly attractive in general: They reduce the energy demand and also provide the necessary hygienic air conditions in the building.
Moreover, the use of a photovoltaic system is also possible in every case: The solar power generation can be operated in parallel with all systems mentioned here since the generation of electricity using PV systems always runs independent of the heating system.
Smart control and communication facilities enable the optimal interaction of all components. The heating can be remotely controlled and diagnosed via radio or online access. This makes operation very convenient.
However, the optimised use of modern heating systems should always be considered in agreement with the energy-related quality of the building envelope.

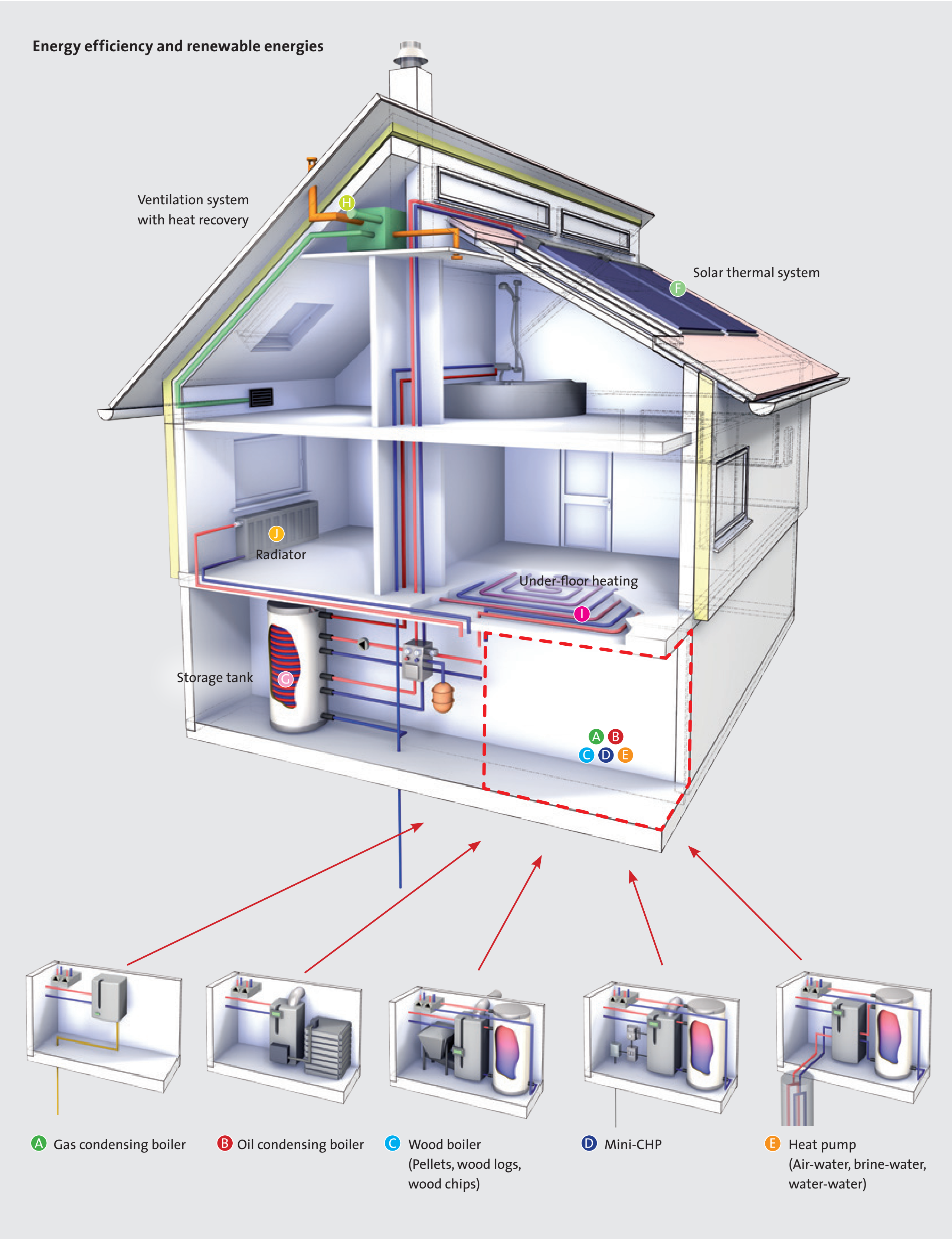


Fig. 29: Modern heating systems

System characteristics

- Ideal for system modernization
- Easy integration of solar thermal systems
- Use of bio-natural gas through gas network possible
- Operation independently of ambient air possible
- Naturalization of condensate not required in one and two-family houses (Worksheet ATV DVWK-A251)

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

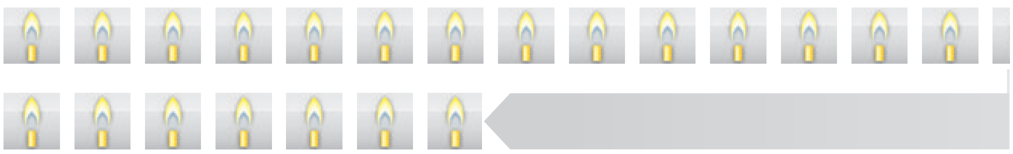
Refurbishment work undertaken

- Modern gas condensing boiler
- Solar thermal system for domestic hot water and heating purposes
- Regulated high-efficiency pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

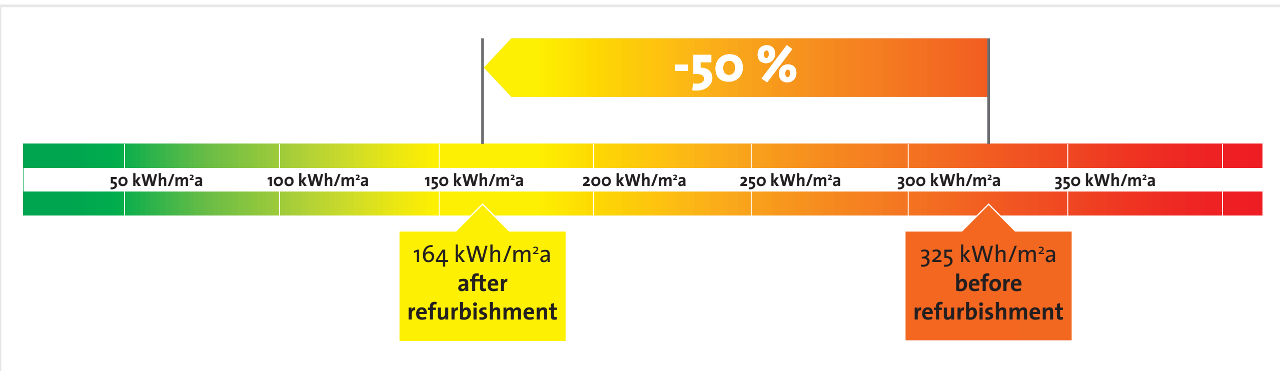
Annual energy demand

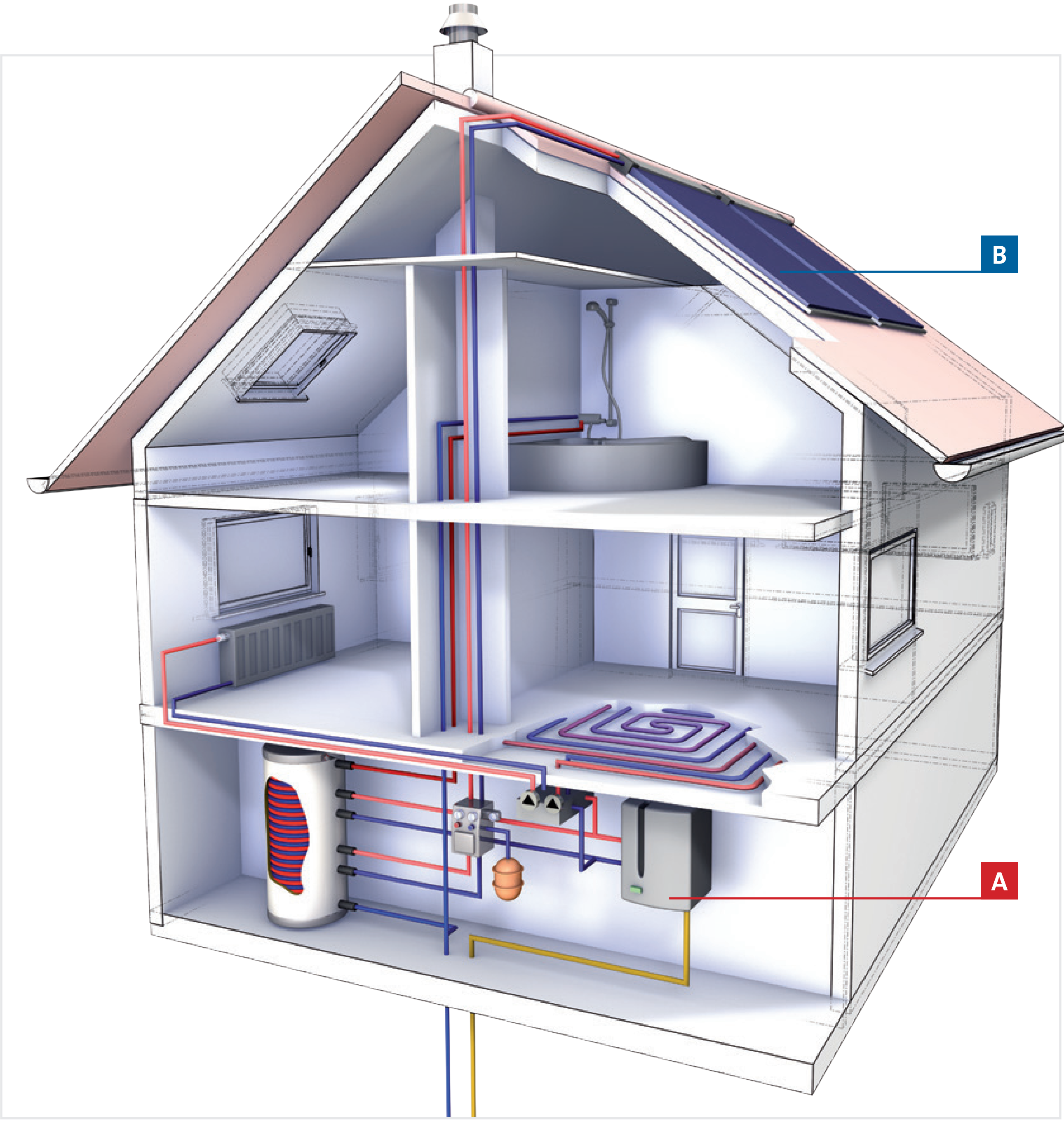
4,290 m³/a
Gas before refurbishment

2,092 m³/a
Gas after refurbishment



Annual primary energy demand





Modern gas condensing boiler

Solar thermal system for domestic hot water and heating purposes

System condensing technology with apartment

System characteristics

- Ideal for system modernisation
- Gas/oil condensing technology as centralized heat generator
- Use of solar thermal system to support domestic hot water preparation
- Controlled apartment ventilation with heat recovery ensures high air quality in the building and minimises ventilation heat losses
- Use of bio-natural gas via gas network or mixing of bio-oil is possible

Example of modernisation: Detached apartment block

- Partially refurbished building, constructed in 1970
- Floor area 8 x 82 m²
- Type of construction solid walls/render
- Old gas/oil boiler

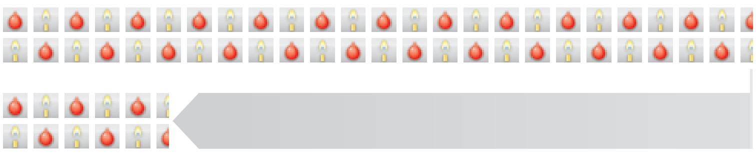
Refurbishment work undertaken

- Modern gas/oil condensing boiler
- Solar thermal system for domestic hot water
- Controlled apartment ventilation with heat recovery
- Renovation of building shell according to the KfW-Effizienzhaus-100 standard
- Regulated high-efficiency pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

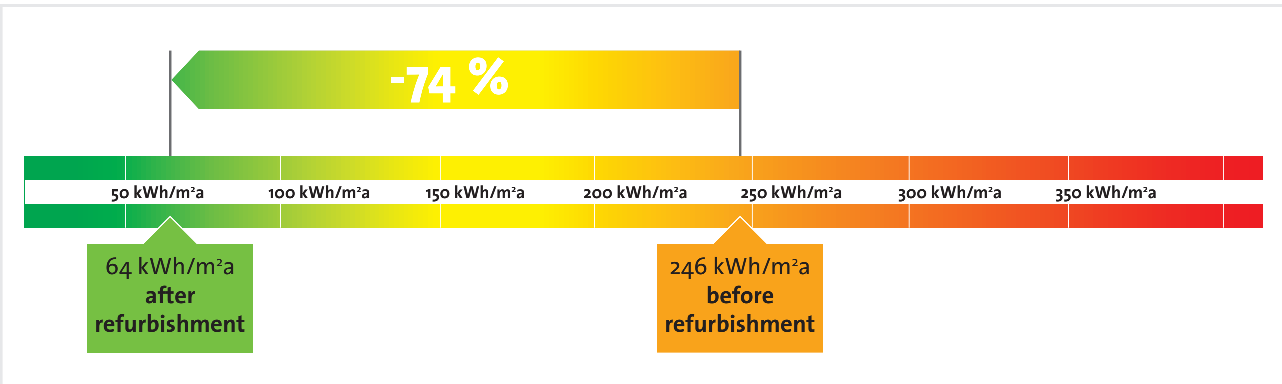
Annual energy demand

14,700 m³/a (l/a)
Gas (oil) before refurbishment

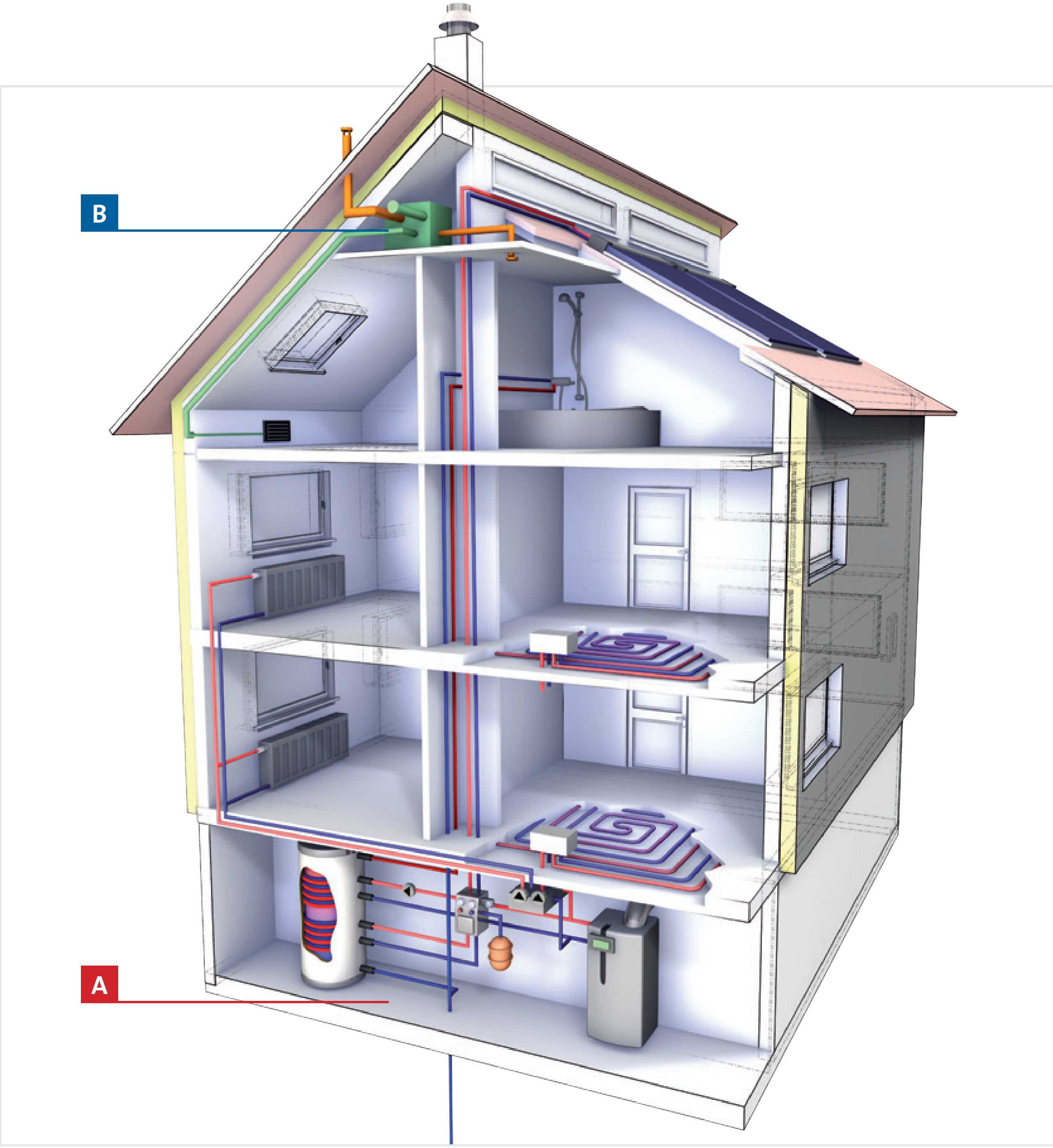
3,300 m³/a (l/a)
Gas (oil) after refurbishment



Annual primary energy demand



VENTILATION IN MULTI-FAMILY HOUSES



Modern gas/oil condensing boiler

Controlled apartment ventilation with heat recovery

System Oil condensing technology

System characteristics

- Ideal for system modernisation
- Easy integration of solar thermal systems
- Mixing of up to 10 % liquid biomass possible (observe manufacturer specifications)
- Operation possible independently of ambient air
- In case of low-sulphur fuel oil, naturalisation of condensate is not required up to 200 kW boiler capacity (Worksheet ATV-DVWK-A 251)

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

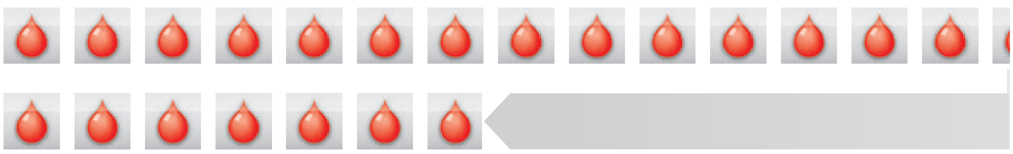
Refurbishment work undertaken

- Modern oil condensing boiler
- Solar thermal system for domestic hot water and heating purposes
- Regulated high-efficiency pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

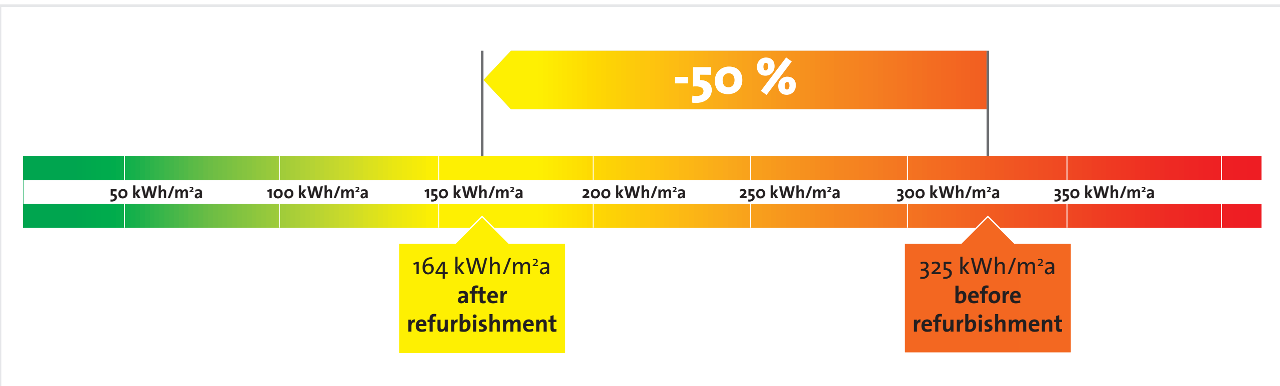
Annual energy demand

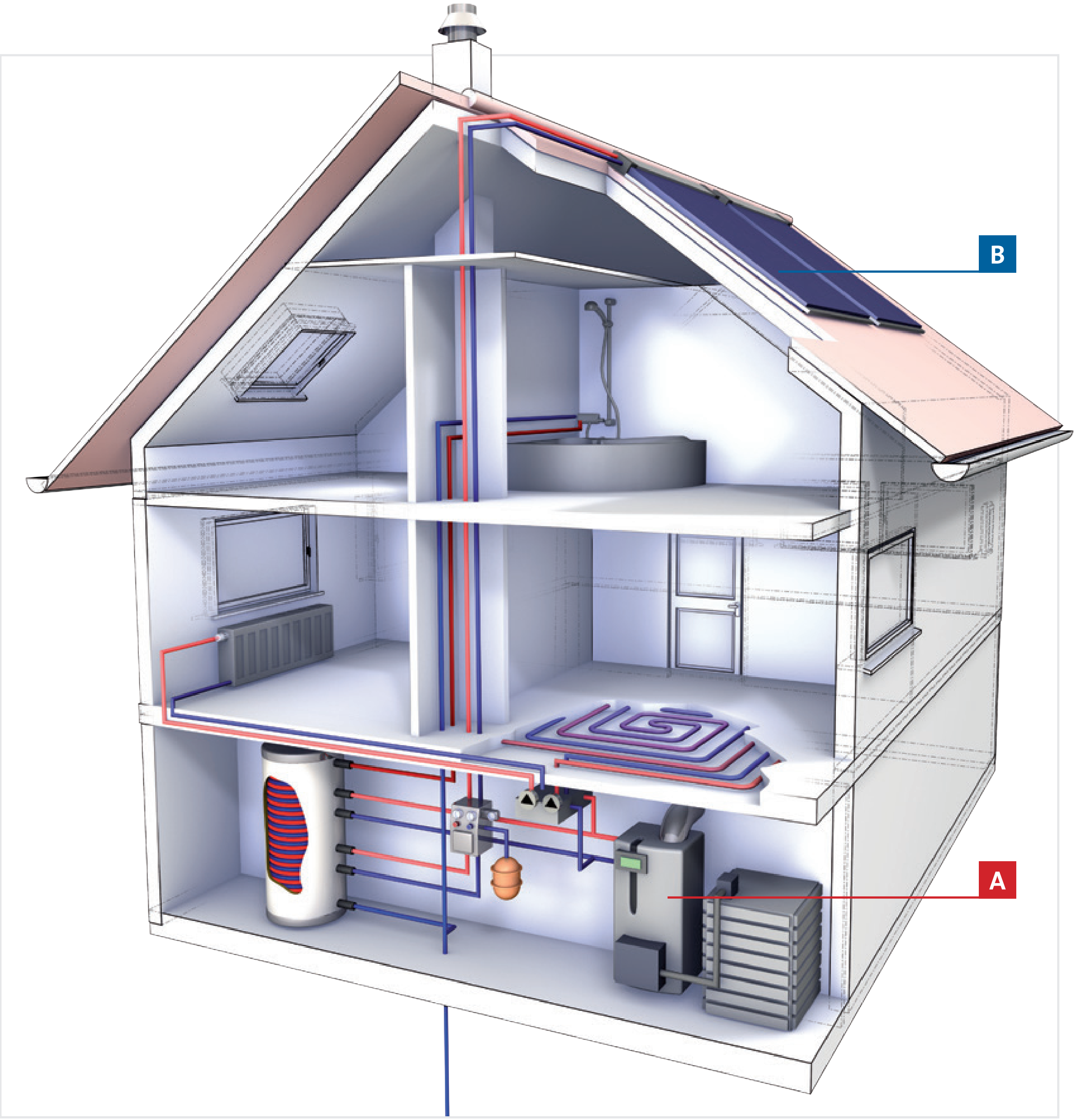
4,290 l/a
Oil before refurbishment

2,092 l/a
Oil after refurbishment



Annual primary energy demand





Modern oil condensing boiler

Solar thermal system for domestic hot water and heating purposes

SYSTEM MULTIVALENT HEATING

System characteristics

- Gas/oil condensing boiler with solar thermal system and wood based single room furnace having integrated collection basin
- Gas/oil condensing boiler as basic load heat generator
- Full domestic hot water production during summer months through solar thermal system
- Integration of wood/pellet furnace in the heating system through integrated water heat exchanger
- Heat storage via combi or buffer and domestic hot water storage tank
- Saving of gas/oil by using renewable energies

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

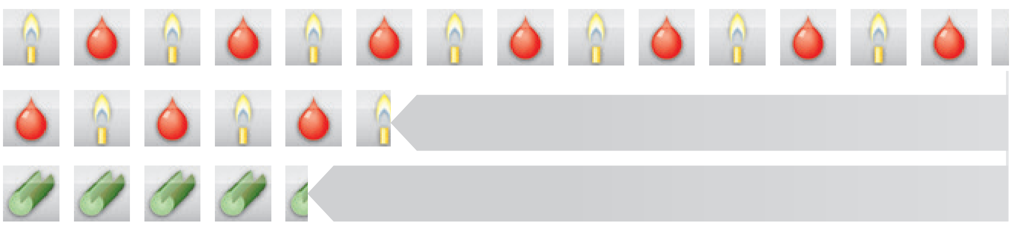
- Modern oil/gas condensing boiler
- Solar thermal system
- Wood-based single-room furnace with collection basin
- Modern combi-storage tank
- Regulated high-efficiency pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

Annual energy demand

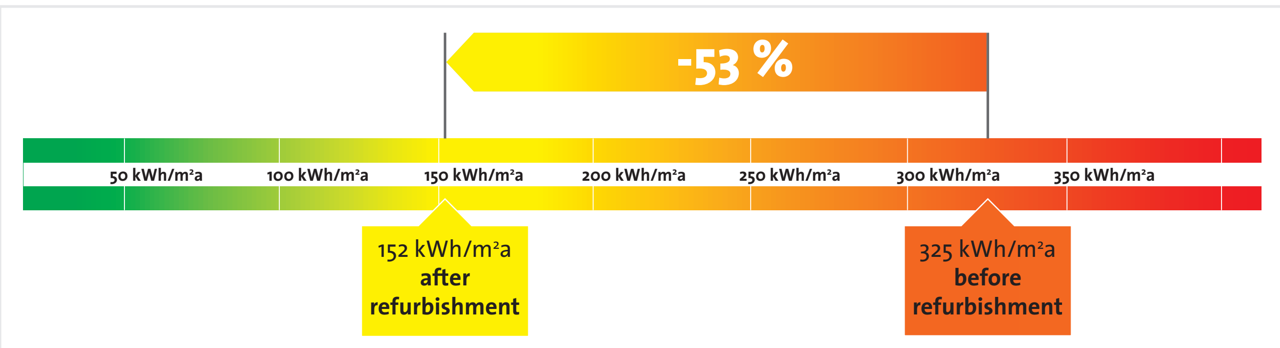
4,290 m³/a (l/a)
Gas (oil) before refurbishment

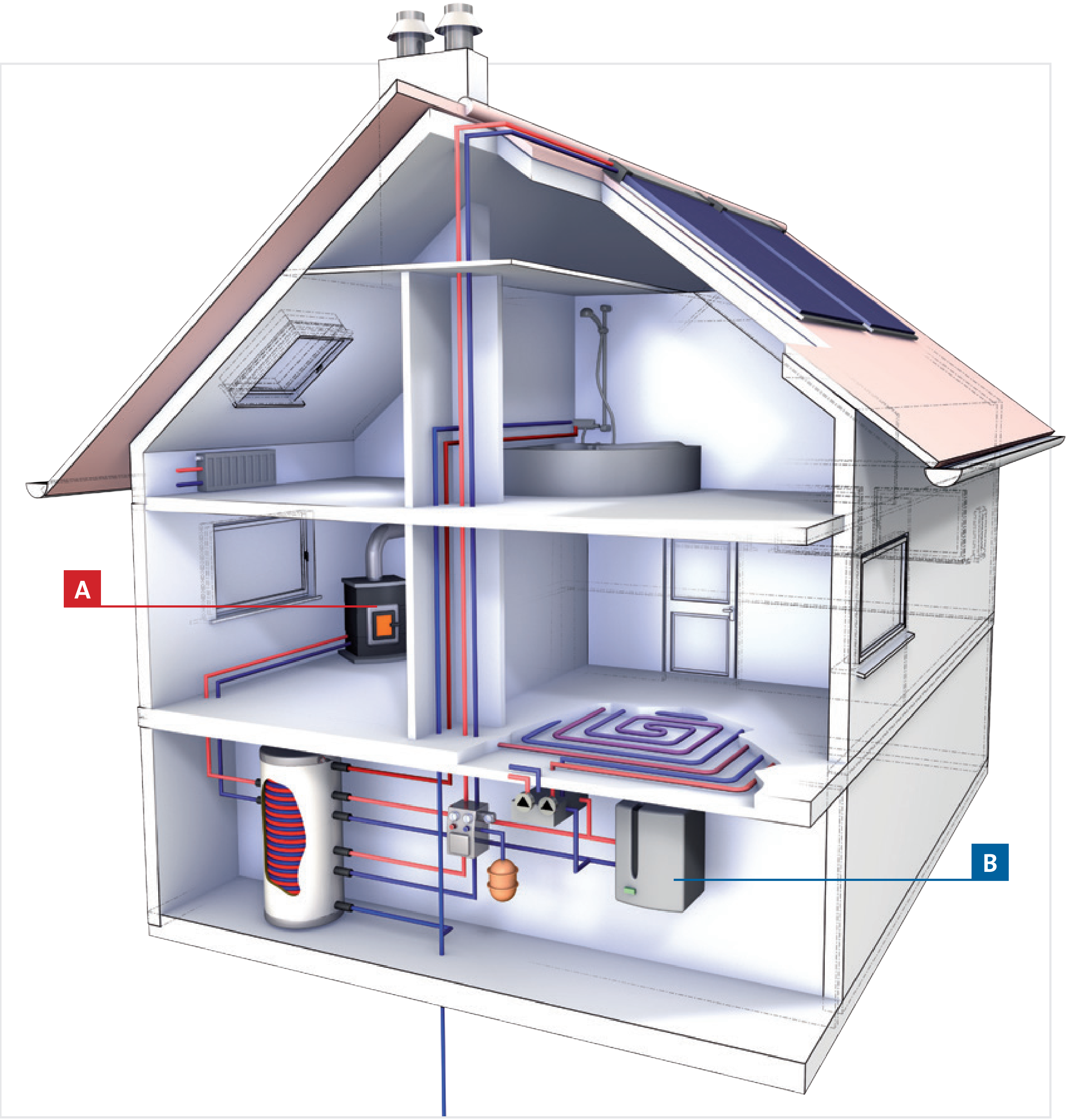
1,684 m³/a (l/a)
Gas (oil) after refurbishment

6.4 stère/a Hardwood
(2.6 t/a Pellets)
after refurbishment



Annual primary energy demand





Wood-based single-room furnace with collection basin

Modern oil/gas condensing boiler

System air-water heat pump

System characteristics

- Outer air as heat source can be used easily and is always available
- Indoor or outdoor installation possible
- Low space requirement due to absence of fuel storage tank
- Integrated cooling through heating and cooling convectors
- Zero-emission at installation site

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

- Installation of an air-water heat pump
- Installation of a buffer storage tank
- New, indirectly heated domestic hot water storage tank
- Regulated high-efficiency pumps
- Adjustment of the heat emission system
- Insulation of the distribution pipes
- Hydraulic balancing

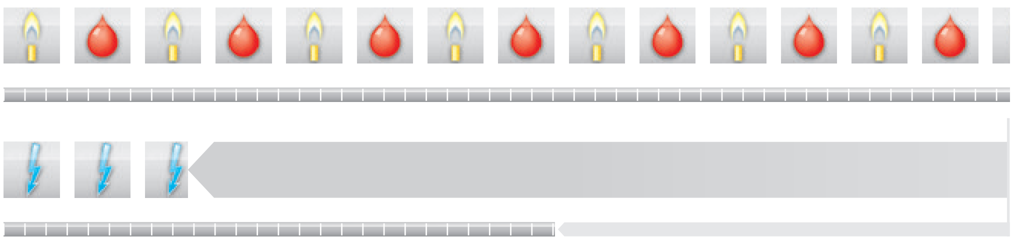
Annual energy demand

4,290 m³/a (l/a)
Gas (oil) before refurbishment

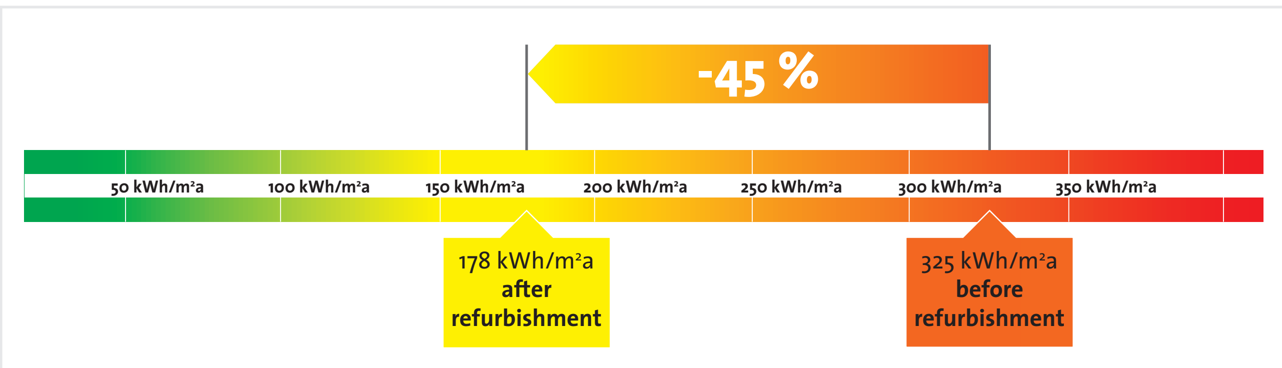
48,607 kWh/a primary energy
before refurbishment

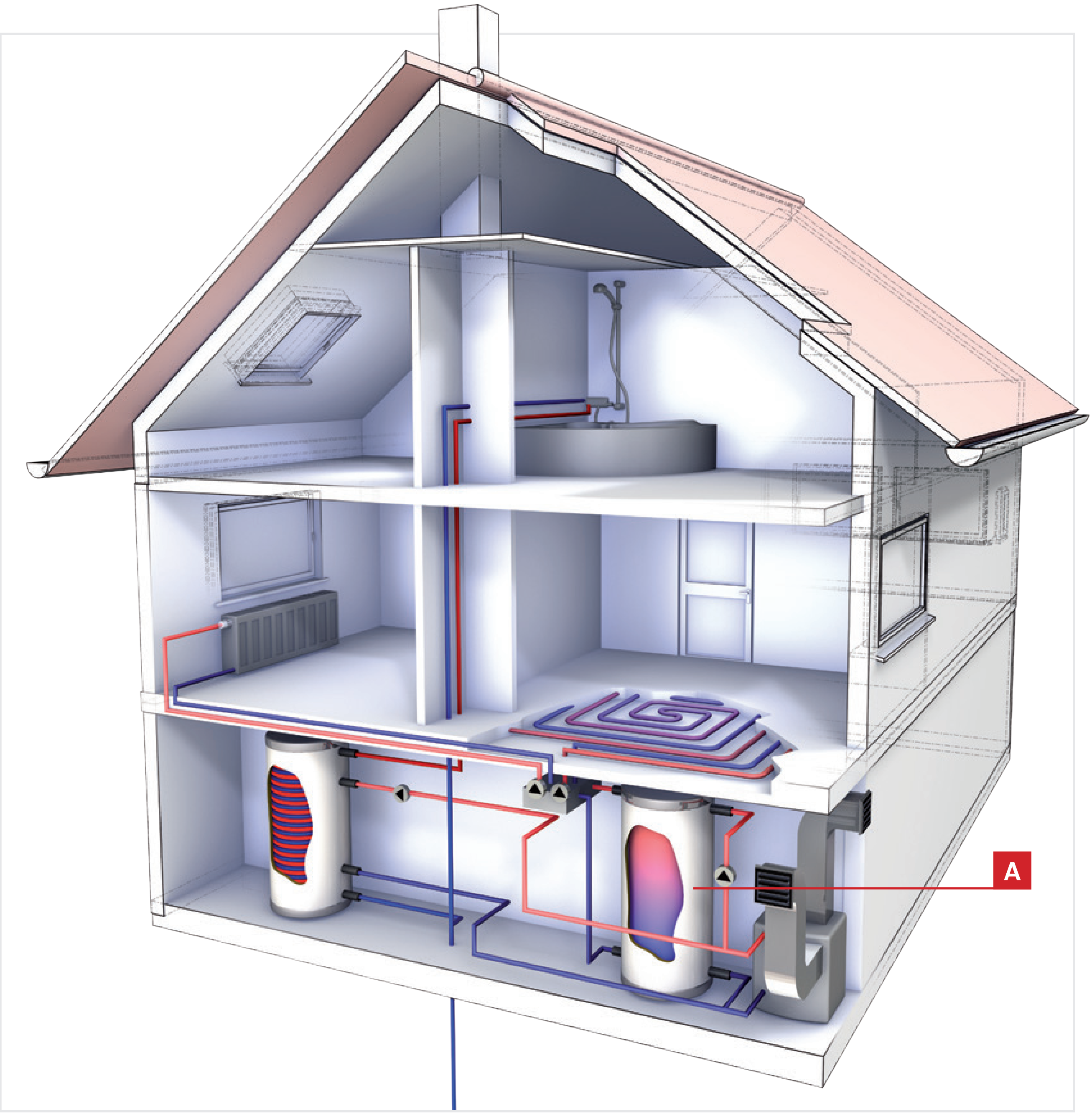
9,873 kWh/a
Power after refurbishment

26,608 kWh/a primary energy
after refurbishment



Annual primary energy demand





Air-water heat pump with buffer storage tank and indirectly heated hot water storage tank

System characteristics

- Vertical geothermal probes – temperature of heat source remains constant throughout the year
- Integration of active and very efficient passive cooling
- Low space requirement for drilling
- Full domestic hot water preparation through solar thermal system during the summer months

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

- Installation of a brine-water heat pump
- Installation of a buffer storage tank
- Solar thermal system for domestic hot water
- Controlled apartment ventilation with heat recovery
- Checking the heat emission system
- Insulation of the distribution pipes
- Hydraulic balancing
- Creation of an air-tight building shell with additional heat insulation to achieve the KfW-70 standard

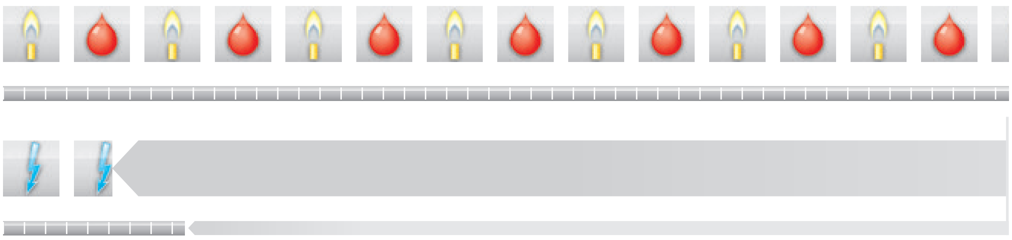
Annual energy demand

4,290 m³/a (l/a)
Gas (oil) before refurbishment

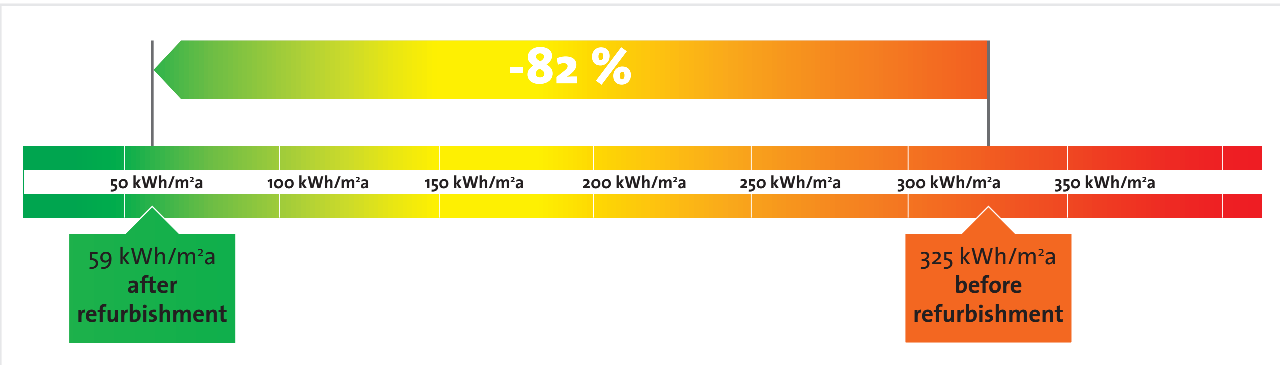
48,607 kWh/a
primary energy before refurbishment

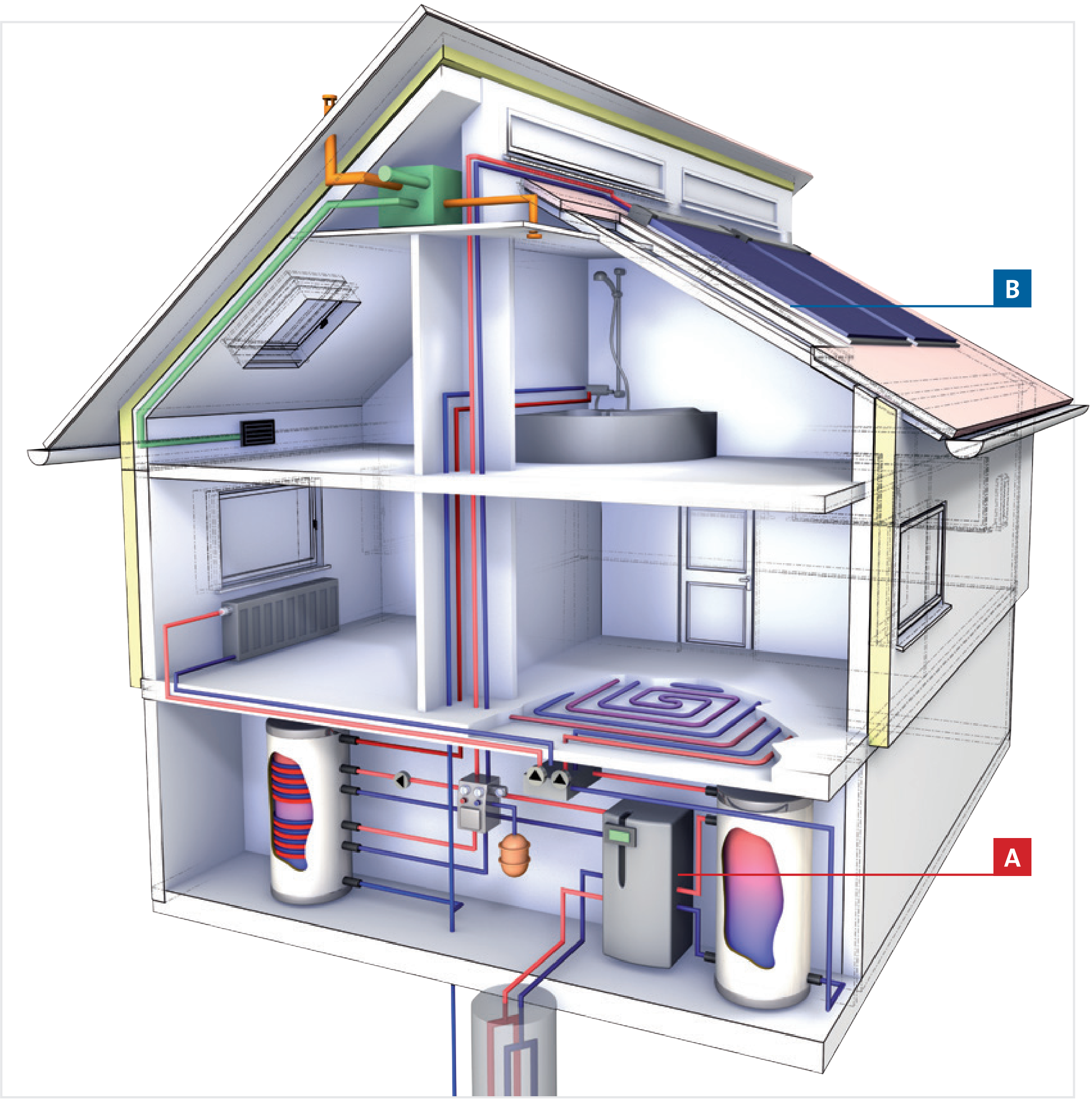
2,800 kWh/a
Power after refurbishment

8,753 kWh/a
primary energy after refurbishment



Annual primary energy demand





Brine-water heat pump with buffer storage

Solar thermal system for domestic hot water

System wood pellet boiler with solar thermal

System characteristics

- Ideal for system modernisation and new construction
- Full domestic hot water production through solar thermal system during the summer months
- Low emission values
- Operation possible independently of ambient air
- Fully automatic modulating operation and pellet supply

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m²
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

- Wood pellet boiler
- Solar thermal system for domestic hot water
- Regulated pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

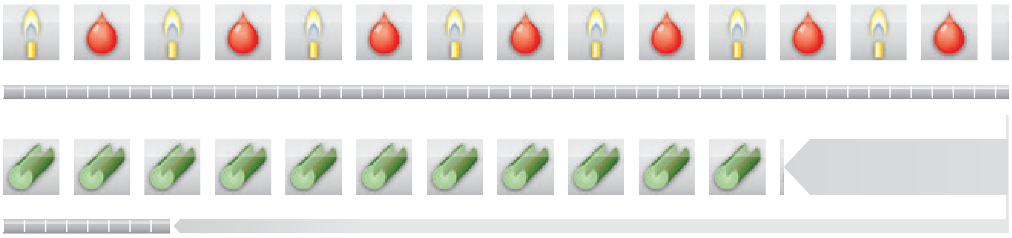
Annual energy demand

4,290 m³/a (l/a)
Gas (oil) before refurbishment

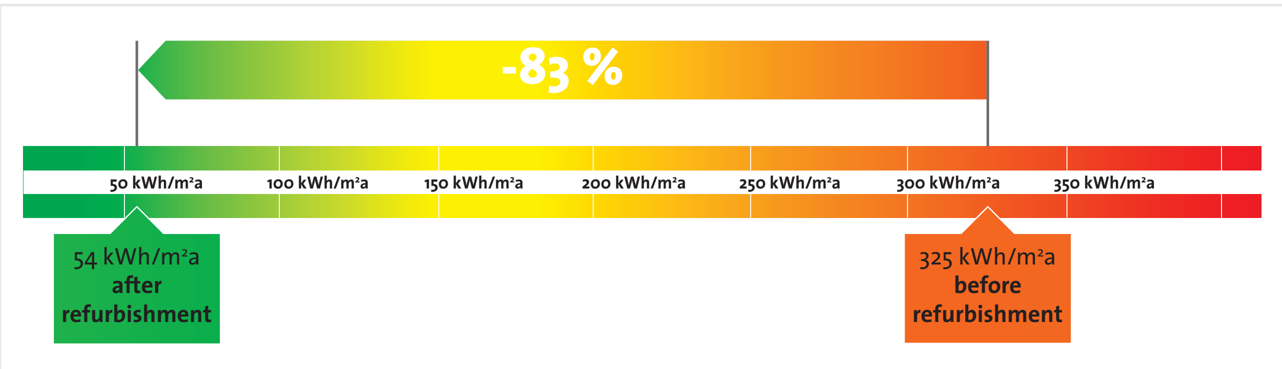
48,600 kWh/a
primary energy before refurbishment

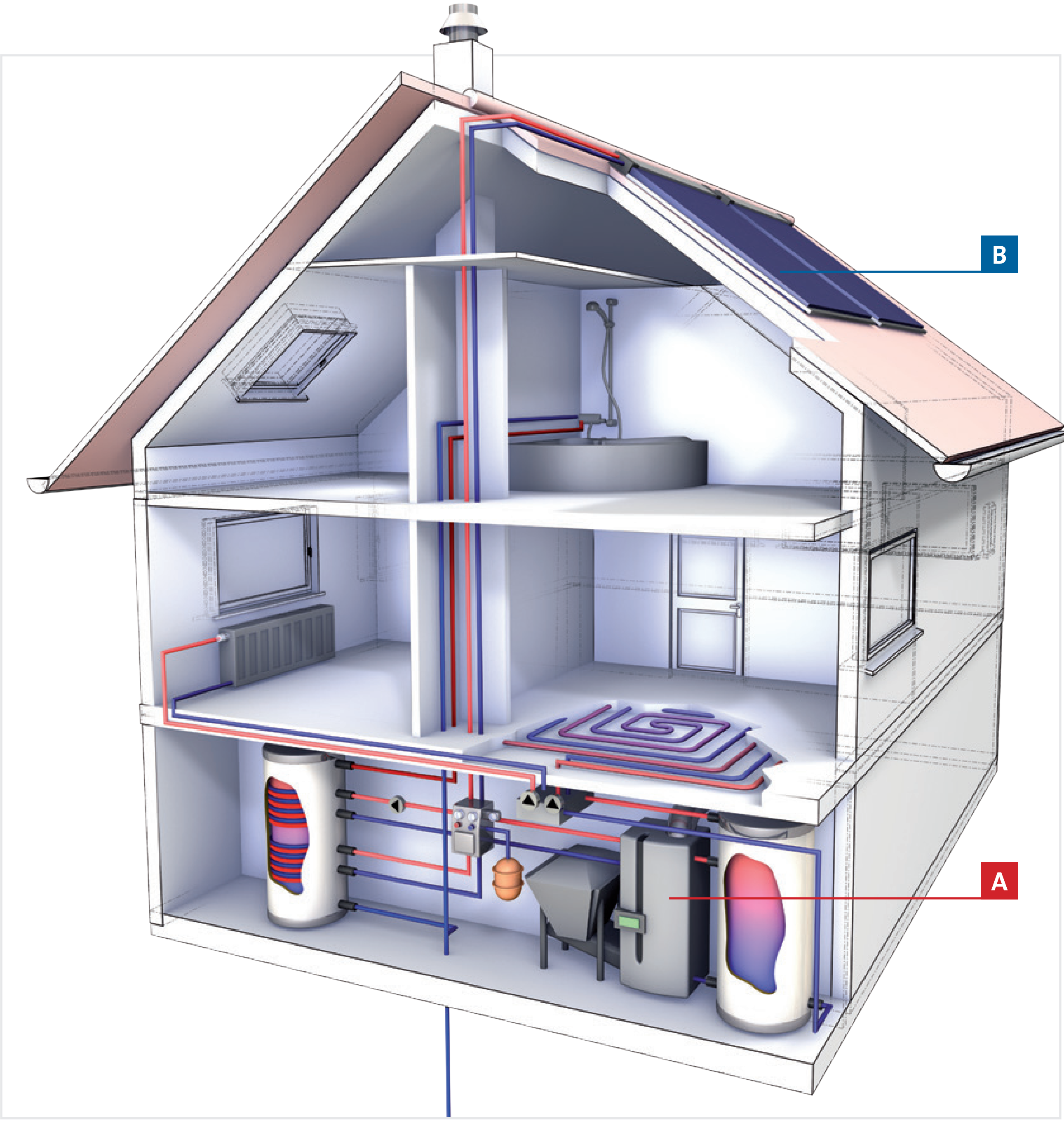
6.4 t/a
Pellets after refurbishment

8,040 kWh/a
primary energy after refurbishment



Annual primary energy demand





Wood pellet boiler

Solar thermal system for domestic hot water

System characteristics

- Ideal for system modernisation
- Full domestic hot water production during the summer months through solar thermal system
- Innovative performance and combustion regulation enables low emission, continuous output and high efficiency
- More comfort through long firewood laying intervals
- Easy and comfortable to operate

Example of modernisation: Detached family house

- Partially refurbished building, constructed in 1970
- Floor area 150 m^2
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

- Modern wood log boiler
- Solar thermal system for domestic hot water
- Regulated pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

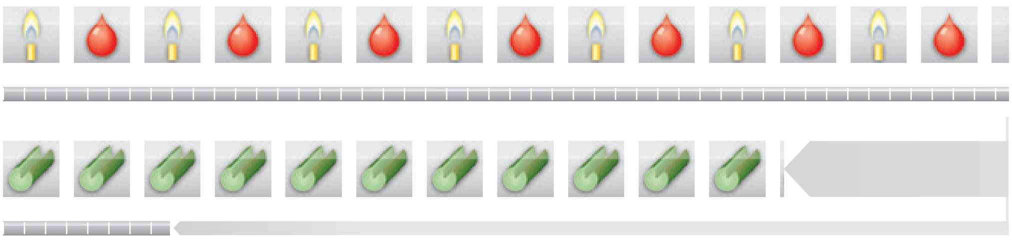
Annual energy demand

4,290 m^3/a (l/a)
Gas (oil) before refurbishment

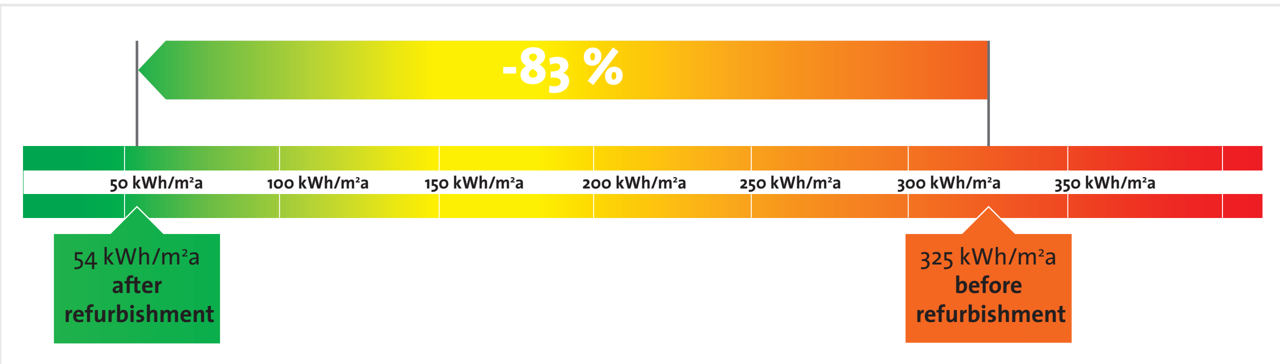
48,600 kWh/a primary energy before refurbishment

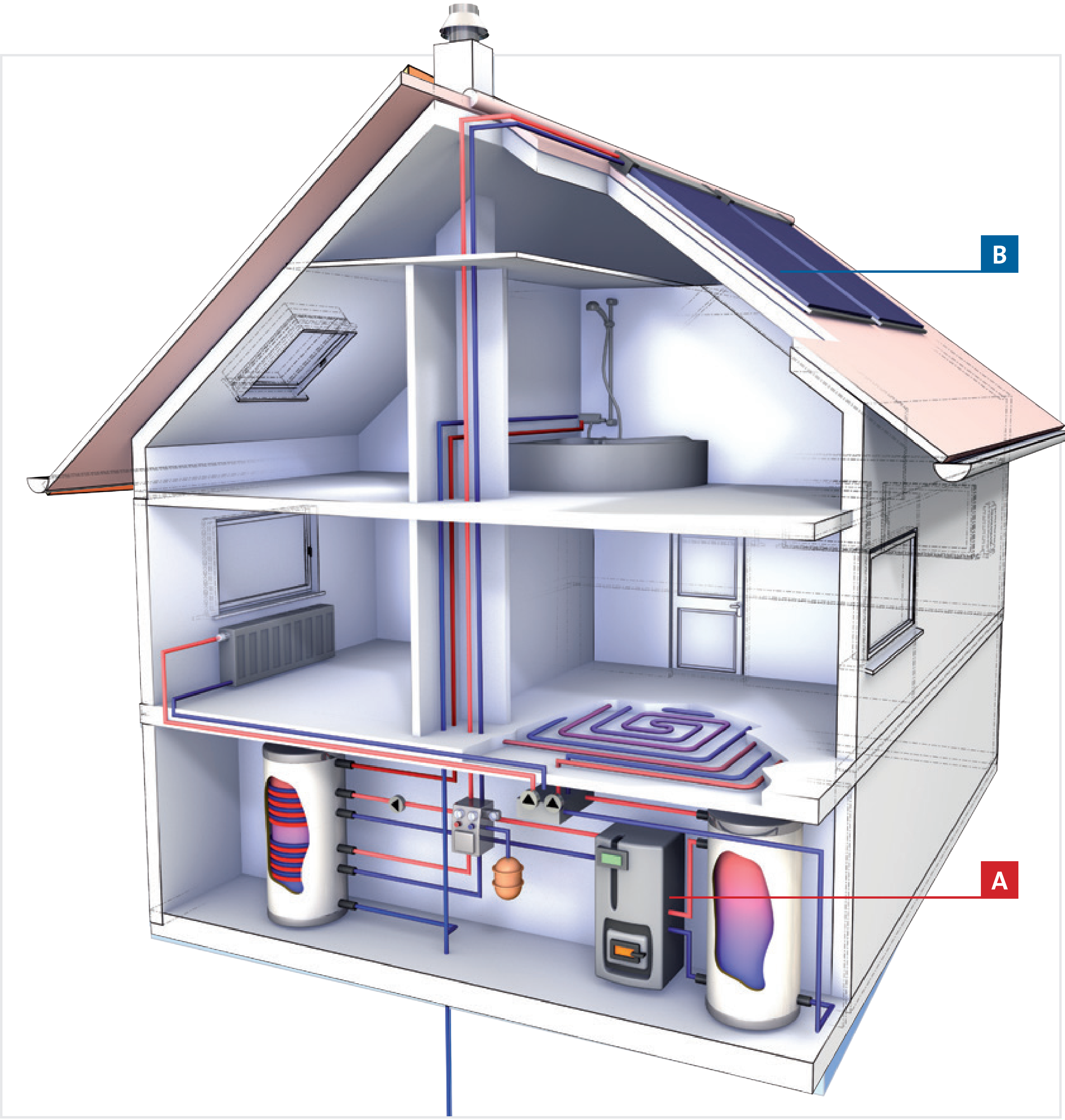
16 stère/a
Hardwood after refurbishment

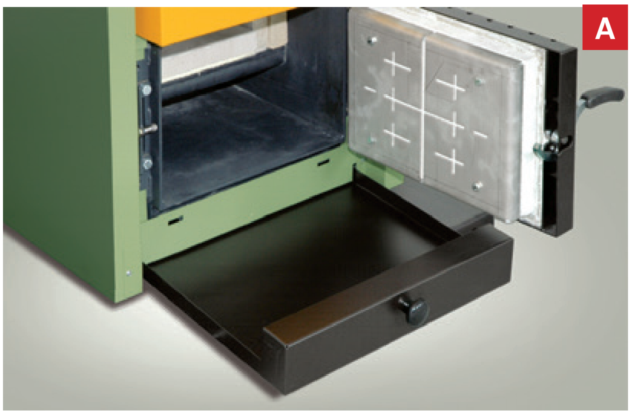
8,040 kWh/a Primary energy after refurbishment



Annual primary energy demand







Modern wood log boiler

Solar thermal system for domestic hot water

System Mini-CHP in a multi-family house

System characteristics

- Ideal for use in multi-family buildings and small business enterprises
- Efficient utilisation of the energy resource through combined power and heat generation
- Reduction of power costs through utilisation of self-generated power
- Extra revenue while supplying power to the public power network
- Low noise operation through special heat and noise insulated housing
- Can be combined with gas/oil condensing boilers to cover peak thermal loads

Example of modernisation: Detached apartment block

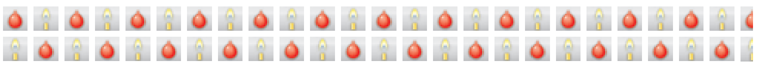
- Partially refurbished building, constructed in 1970
- Floor area 8 x 82 m²
- Type of construction solid walls/render
- Old gas/oil boiler

Refurbishment work undertaken

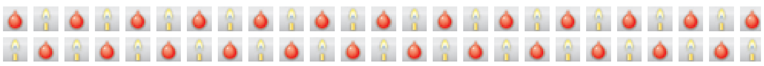
- New mini-CHP system with buffer storage tank and new condensing boiler (peak load)
- Regulated high-efficiency pumps
- Adjustment of heat emission system and new thermostatic valves
- Insulation of the distribution pipes
- Hydraulic balancing
- Refurbishment of flue system

Annual energy demand

14,270 m³/a (l/a)
Gas (oil) before refurbishment



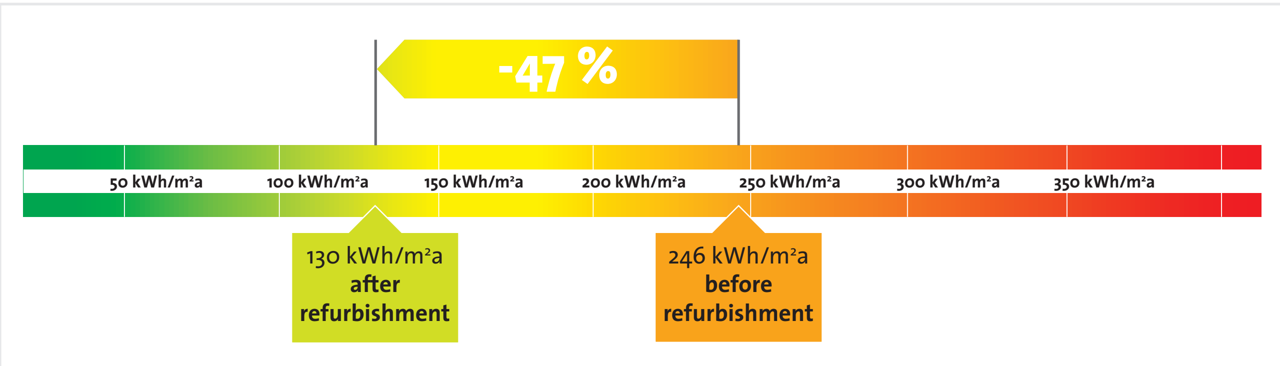
14,919 m³/a (l/a)
Gas (oil) after refurbishment

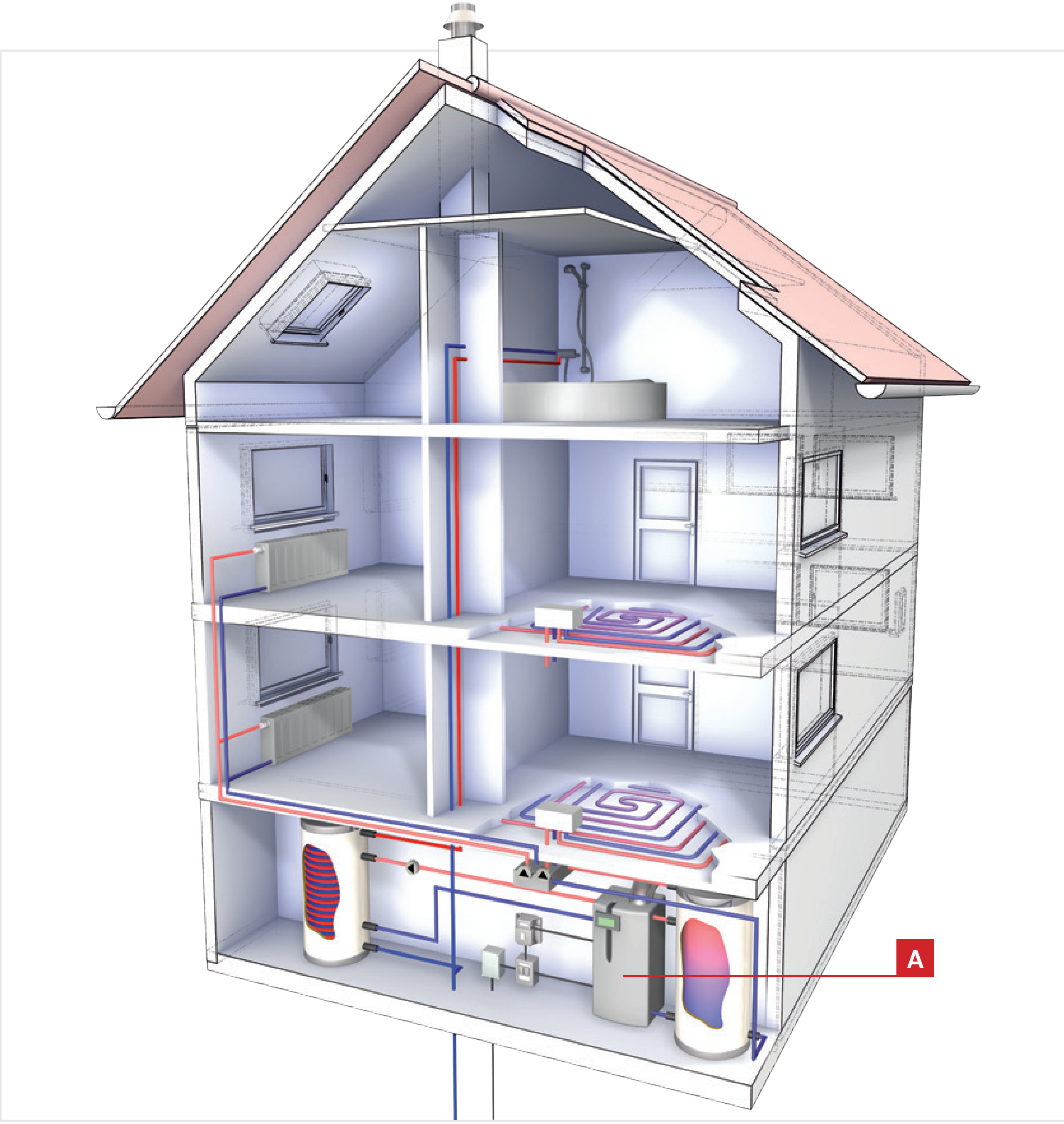


31,267 kWh
Power generated

Additional power generation to be used directly or fed into the grid

Annual primary energy demand





Mini-CHP system

Note: new condensing boiler not pictured in system house

Technologies/products

About 78 % of the gas devices installed newly in Germany in 2012 are condensing devices

Efficient heat supply

Gas-fired condensing devices can secure the heat supply to domestic heating and domestic hot water economically.

The condensing devices work more efficiently because they also use the heat of condensation of the water vapour contained in the flue gases. Thus, (percentage) utilisation ratios of up to 98 % based on the higher heating value are possible. This makes the condensing technology using gas highly resource-efficient, environmentally friendly and highly convenient at the same time.

Gas-fired condensing devices are now used not only for new installations, but also in modernising existing heating systems. In the process, the primary heat load is largely within the condensation range even at a temperature specification of 80 °C/75 °C.

In Germany, about 336,000 gas-fired condensing boilers have been sold in 2012. With its market share of around 55 % they assume the first place in the sales statistics of the centralised heat generators.

Gas-fired condensing devices cover virtually all output ranges: Wall-mounted devices deliver up to 100 kW. Cascaded in series, this power can be increased even to several 100 kW. Floor-standing boilers are offered up to the megawatt range.

Perfected technology

After more than twenty years of use, the gas-fired condensing technology is now more technically developed, both in terms of comfort and emissions.

The sophisticated and advanced design ensures that the devices integrate more discretely into their environment.

Gas-fired condensing devices operate very quietly and are odourless. They can be installed almost anywhere in the building. The devices need little space, a fuel storage tank is not required. Another advantage is that highly fluctuating power requirements for heating and hot water are also covered by gas-fired condensing devices with high efficiency.

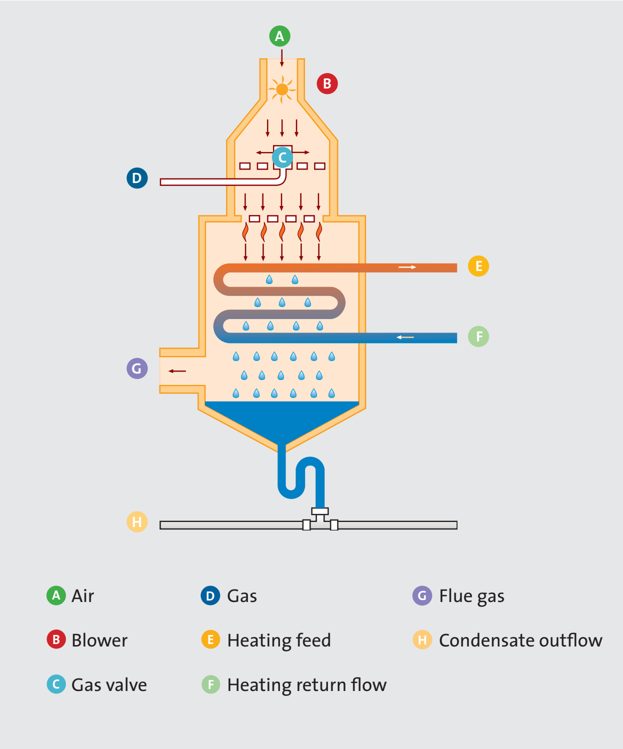


Fig. 30: Diagram of a condensing appliance

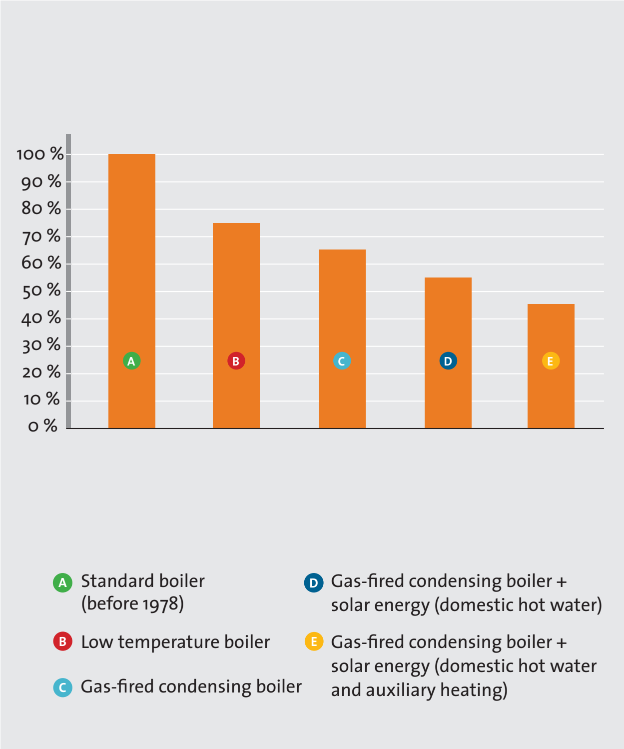


Fig. 31: Carbon dioxide emissions

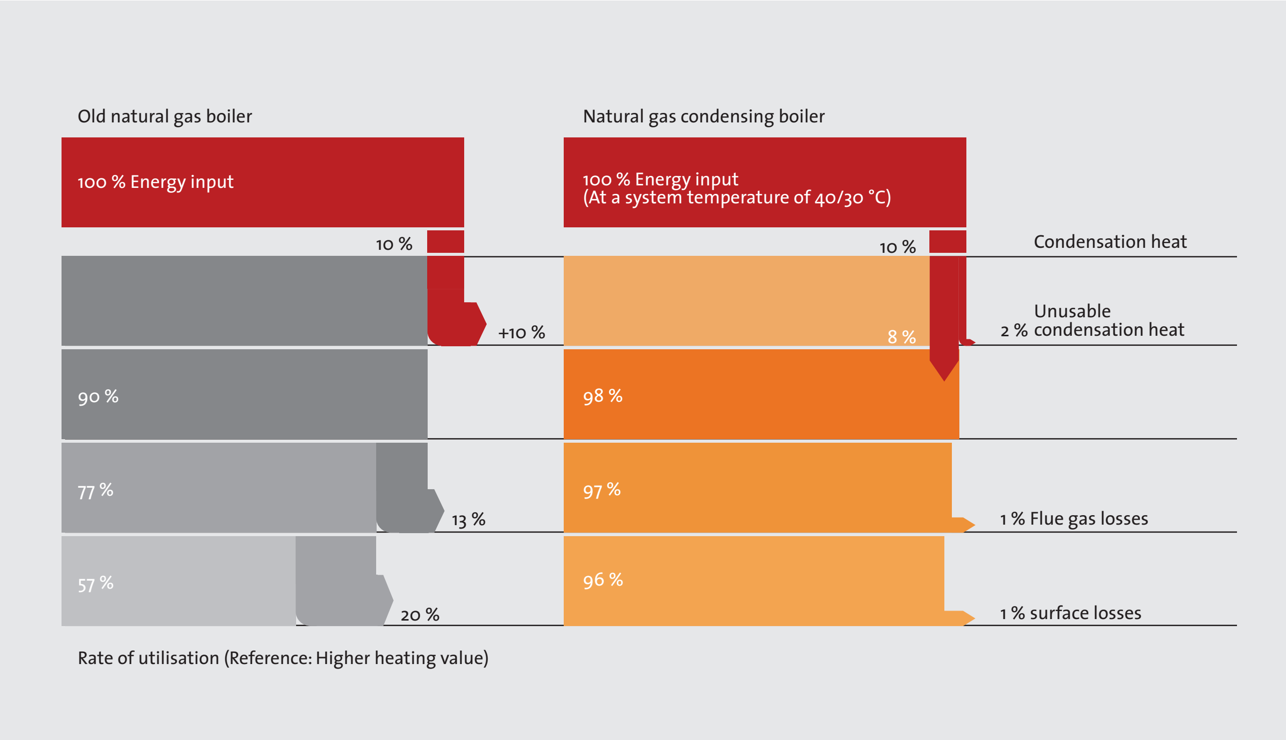


Fig. 32: Efficiency comparison between old boiler and natural gas condensing boiler

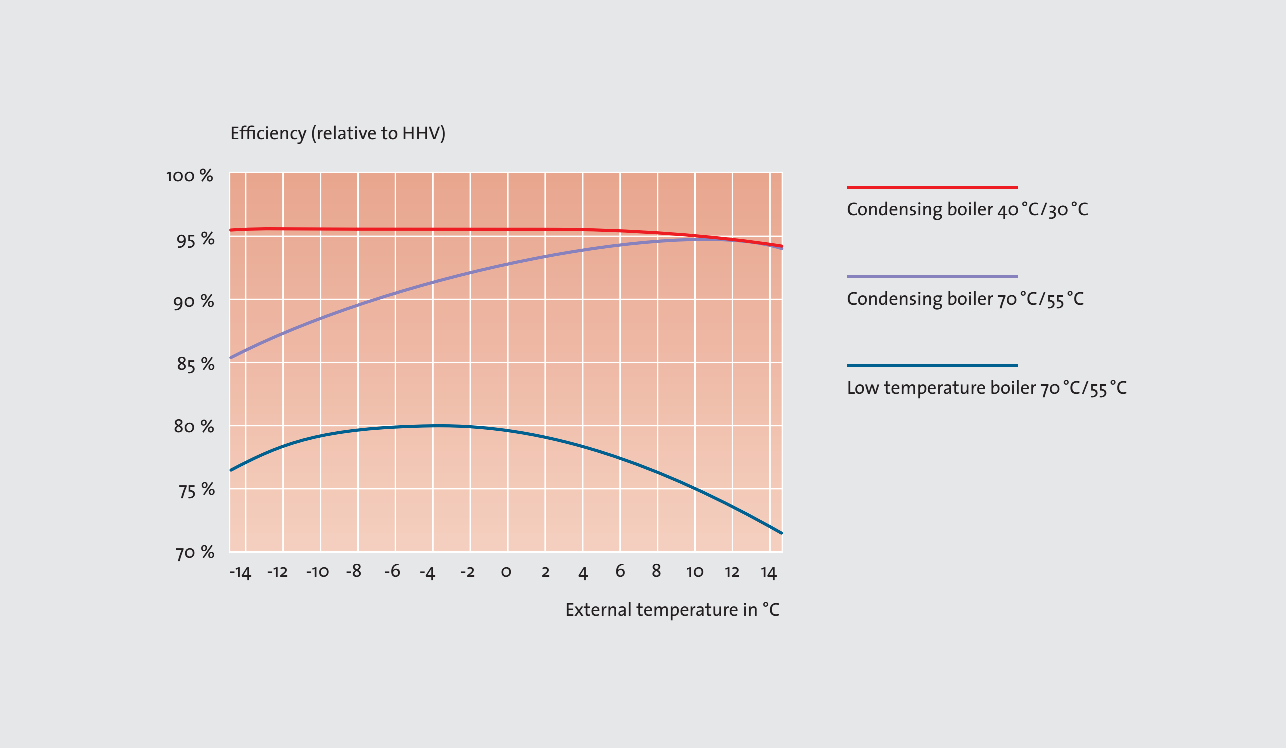


Fig. 33: Effectiveness comparison between condensing and low temperature boiler

The modern oil-fired heating is a highly efficient technique to generate heat in the house. Two-thirds of the newly installed oil heating systems in Germany are now condensing devices – and the percentage is rising.

High ratio of utilisation

Condensing devices are technically designed, so as to use virtually the entire energy content of the fuel – the so-called higher heating value. In contrast to standard and low-temperature technology condensing devices also process the heat of condensation of the water vapour contained in the flue gas. This results in (percentage) ratios of utilisation of 98 to 99 percent. In practice, one uses the oil condensing technology especially for modernisation because the return flow temperature here is often below the dew point of the flue gas throughout the year (see fig. 34). This is especially because the radiators were dimensioned usually larger those days due to reasons of safety. If the central heating demand is reduced further (for example, by an insulated façade or new windows), even less mass flows through the radiator. The return flow temperature continues to fall, and thus, provides an additional argument to opt for the oil condensing technology.

From oil-solar to hybrid heating

Oil condensing technology can easily be combined with solar thermal system. The solar collectors support domestic hot water preparation and also heating the building partly. The combination of a solar thermal system with an oil-fired heating system reduces oil consumption by 10–20 percent. Therefore, almost every other oil heater is combined with solar thermal system as part of the modernisation of heating systems (see fig. 35). Besides this bivalent heating concept, plants that incorporate more renewable energy are becoming increasingly prevalent: Hybrid heating systems combine condensing technology, solar thermal system and wood-fired furnaces that fill up the heat storage tank. Excess "green" electricity which could contribute to the heat supply via an electric heating rod in the heat storage tank also comes into question as an additional energy source in the future.

Approximately 66 % of the oil devices installed newly in 2012 in Germany are condensing devices.

The variants of condensing technology

Different methods are used to cool the flue gas below the dew point.

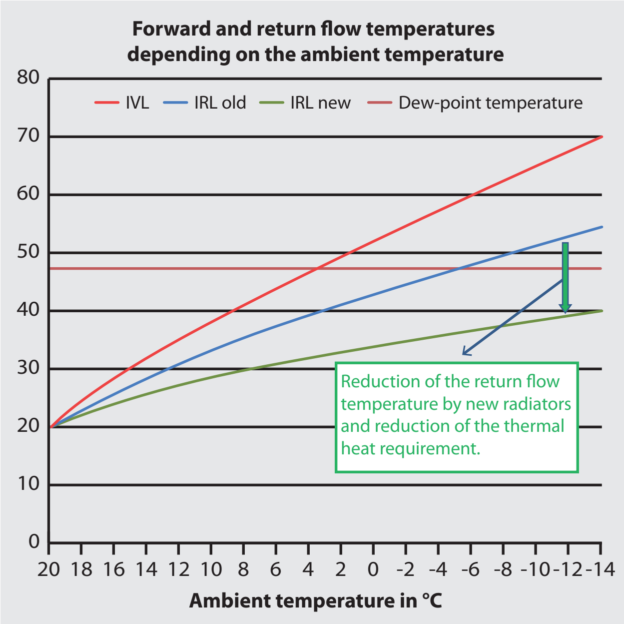


Fig. 34: Influence of heating temperature on condensation behaviour

- The return flow of the heating circuit may be used for cooling the flue gases. Embedded heating systems may be used here because of their very low return flow temperatures. Unfortunately, the return flow temperature is automatically increased with increasing heat demand of the heating system. In normal radiators, only partial condensation takes place. That's why it must always be ensured that the return flow temperature does not increase upstream to the boiler (e.g. by a mixer or a four-way valve) (see fig. 37). The cooling of the flue gases is achieved at the end either directly in the boiler (internal condensation) or in a downstream heat exchanger.
- One can also use the combustion air drawn in for cooling the flue gases: This results in a good correlation because the work of the oil burner increases automatically with falling ambient temperatures.

The two types are often combined. Thus, for example, many devices that actually use the heating return flow for the condensation, may also be supplied with combustion air via an air/flue system (LAS), irrespective of the indoor air. The combustion air is then pre-heated by the flue gases in counterflow in an exhaust system with concentric arrangement of the fresh air and exhaust pipe. This provides for greater utilisation of energy. This solution shall be considered optimum against the background of the Energy Conservation Regulation.

In practice, depending on the heating system, about 0.5 to a maximum of 1 litre condensate results in the combustion of one litre of oil (approx. 10.68 kWh_{Hs}). Due to the relatively low flue gas temperature of 45 to 50 °C, an air/flue system (LAS) made of plastic (see figure 38) may be used for the discharge of combustion gases from oil condensing boilers.

The eco-friendly fuel

Heating oil EL (domestic fuel oil) is according to DIN 51603-1 a standardised fuel that is manufactured in two grades. They mainly differ in their sulphur content: Heating oil EL standard has a sulphur content limit of 1,000 ppm (mg/kg). This is only 50 ppm in low-sulphur heating oil EL. The proportion of low-sulphur heating oil in Germany is now at 98 percent (see figure 36). Thus, low-sulphur fuel oil has established itself as the standard fuel in Germany.

Low-sulphur heating oil is perfectly adapted to the requirements of condensing technology and is also beneficial for low-temperature boilers. The heating devices industry supports this explicitly. Low-sulphur heating oil burns without leaving virtually any residue. This ensures high utilisation of energy while reducing the maintenance requirements for boilers and burners. The inspection intervals of the exhaust paths were extended by a chimney sweep because of the scarce occurrence of any deposits and soot – thanks to the clean combustion: Oil-fired condensing heaters which are operated with low-sulphur heating oil must be checked every two years.

Use of low-sulphur heating oil is recommended also in view of the regulatory requirements for the introduction of the condensate in the waste water: In the case of oil-fired condensing devices up to 200 kW of power, no neutralisation of the condensate is required, if low-sulphur heating oil is used (see worksheet 251 of the Waste water Treatment Association, Aug. 2003).
Moreover, since 2009, low-sulphur heating oil is more tax-supported than standard heating oil in Germany.

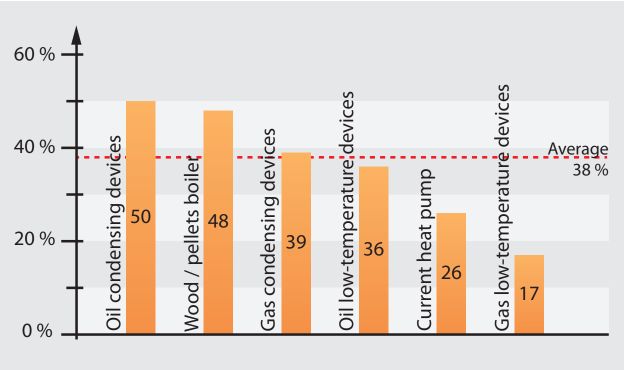


Fig. 35: Oil condensing technology – combined most frequently with solar

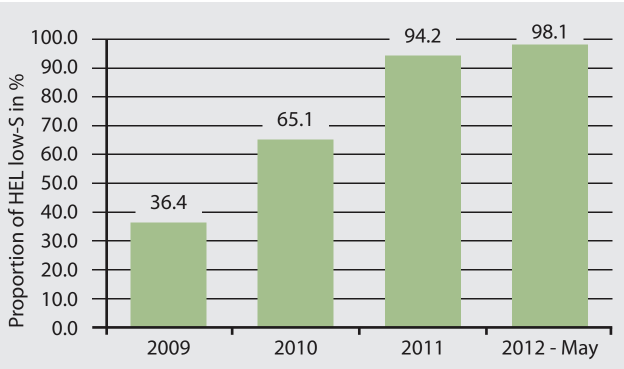


Fig. 36: Proportion of HEL low-S in the total sales

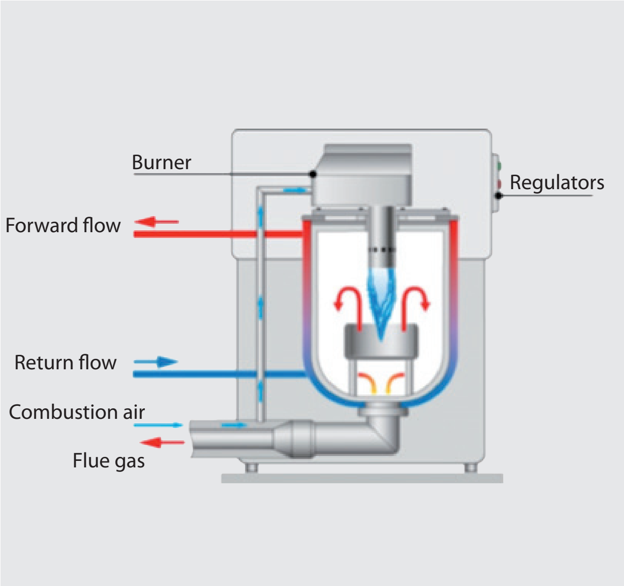


Fig. 37: Boiler with internal condensation without increase in return flow

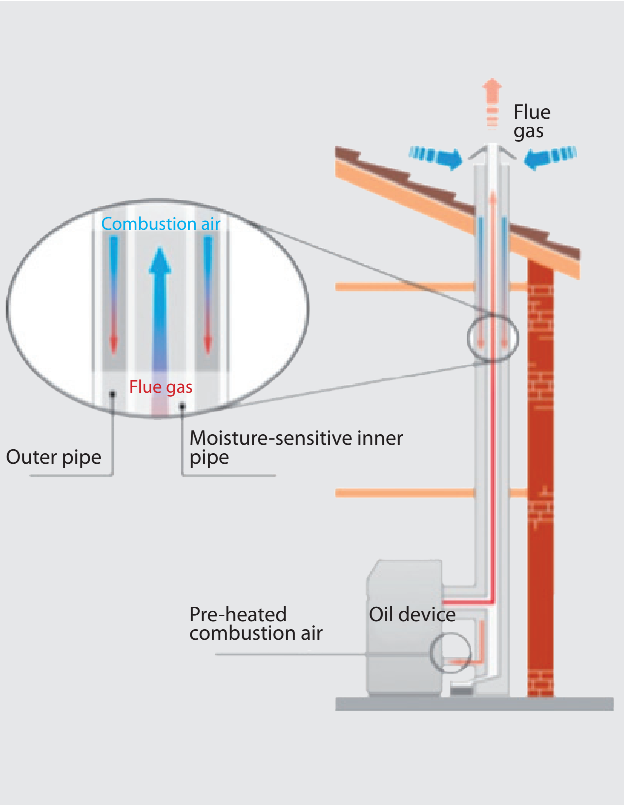


Fig. 38: Preheating the combustion air in LAS

Energy from air, water and earth

A heat pump makes the renewable energy stored in the soil, groundwater or the environment usable for heating purposes. The most common are electric heat pumps, but now gas heat pumps have also been introduced.

A heat pump heats, prepares the domestic hot water and also can be used for cooling.

Electric heat pumps are very efficient: A heat pump with a coefficient of performance of 4.0 can generate four kilowatt-hours of heat from one kilowatt-hour drive current. The heat pump should be designed exact to the individual heat demand, so as to make them achieve this high efficiency in daily operations.

Heating, cooling, ventilation

Heat pumps work all the more efficient, the higher the source temperature. Therefore, it is worthwhile to make a heat source with a high and constant temperature usable, for example, the ground: Geothermal heat pumps generate high yields, because the temperature of the soil varies little during the year, and is continuously at a comparatively high level. This is opposed by the cost to tap the heat source.

With an air heat pump, the investment costs are lower, because this cost is eliminated completely. Due to the fluctuating ambient air temperatures that is also low during the heating period, decrease in efficiency should be reckoned with.

Modern heat pumps heat, prepare the domestic hot water upon request and can also be used for ventilating and cooling a building depending on the model. They work very quietly and are virtually maintenance-free. In particular, a high standard of comfort is assured in conjunction with floor heating.

Heat pumps are an efficient alternative especially when combined with low system temperatures and sufficiently dimensioned heating surfaces (such as an embedded heating system).

If they receive their drive current from renewable sources such as wind power or photovoltaic power, they are working virtually emission-free in addition.

The heat pump demonstrably contributes to climate protection because heat pumps use renewable sources and ultimately save fossil energy sustainably. Therefore, it is financially supported in many parts of Germany: The federal government, states and corporations support the purchase of a new heat pump with attractive grants.

Many utility companies also offer special electricity tariffs for operators of heat pumps.

Even in other countries such as Sweden, Switzerland and Austria, the heat pump has established itself as a heating system: Nearly 90 % of all new buildings in Sweden are equipped with heat pumps, in Switzerland it is about 75 %.

A closed circuit

In technical terms, a heat pump works practically like a refrigerator – only that the heat removal is used in the refrigerator, while the heat pump is used to heat the heating water: A refrigerant draws heat from the environment and evaporates as a result. Subsequently, the refrigerant is compressed in a compressor. This increases the pressure and temperature of the refrigerant automatically. The refrigerant brought to a higher temperature level in this way then delivers the stored heat to the heating water and condenses again. Expansion and cooling of the refrigerant creates the condition that this circuit can restart from the beginning.

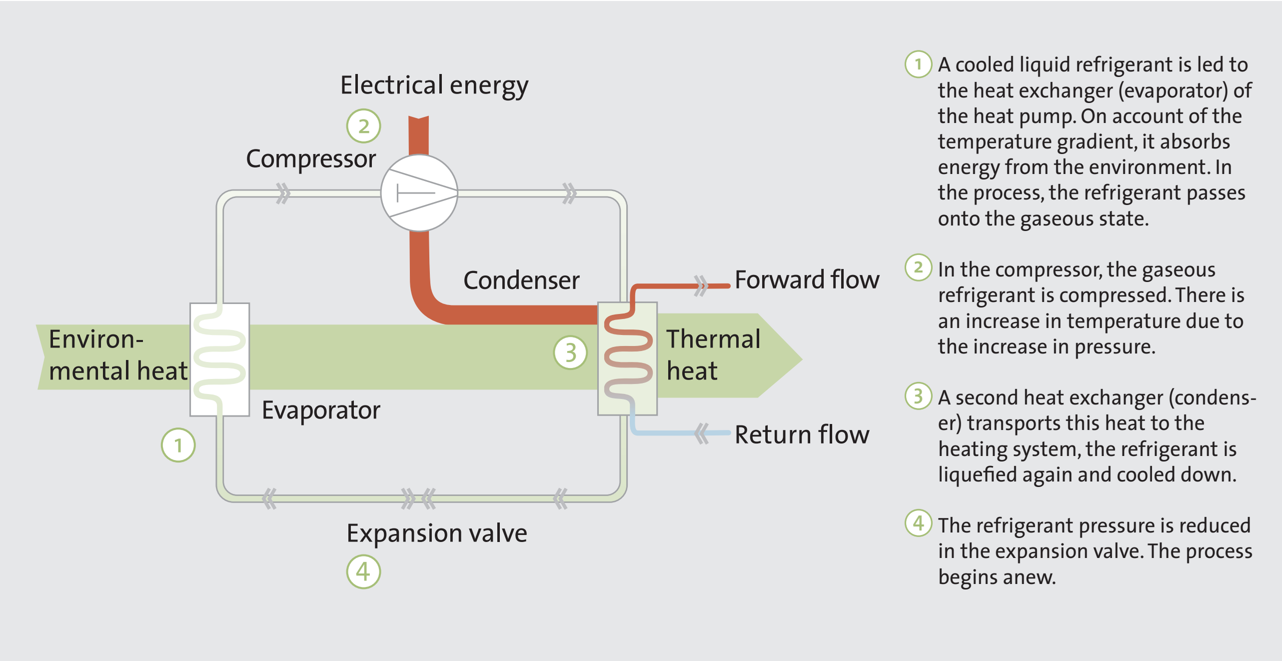


Fig. 39: Functional principle of a motor-driven heat pump

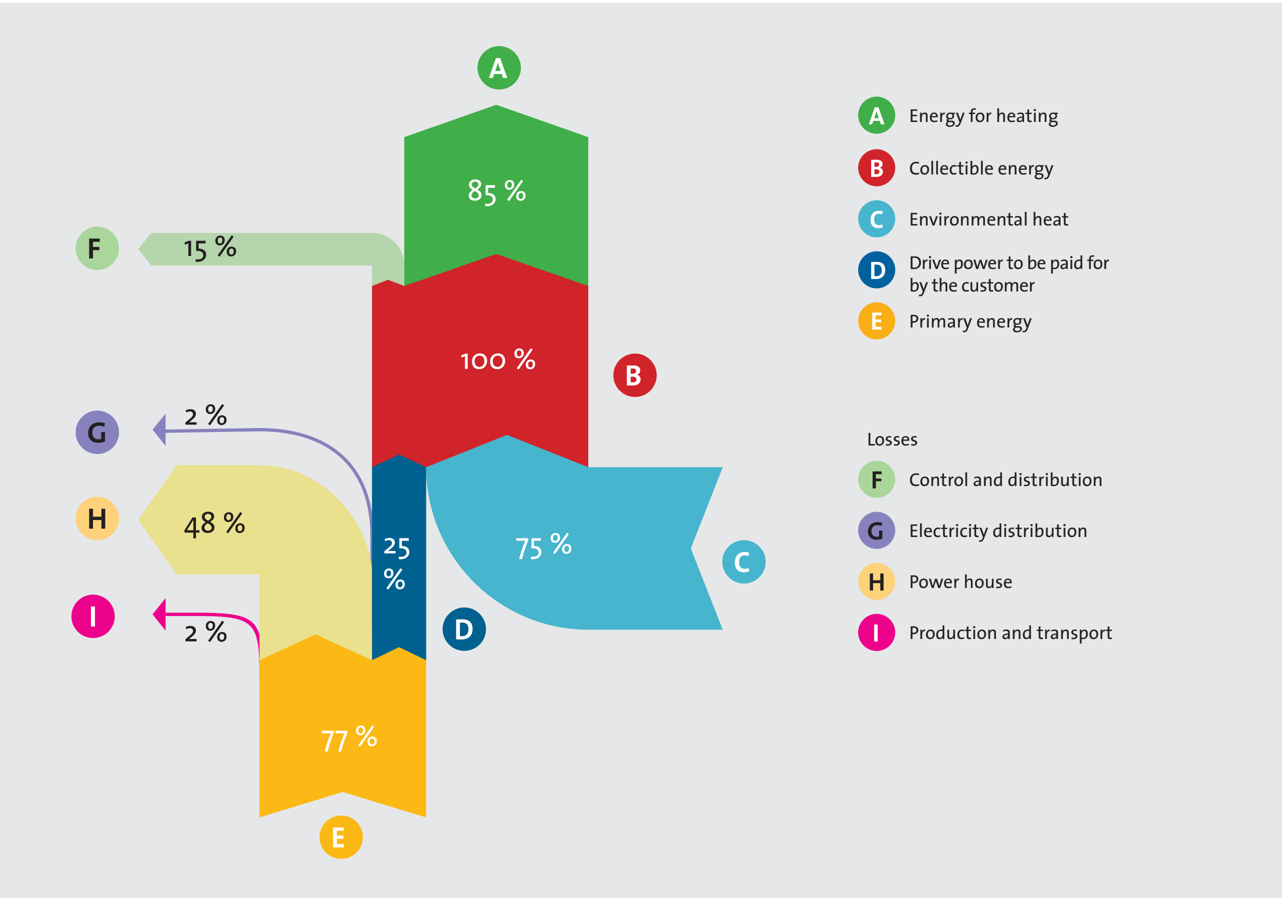


Fig. 40: Energy flow in the example of an electrical heat pump

Geothermal energy, ground water, air and absorber systems with direct exposure to sunlight can be used to operate a heat pump. Wastewater or process heat can also be used as an energy source. Three commonly used types of heat pumps can be distinguished:

Brine-water heat pumps

The brine-water heat pump uses the earth's heat (geothermal energy) or absorber systems as a heat source.

There are two ways to make near-surface geothermal energy usable: Geothermal probes and ground-coupled collectors. Geothermal probes are placed up to 200 meters deep in the ground through a hole, and use an average soil temperature of about 10 °C there. The geothermal probes (U-pipes made of polyethylene) are introduced through the borehole, and then pressed. Only by pressing, a constant heat flow towards the geothermal probe is guaranteed. If the land is large enough, the

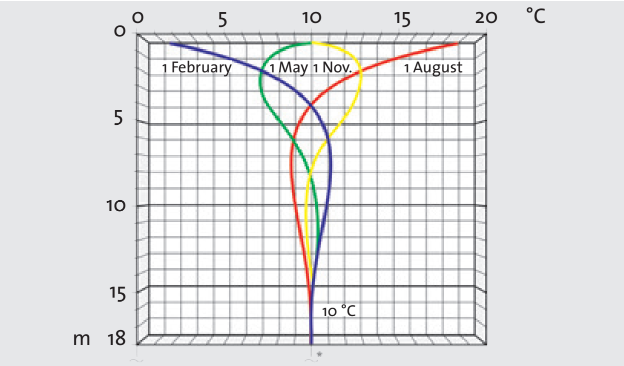


Fig. 41: Temperature increase in the soil

ground can also be tapped by a flat plate collector. Here, plastic pipes are laid in a large area to remove heat from the soil. Ground collectors are pipes made of polyethylene that are installed at 1.2 to 1.5 m depth in the garden. The distance between the pipes must be 0.5 to 0.8 m. About 25 m² area is sufficient for a kilowatt of heat output. The collectors are covered by soil after installation. The use of absorber source systems is an alternative: Here, solar thermal systems (flat and tubular collectors, absorber systems made of corrugated polyethylene pipe) are connected with soil tares to be able to take advantage of geothermal heat pumps even in small lands.

HEAT PUMPS USE THE HEAT FROM THE SURROUNDINGS

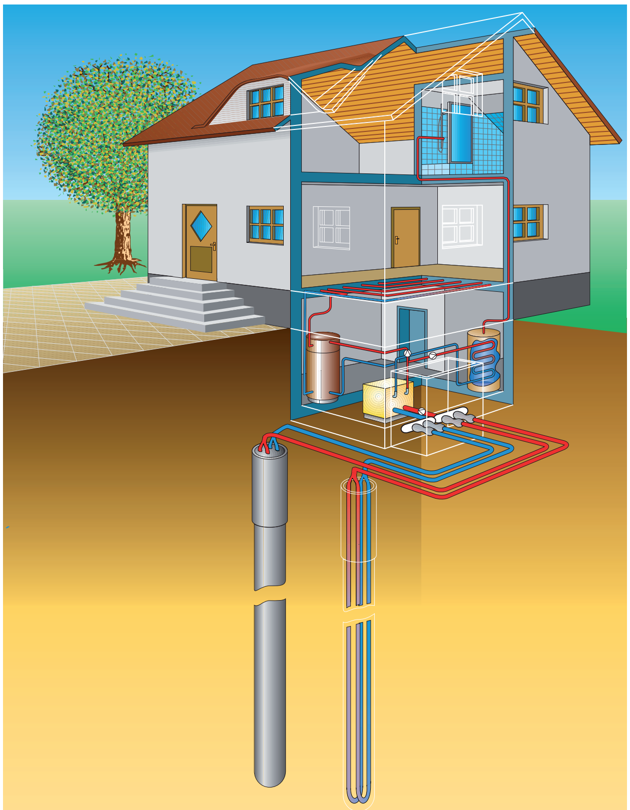


Fig. 42: Ground-coupled heat pump with probe system

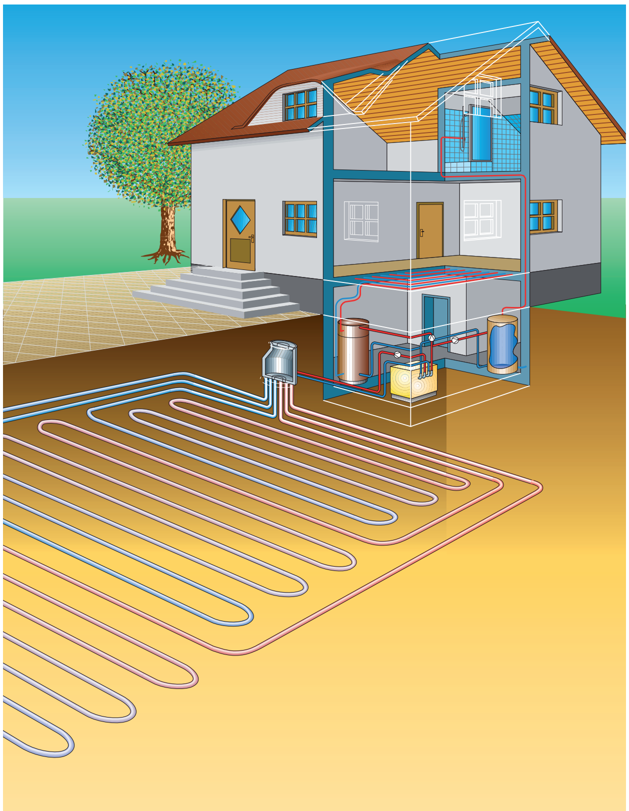


Fig. 43: Ground-coupled heat pump with flat plate collector

Brine-water heat pumps use an anti-freeze liquid which is called "brine" for exploring heat sources. This liquid circulates in the geothermal probes.
The heat extracted from the ground is transferred to the respective heating system after being increased to the heating water temperature. Brine-water heat pumps achieve high coefficients of performance between 3.8 and 5.0. They are available in different designs, with and without integrated drinking water storage tank. If the heat pump has a cooling function, it can also be used to keep the temperature of rooms low in summer: Then the heat extracted from the rooms is delivered to the geothermal probe or the ground-coupled collector.

Water-water heat pumps

In the water-water heat pump, the heat is removed from the groundwater. A suction well brings the water up, the heat pump removes the heat from it. Then the cooled water is returned to the groundwater by means of an injection well. The water-water heat pump can achieve the highest annual coefficients of performance of more than about 5.0, as it uses the almost equally high temperature level of the groundwater of about 15 °C. Water-water heat pumps are offered just like the other heat pump types with or without hot water storage tank.
A cooling function is possible also with them. In order to install them, a permission must be usually obtained from the local water authority.

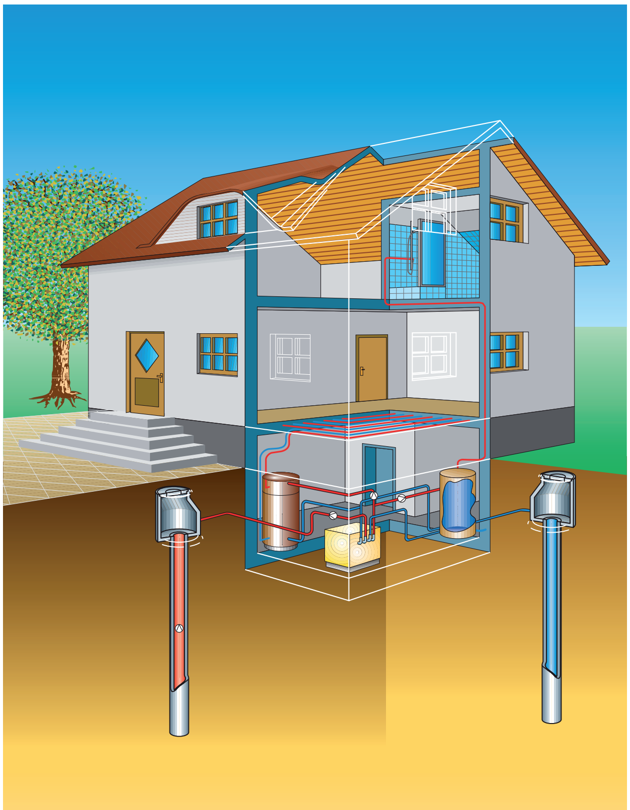


Fig. 44: Water-water heat pump with suction and injection wells

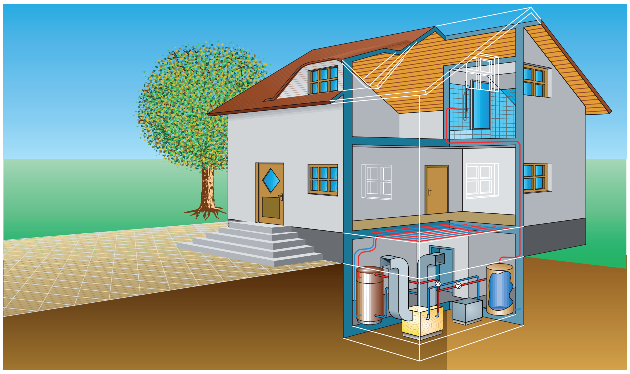


Fig. 45: Internally installed air-water heat pump

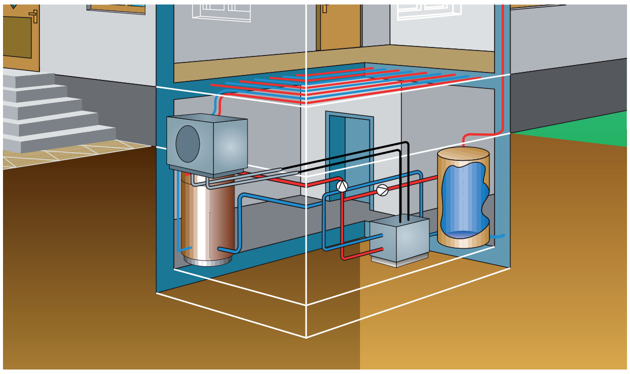


Fig. 46: Air-water heat pump as a split system

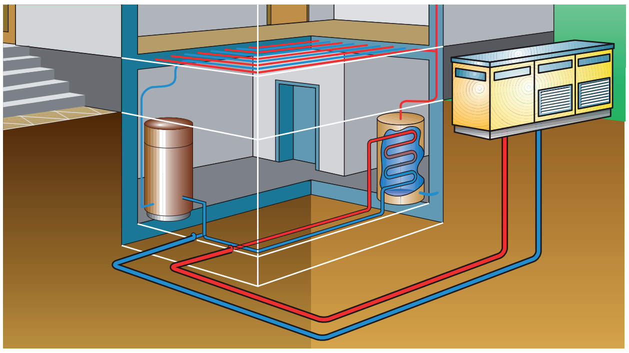


Fig. 47: Externally installed air-water heat pump

Air-water heat pumps

Air-water heat pumps use the ambient air to remove heat from it. They are able to withdraw energy from the external air even when the temperature is -20 °C or less. Air-water heat pumps achieve only annual coefficients of performance from 3.0 to 4.0 because the heat source temperature fluctuates and is often lower than that of the other types of heat pumps during the heating period. Complex utilisation of heat sources, which is required for brine-water and water-water heat pumps is omitted for this. Some air-water heat pumps also provide a cooling function that can be used in summer.

Application in the system

In solar thermal systems, the solar energy is used to extract thermal energy.

Solar collectors convert sunlight into heat that can then be used for heating buildings. This saves a lot of energy and thus, fossil fuels as well.

Solar thermal system allows combination with all heat generators

Solar thermal systems are usually designed bivalent. To take advantage of solar heat, the system must be well-matched with the other heat generators – the systems may not work against each other. The desired savings can be achieved in the end only with an overall system with optimised control technology and hydraulics.

Domestic hot water preparation

If the solar thermal system is used to prepare domestic hot water, solar collectors will be installed at first on the roof to allow heating of the heat transfer medium by the sun. A frost-proof and heat-resistant medium is used as the heat transfer medium in the solar circuit. The heat recovered heats the solar storage tank via a heat exchanger. Only when the solar energy is not enough, the conventional heat generator is turned on.

Other components of the system are pumps, temperature indicator, expansion tank, vent and controller for regulating the solar pump. The solar-assisted domestic hot water preparation covers about 60 % of the energy demand.

Auxiliary heating

Support of indoor heating besides domestic hot water preparation requires increase in the collector surface by 2 to 2.5 times. Depending on the heat insulation of the building, this saves 10–30 % of fuel. For low-energy buildings, it can be as high as 50 %.

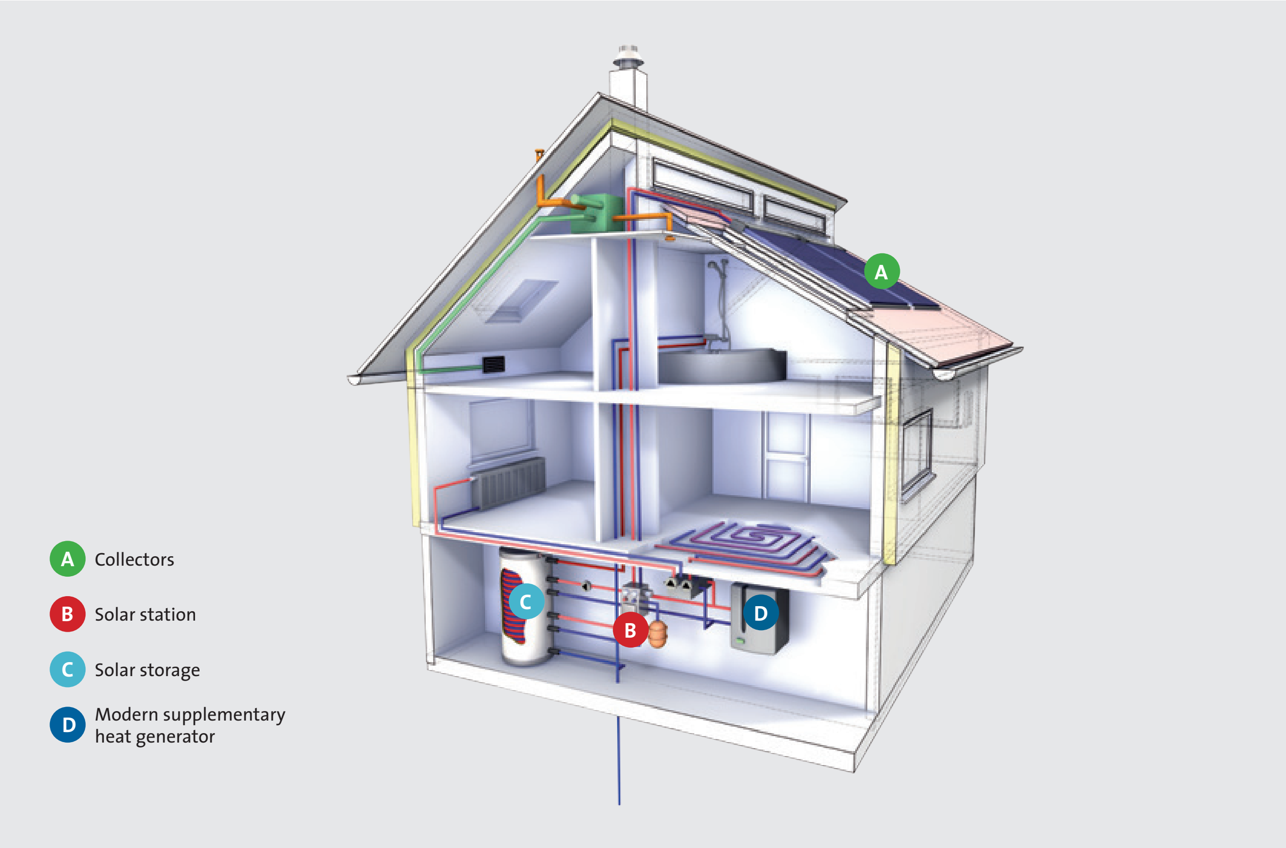


Fig. 48: Solar thermal system in a detached house

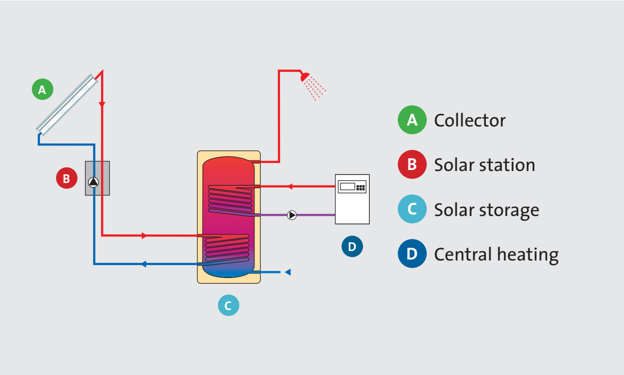


Fig. 49: Standard solar thermal system for domestic hot water production in a detached house

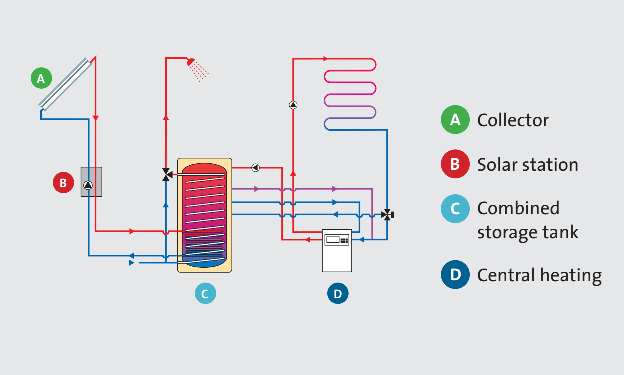


Fig. 50: Solar system for supporting indoor heating and domestic hot water heating with combined storage tank

Fig. 51: Example of solar installations – Flat plate collector

Fig. 52: Example of solar installations – Vacuum tube collector

Storage tank

In auxiliary solar heating, either a second storage tank (buffer storage) or a combined storage tank with built-in domestic hot water processing unit is used. All systems are also available with batch loading facilities.

Large potential

Solar thermal systems for domestic hot water preparation and auxiliary heating are now mainly installed in residential buildings – especially in one and two-family homes. High growth rates are expected for apartment buildings in the future.

Grants and low-interest loans accelerate this trend. Even hospitals, hotels and sports facilities can save energy using a solar system. Almost all heat consumers allow auxiliary heating using solar thermal system.

Other applications

Solar collectors can also produce hot water for outdoor and indoor swimming pools, thus saving enormous energy costs.

In southern countries, there are systems that operate on the thermo-siphon principle with a heat-insulated storage tank above the collector.

The solar thermal support to commercial or industrial processes is still in its infancy, but offers huge potential. The same applies to thermally driven chillers for solar air-conditioning.

Wide scope of applications

Almost all the requirements and technical systems in the heating market can be meaningfully combined with a solar thermal system. Ready-made system solutions are now available for most applications. These pre-assembled systems shorten the set-up time significantly.

The unit pre-assembled as a solar station allows quick and safe commissioning. High workmanship and good material ensure reliability and secure the energy savings over decades.

Several combination options of the various components enable flexible use of the solar thermal system

Collectors

The member companies of the BDH produce collector types with different parameters and dimensions. All collectors are characterised by their high quality and long service life. Besides architectural considerations, the selection of the collector always depends on the intended application.

The solar liquid flowing into the solar collectors is frost-proof and biologically safe down to -30 °C. The pump for the solar circuit is very economical to use, and is regulated as required. All fittings and pipelines are suitable for high temperatures and operation with glycol.

Flat plate collectors

Flat plate collectors are currently the most widely used collector type. Selectively coated high-performance absorbers provide for maximum heat output at all times.

These collectors allow versatile architectural design options and are suitable for both in-roof installation as well as on-roof or flat roof mounting.

Vacuum tube collectors

Vacuum-assisted insulation (evacuated glass tube) allows achievement of high outputs in applications with high target temperatures. In standard applications, the vacuum tube collector requires a smaller area than a flat plate collector, based on the average annual output.

Storage tank

For all applications, sophisticated types of storage tanks are available to the consumers (bivalent drinking water storage tank, buffer storage tank and combined storage tank). Common quality characteristics are their slim, tall design and seamless insulation, with which the stored heat can be kept best.

Fig. 53: Example of vacuum tube collector installations

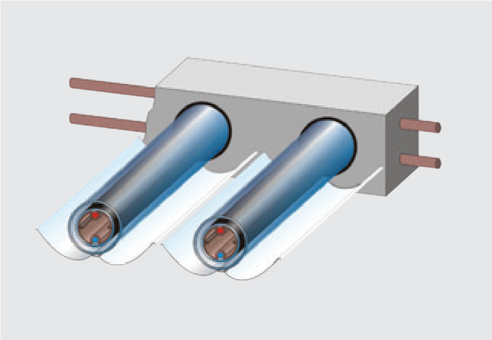


Fig. 54: with externally mounted reflector

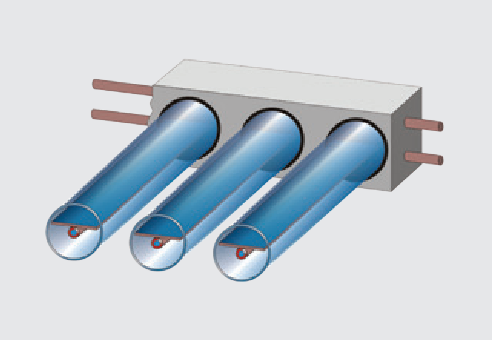
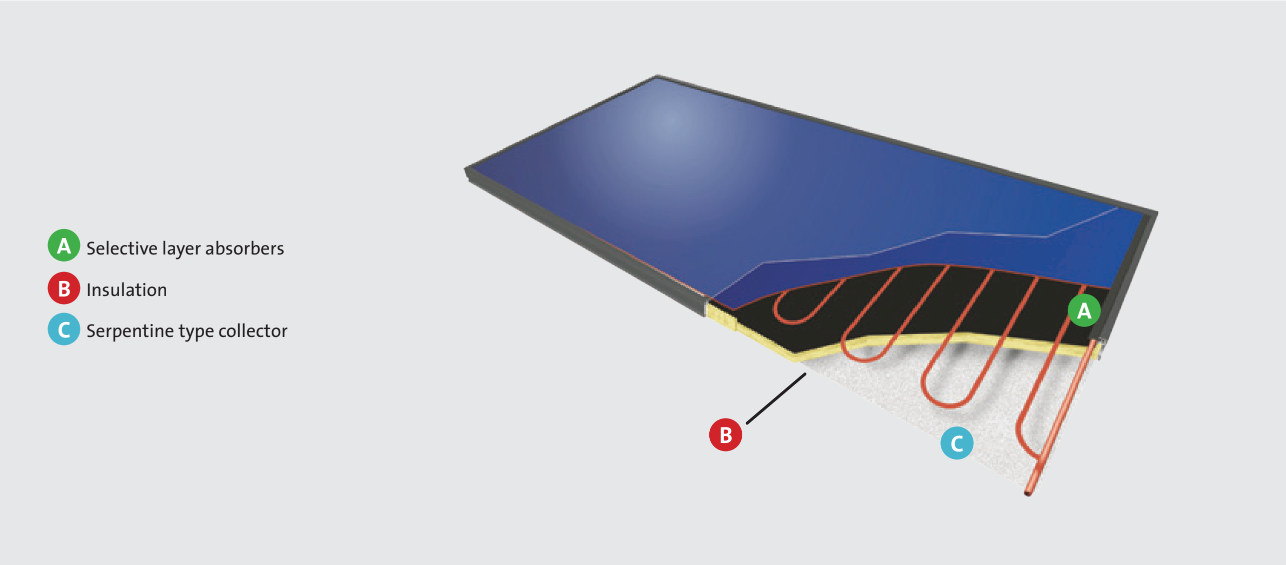


Fig. 55: without reflector

Fig. 56: Example of flat plate collector installations



Pleasant warmth from the nature

Modern heating systems were operated for many years almost exclusively with oil or gas. Today, a fuel with a long tradition is used more intensely: Wood is a constantly renewable resource, which can be obtained relatively easily with less energy expenditure. Especially in Germany, as part of sustainable forestry, no more wood than what regrows at the same time is obtained from forests – which makes it even more environmentally friendly. Moreover, thanks to the high forest volume in Europe, long-term ability to supply wood is considered secure.

Efficient single room wood furnaces supplement the heating system.

Wood can be used in various forms for heating. The most common is the use of split logs, wood pellets and wood chips. Here, wood is suitable to heat individual rooms and as a fuel for centralised heating of the whole building. The output range, the storage options, manual labour associated with the wood and the individual preferences of the owners and residents are primarily decisive.

Single-room wood fireplaces for the living room

There are two effective types for the heating of individual living rooms: Air-guided living room devices and living room devices with collection basin. In both types, split logs, wood pellets and wood chippings are especially used.

Air-guided living room devices

This category includes especially wood burning stoves and pellet furnaces: Both furnace types burn the wood in a separate combustion chamber, emitting less pollutants. Air ducts in which the indoor air heats up go past the combustion chamber. The indoor air is then passed back into the living room.

Moreover, the furnace itself dissipates radiant heat which is felt by many people as particularly pleasant.

These single-room furnaces with direct heat radiation have an output range of up to 10 kW. They are used primarily for heating individual rooms, as additional or transitional heating and to cover peak loads

Living room devices with collection basin

In living room devices with so-called collection basins, the heating water circulates inside the fireplaces. The devices are integrated into the centralised heating and hot water system of the house via a built-in heat exchanger. In addition to direct heat dissipation to the room in which the fireplace is installed, heat for auxiliary heating and/or domestic hot water preparation is produced in the furnace.

In low-energy buildings, such a pellet furnace or wood burning stove with collection basin can significantly relieve the load of the main heating system.

If living room devices with collection basin are also used for domestic hot water preparation, they should also be in operation during summer, namely even if no heating is required for the air. Therefore, this heating system is well suited for a combination with a solar thermal system: Thus, each of the two heating systems can bring about its unique strengths during the appropriate season.

Example: Pellet furnaces for the living room

Pellet furnaces for the living room offer numerous advantages: The pellets are led automatically from the storage container directly into the furnace. The control is electronic – depending on the desired room temperature. It is more accurate, convenient and efficient than manual firing.

Heating devices of the latest generation have high efficiencies of over 90 %, radiate a pleasant warmth and have low emissions.

Interested parties can choose from a wide range of models in various sizes, designs and price ranges. Automatic operation becomes very convenient through the use of modern control systems, such as indoor or time-controlled thermostats; moreover, remote control via mobile phone is also possible. Of course, operation can be controlled irrespective of the indoor air temperature upon request.

Fig. 57: Wood and wood pellets are CO_2 neutral fuels

Fig. 58: Pellet furnace with pellet storage tank

1. Wood burning stove with water heat exchanger
2. Inlet of thermal outlet protection
3. Adapter assembly for hydraulic connection of the furnace to the buffer storage tank
4. Electronic thermostat for controlling the pump
5. Central heating
6. Buffer storage tank min. 500 l
7. Hot water consumer
8. Radiators
9. Solar collectors

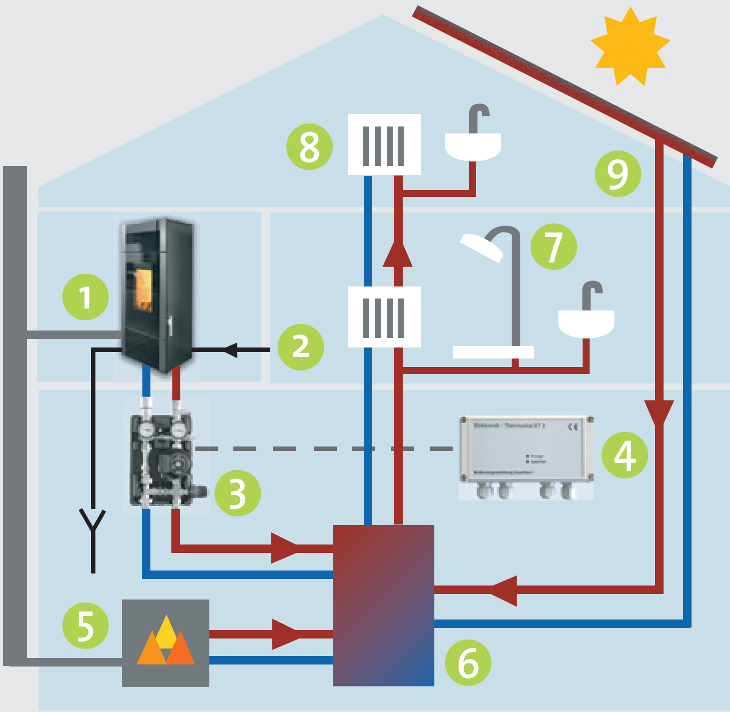


Fig. 59: Integration of a wood burning stove with collection basin in the heating system

Wood-based central heating systems

Environmentally friendly and flexible: Wood-based central heating systems are capable of supplying an entire house with heat throughout the year. They are suitable for use as a renewable energy in single family houses and apartment houses, business establishments and as a solution, in conjunction with district heating systems. Wood-based central heating systems can easily be combined with solar thermal systems.

There are three systems for Wood-based central heating systems: Pellet boilers, split log boilers and wood chips firing. In all these systems, combustion is very efficient and low on emissions.

The centralised wood-fired heating system as regenerative alternative to oil and gas

Wood burns as a renewable energy from a renewable resource in a carbon-neutral manner. Thus, all the technologies described here make an important contribution to climate protection.

Pellet boilers

Central heating systems, which are operated with wood pellets are particularly convenient. During operation and maintenance, they are comparable to oil and gas heaters. Hybrid and combination systems can also be loaded with other firewood such as wood chips or split logs.

The pellets are stored in a storage room or tank and supplied to the boiler by means of either a suction or screw conveyor system. Pellet boilers achieve high boiler efficiencies of over 90 % with low emissions. The systems are fully automated and can be modulated in a power range of 30 to 100 %. Operation, independent of the indoor air, is often possible

Wood gasification boiler

Wood gasification boiler is used to burn split logs efficiently. To this end, the individual stages of wood combustion (wood gasification and wood gas combustion) occur separately. This local division – in conjunction with a sufficiently dimensioned heat exchanger surface area – ensures particularly low emissions, low flue gas temperatures and high boiler efficiency.

An induced draft fan ensures the correct air supply: Excellent wood gasification is secured by the primary air duct. The secondary air supply is then responsible for complete combustion.

The boiler works intermittently, the boiler is filled and then burns out for several hours before it is refilled. Therefore, the combination with a buffer storage tank is a mandatory technical and legal requirement.

The use of a sufficiently dimensioned buffer tank increases the ease of operation significantly. Refuelling intervals of one to two times per day are possible even in winter.

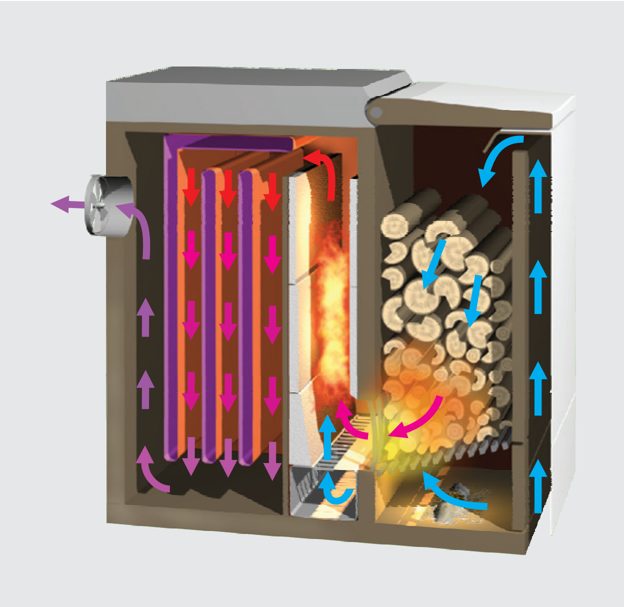


Fig. 60: Section of a wood log boiler

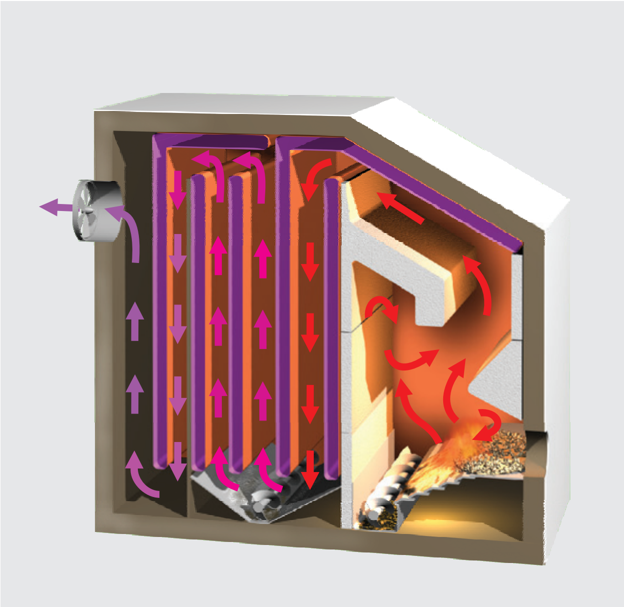


Fig. 61: Section of a wood chip boiler with push grate furnace

Wood chip boilers

Wood chip boilers work on the same principle as pellet boilers: The wood chips are transported automatically from a storage room into the boiler by means of a screw conveyor or similar device. An electronic control system regulates the combustion process and optimises it permanently. This guarantees good coefficients of combustion even for different fuels.

Power adjustment of up to 30 % of rated useful heat is possible for wood chips boilers. The output range of wood chip-fired central heating systems is immense, ranging from 30 kilowatts to several megawatts. This allows heating of apartment houses and entire business establishments.

The economic feasibility of a system increases with its size. This is why wood chip-fired heating systems are often found in larger residential or industrial complexes.

The fact that wood waste from the timber industry is often used in this system offers the opportunity of installing a larger wood chip-fired heating system primarily near woodworking companies. Finally, short fuel transportation routes also contribute to the economic and environmental benefits of a plant.

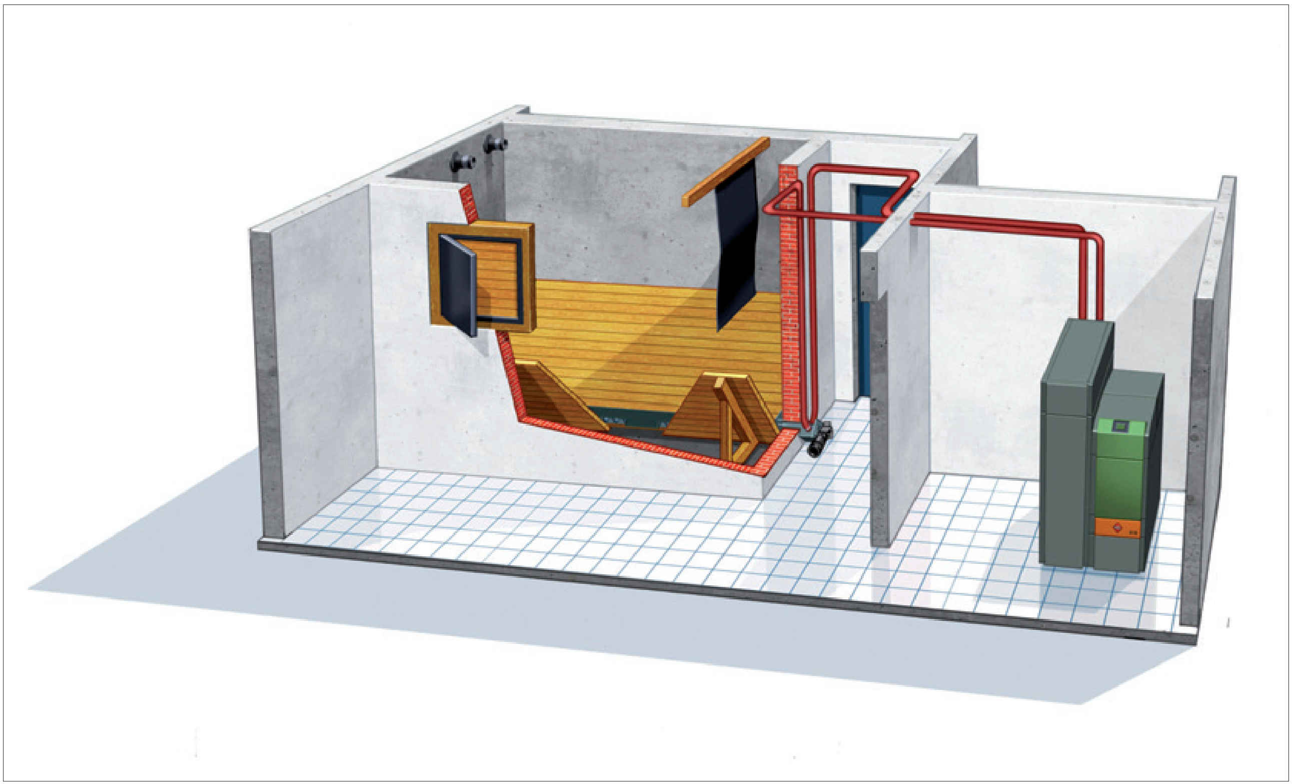


Fig. 62: Centralised heating with wood pellets

Generates more than just heat – even electricity

Conventional heating systems work according to a clear principle: The used energy carrier is converted into heat.

The so-called decentralised cogeneration of heat and power (CHP) system generates both electricity and heat. This saves energy and increases the efficiency of the system. Very high overall efficiency of over 90 % can be achieved through simultaneous production of electricity and heat. Losses due to waste heat, resulting in separate power generation in power plants, are avoided.

ALL-IN-ONE SYSTEM HEAT, POWER AND DOMESTIC HOT WATER

A power-generating heating system reduces energy costs and the primary energy demand, as well as climate-damaging CO_2 emissions. Thus, it makes a direct contribution to environmental protection.

The decentralised CHP is particularly worthwhile if heat and electricity are produced where they are needed, no heating grids are required and the equipment are operated at the base load (i.e. with operating times of more than 3,000 hours per year).

In many countries, the use of decentralised CHP is particularly encouraged. As a rule, self-generated electricity is subsidised, and there are incentives in the payment of taxes on energy.

Fields of application and their advantages

The range of decentralised CHP solutions offered is as broad as the demand:

- For single and two-family houses, there are so-called “micro-CHP systems” with a power range up to about 2 kW_{el}.
- For apartment houses and small and medium-sized businesses, there are “mini-CHP systems” with power outputs up to 50 kW_{el}.
- In the industrial sector and large residential complexes, CHP systems with more than 50 kW_{el} power are used.

Decentralised cogeneration of heat and power is a technology with a great future. Many decentralised CHP systems – together as a kind of “virtual power plant” – could soon help compensate for voltage fluctuations in the public grid, e.g. to pick up peak loads. This is necessary, e.g. in weather-related power fluctuations – a predictable consequence of the development of solar and wind power plants.

CHP systems are designed according to either the power demand of an object (supplied with power) or the heat demand of an object (supplied with heat). In general, they are orientated towards the heat demands of buildings.

However, the heat from decentralised CHP systems is used not only to supply the building with heat and domestic hot water. It is also used as process heat, for technical refrigeration, compressed air supply and allows other technical applications.

There is no standard classification of CHP systems. But small systems are usually classified as follows depending on their electrical power:

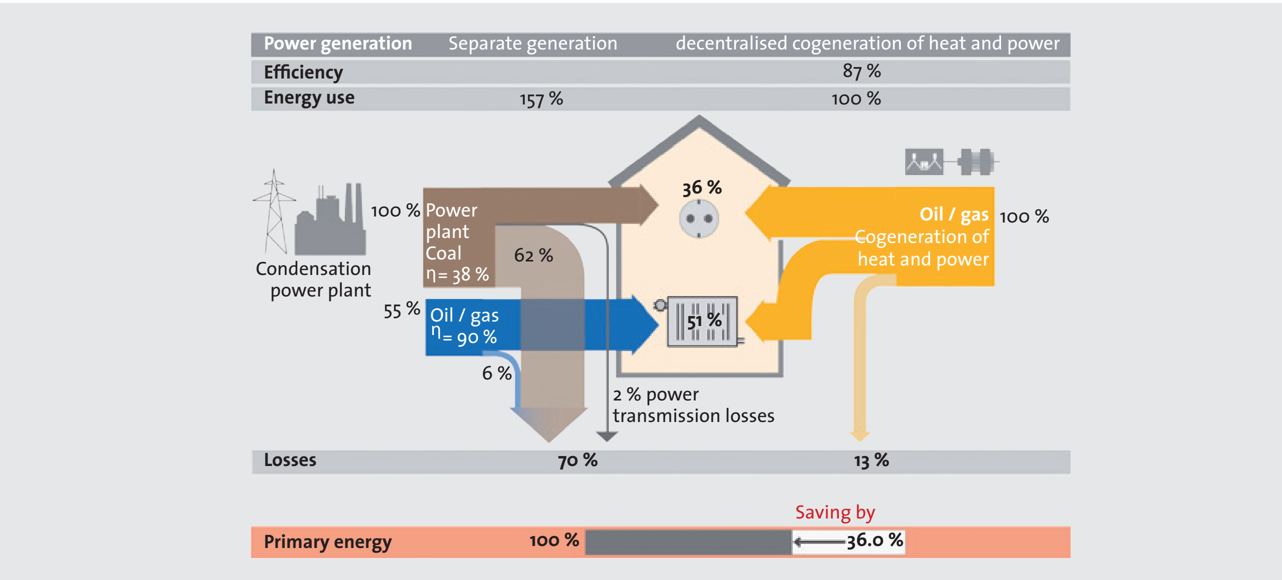


Fig. 63: Primary energy comparison

Micro-CHP	< 2 KW_{el}
Mini-CHP	2–50 kW_{el}
Small-CHP	50 kW_{el}–2 MW_{el}

The so-called micro-CHP systems with specified power outputs of 0.3–2 kW (electric) and 2.8–35 kW (thermal) cover the lowest power segment of the CHP technology.

In terms of their dimensions and weight, micro-CHP systems are comparable with conventional heating technologies.

CHP systems are usually operated in conjunction with a condensing device. They are suitable for installation in the cellar and on the roof same as in the living area. The systems are easily integrated into existing heating systems and help to reduce the purchase of electricity from the public grid. Excess power generated can be fed into the public grid. The local power utility company takes it off and pays for it as well.

Micro-CHP technologies

Micro-CHP systems from several manufacturers are currently available. They can be primarily distinguished

- in the technology used,
- in their power and thermal output and their ratio to each other (coefficient of power),
- in the possibility of modulation
- and the fuel used.

Heat and power units and fuel cells are available as basic technologies. The former units are classified as follows:

- Internal combustion engines (e.g. petrol engine)
- External combustion engines (e.g. Stirling engine and steam expander)
- and micro-sized gas turbines.

The most developed micro-CHP systems that are already available in the market are based on combustion and Stirling engines.

Stirling engine

The Stirling engine works with external combustion, through which a working gas (such as helium) is heated from the outside. The gas expands and flows into the region, which is cooled with water from the heating circuit of the building. There, a working piston is pushed upwards, as a result of which the piston in the hot area displaces more gas into the cooler area. After the piston has reached the top dead centre in the cold region, it pushes the cooled air back into the hot area. There, it is reheated, expands and the process restarts from the beginning.

Stirling engines operate quietly, with low emissions and virtually no wear. Similar to refrigerators they have hermetically sealed workspaces, which reduces maintenance costs considerably. Relatively low electrical efficiencies (about 10–15 %) combine with high thermal efficiencies, so that an overall efficiency of over 95 % can be achieved.

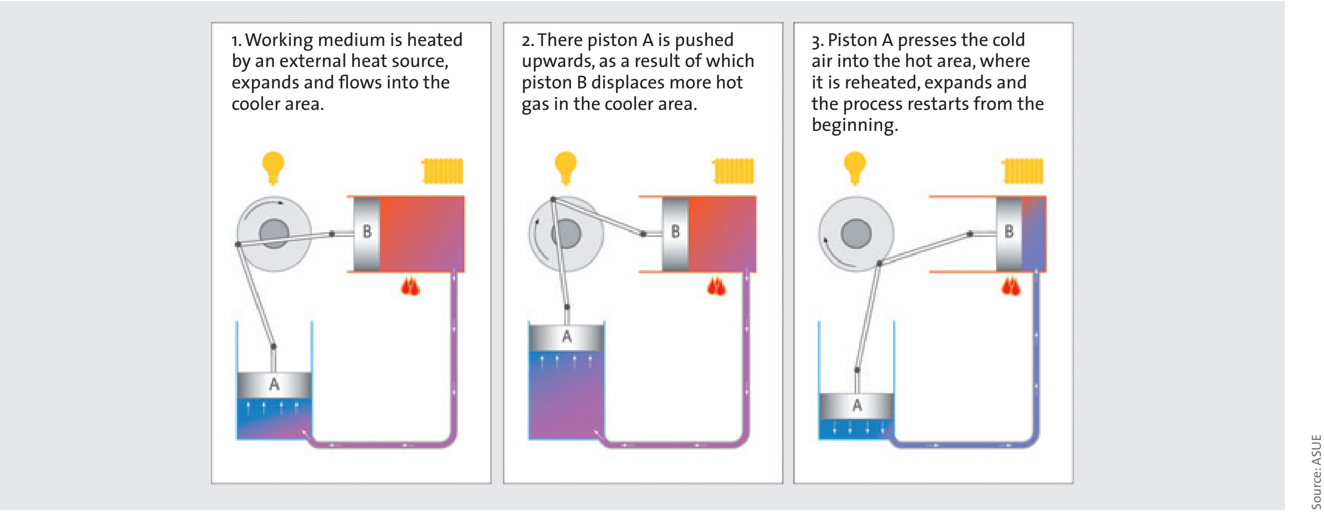


Fig. 64: Functional principle of Stirling engine

Maximum efficiency with natural gas by using renewable energies

The gas-fired heat pump combines high efficiency gas-fired condensing technology with environmental heat.

In this way, renewable energy can be used relatively easily for heat supply to new and existing buildings. The gas-fired heat pump systems are classified into compression, absorption and adsorption systems according to their ways of working.

Gas-fired heat pump links efficient technologies of condensing boiler and heat pump

Gas-fired compression heat pumps

The functional principle corresponds to that of the conventional compression heat pumps: The devices are driven by an combustion engine and additionally utilise the waste heat of the engine.

Gas-fired adsorption heat pumps

Gas-fired adsorption heat pumps operate under vacuum: The refrigerant water vaporises in a closed container, where it is adsorbed, desorbed and liquefied again. Besides the refrigerant water, the environmentally friendly mineral zeolite is also present in the tank.

The actual process takes place in two sub-steps. First, the water is evaporated with free heat from the environment and then absorbed by the zeolite. The heat released by adsorption is used directly for heating purposes. Then the water is expelled (desorbed) again from the sorbent with the help of the gas burner and then condensed. Through condensation, the water also delivers the “saved” environmental heat to the heating system. Then the process can start all over again.

Compact gas-fired adsorption heat pumps made of a sorption module and a gas-fired condensing module: The condensing module drives the sorption process and covers the peak load of the heating system. The compact gas-fired adsorption heat pumps have a modulation range from 1.5 to 16 kW. They are particularly efficient in low temperature heating systems. The environmental heat is extracted from the soil, the air or solar radiation.

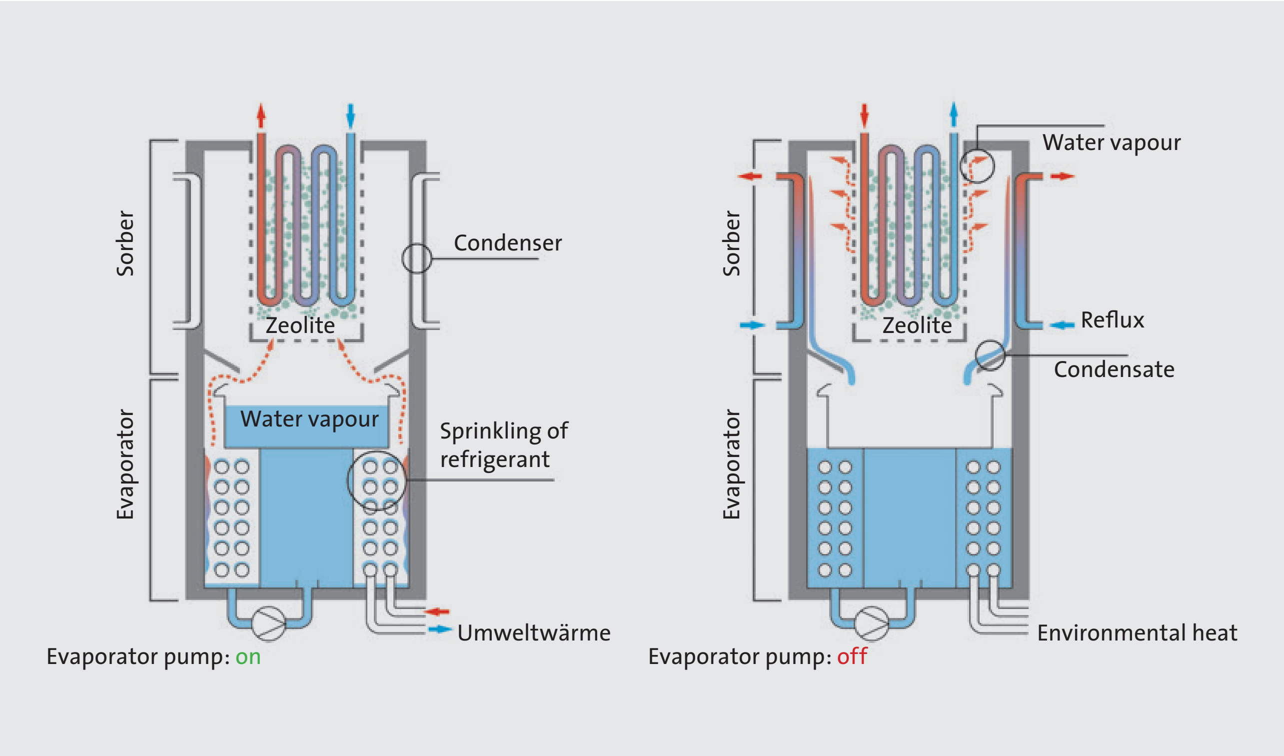


Fig. 65: Technical diagram of the Zeolite compact device

Gas-fired absorption heat pumps

The gas-fired absorption heat pump operates at excess pressure: Besides the refrigerant, another liquid medium with the absorbent is contained as a solvent. The gas-fired absorption heat pump has a thermal compressor, which consists of the absorber, the solution pump, the generator and the pressure reducing valve.

The thermal compression runs continuously in four sub-steps: In the absorber, the refrigerant is absorbed at a low pressure and low temperature by the solvent. The result is a "rich" solution with a high refrigerant content. It is transferred from the solution pump to the generator and heated there with a gas burner. As a result, refrigerant vapour escapes at elevated pressure and is fed to the condenser. The remaining "poor" solution with low refrigerant content flows through a pressure reducing valve back into the absorber where it is cooled.

As with compression heat pumps, the environmental heat is absorbed in the refrigerant evaporator and delivered to the condenser.

Compact gas-fired absorption heat pumps cover a power range from 20 to 40 kW and can be interconnected to form cascades. They are also used especially in low temperature heating systems. The environmental heat is extracted from the soil, the air or solar radiation.

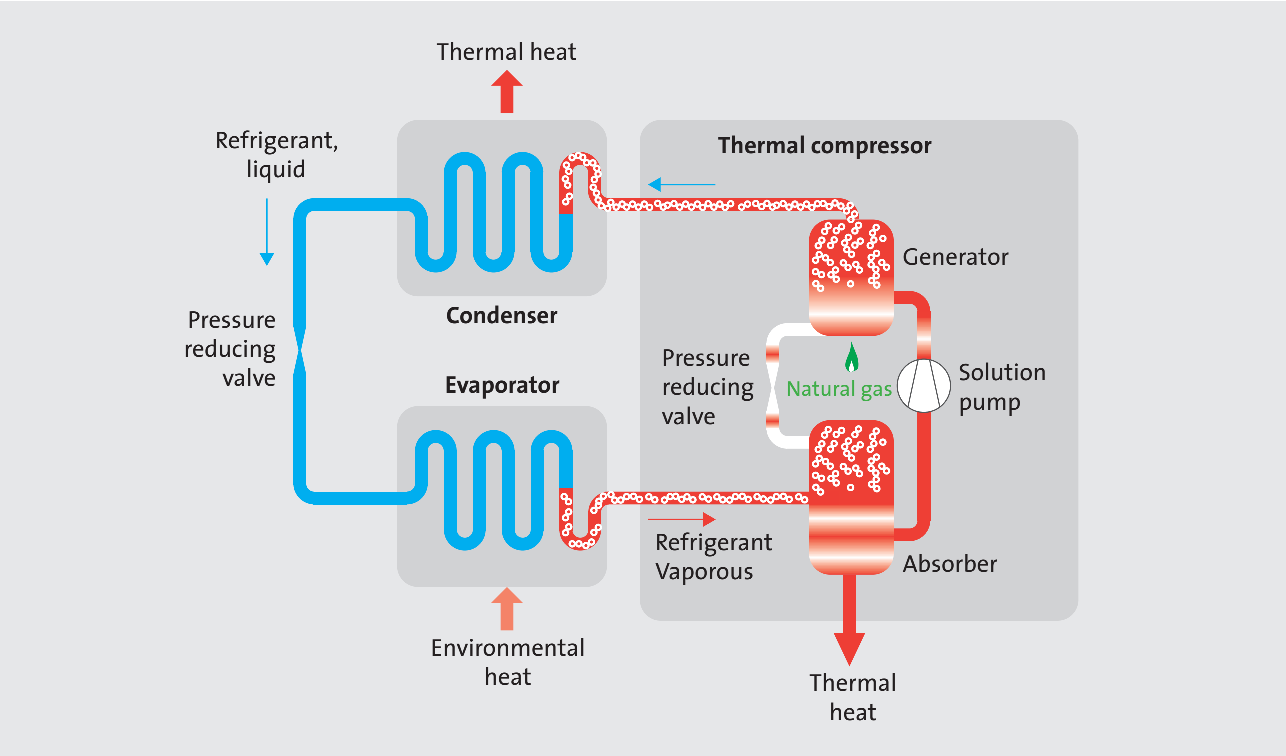


Fig. 66: Layout of an absorption gas heat pump

Fittings and high-performance pumps contribute to efficient heating operation

Hydraulic balancing saves costs and reduces emissions

The figures are impressive: Residential buildings account for about one-third of the energy consumed in Germany. The largest share is held by the heating energy.

Hydraulic balancing of the heating system is required to achieve the high efficiencies of modern heating systems. The individual components of the heating system are precisely coordinated, so that the heat only gets to where it is needed.

Sounds logical, but is rarely implemented: Few heating systems in Germany – only about ten percent – are currently hydraulically balanced. Climate protection aspects implies an annual reduction potential of around 10 to 15 million tonnes of CO_2 which remains untapped.

The path of least resistance

The hydraulic balancing secures the demand-driven hot water supply in the building. Through the regulation of the valves and pumps, the system is calibrated so that only the hot water quantity required as per the design or demand will be provided in each room. Without hydraulic balancing, the water is distributed in the piping according to the principle of least resistance. The result: Heating surfaces in remote rooms are supplied insufficiently and not really with warm water. It is often tried to compensate for this through more powerful heat circulating pumps. In the end, power consumption and the electricity cost shoot up.

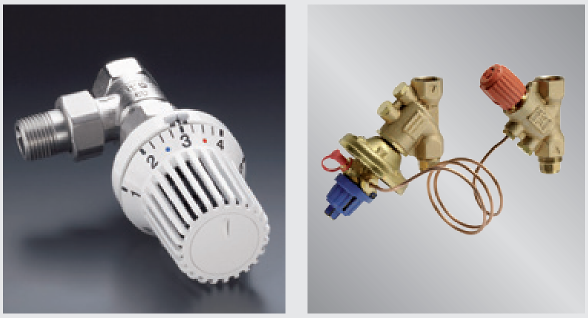


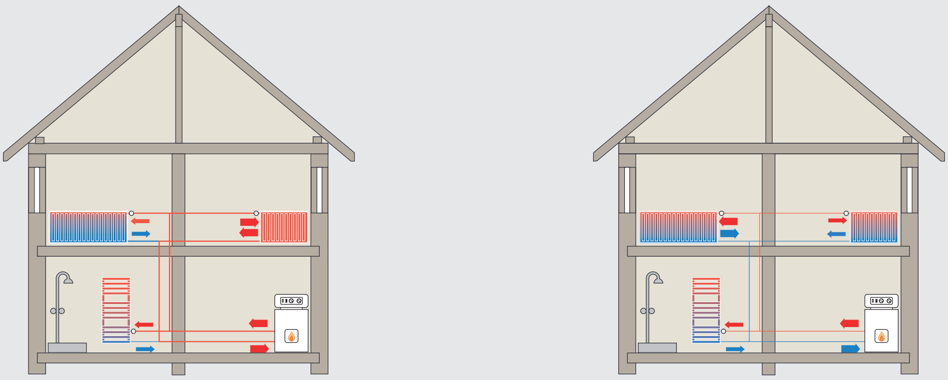
Fig. 67: Valves

Moreover, a non-balanced system can significantly reduce the efficiency of a condensing device: Oversupply to individual heating surfaces leads to higher return temperatures in the system. The water vapour in the flue gases of the condensing device can condense only conditionally or not at all. Therefore, less heat is used – and the savings that are usually brought about by a modern condensing device would be nullified.

Sounds as indicators

Typical signs of lack of hydraulic balancing are radiators that do not or become hot only very late after the automatic night setback, while oversupply occurs in others and the radiator valves throttle down the excess supply of hot water. This is often associated with sounds in the valves and piping, because the differential pressure in the valve or the flow rate is too high. It may also happen that the radiator valves do not open or close at the desired inner temperature due to excessive differential pressure.

Hydraulic balancing pays off: The system can then be operated with optimum system pressure and a lower volume flow rate.



Heat-distribution system not balanced – high return-flow temperatures

Balanced heat-distribution system – low return-flow temperatures

Fig. 68: Hydraulic balancing

This reduces energy and operating costs dramatically. Saving of up to 15 percent of the heating energy costs is possible.

EnEV, VOB & Co.

The Energy Conservation Regulation (EnEV) requires that technicians confirm as part of the subcontractor declaration in writing that their services comply with the ordinance, that the hydraulic balancing has also been executed, in case it has been included in the verification procedure. Even according to the German Construction Contract Procedures (VOB) Part C and DIN 18380, technicians are obliged to balance the set-up of heating systems hydraulically. In addition, it is required by all relevant funding programmes of KfW or the Federal Office of Economics and Export Control (BAFA).

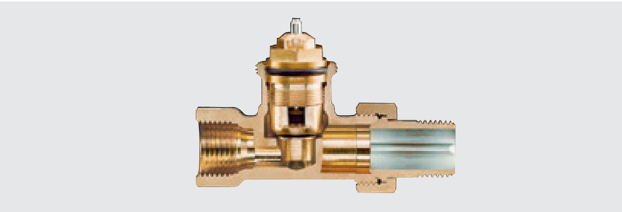


Fig. 69: Valve with a presettable valve insert for the adaptation of the flow rates to the required heat demand

Calculating the heating load, adjusting the heat output

The heating load for each room of the building is calculated at first for hydraulic balancing. The exterior surfaces, walls, ceilings, windows and doors are included in the calculation. According to the calculated heating load, the heating surface with the required heating output is chosen. Moreover, the different pressure drop en route the heat generator to the heating surface should be considered. At the end, all these variables result in the settings for the individual heating surfaces. Hydraulic balancing is achieved when all parallel systems each have the same hydraulic resistance.

In order to perform the hydraulic balancing, pre-settable thermostatic valves or return fittings on the radiators are required. Modern thermostatic valves are characterised by pre-settable valve body for hydraulic balancing and visually responding thermostat sensor with high control performance. Timed radiator controllers are especially useful for professionals who are absent on a daily basis.

The advantage is when the heating system is a 2-pipe system, as 1-pipe systems can be balanced only to a limited extent.

The data for a single-family house are recorded in about one and a half hours and analysed in about one to two hours. The heating surfaces are set within about five minutes per heating surface. The cost of hydraulic balancing will depend on the building size and amounts to around 500 euros for a single-family house. An investment that pays off quickly because of the high energy savings.

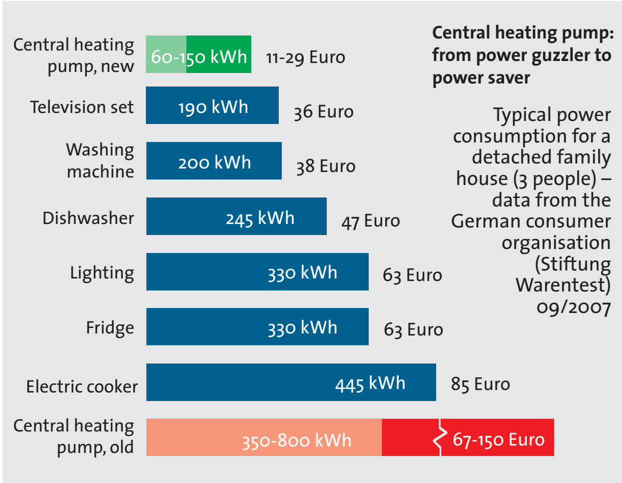


Fig. 70: Saving potential of pumps

Efficient circulation pumps controlled based on the demand

Inspection of the built-in heating pump is always a prerequisite for hydraulic balancing. Unregulated pumps that are oversized in almost all cases need to be replaced so that the benefits of hydraulic balancing can be fully utilised.

From January 2013, in accordance with the ecodesign requirements, the market has access only to circulating pumps that meet the stringent energy efficiency class A – the so-called high-performance pumps. These are much more efficient and adapt to changing performance requirements of the system continuously. Thus, they not only save valuable electrical driving power at full load, but also in the predominant partial load operating condition of the heating system. Compared to the old, unregulated heating pump, power savings up to 80 % can be achieved.

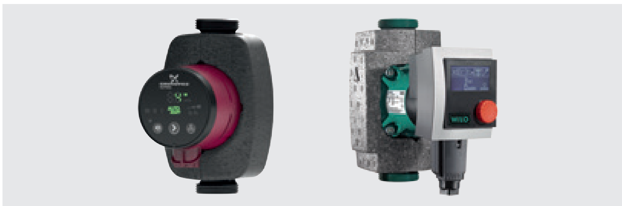


Fig. 71: High-performance pumps according to ecodesign guideline 2013

Heating and cooling in one system

More than half of the builders opt for an embedded heating system when constructing a single-family house newly.

The system is permanently installed in floors, walls or ceilings, and thus forms an integral part of the building. Embedded heating and cooling systems fulfil two functions at once: In winter, they heat the rooms, while in summer, they reduce the temperature of the indoor air noticeably by 4 to 6 °C. Thus, owners consider them as an investment for the future.

Through their large-area installation, they ensure even distribution of heat in the room, and thus contribute to a pleasant indoor climate.

Double application (heating and cooling) freely connected to all heat generators

Wide range of solutions also for old buildings

Conventional floor-heating constructions are often unsuitable for older buildings, because the required design height is not given, or problems related to load-bearing capacity of ceilings may arise. Therefore, special embedded heating systems that can also be installed in existing buildings without massive interventions are designed for installation in the wall, floor or ceiling and subsequent integration. The variety of systems available on the market today range from wet systems (screed or plaster) through dry systems to special thin-film systems. This offers builders the best solutions for new construction as well as modernisation.

More comfort, less costs

In embedded heating systems, generally low system temperatures are sufficient (35/28 °C) – perfect for heat transfer using condensing boilers, heat pumps and solar thermal systems.

Here, the low system temperatures pay off the residents in two ways: the potentially large energy savings and the enormous increase in cosiness and comfort. This can be enhanced by smart individual room control.

Another advantage is that the invisible installation of embedded heating systems in walls, floors and ceilings gives the residents a lot of free space for interior decoration.

Effective cooling in summer

With the additional function "cooling", the embedded heating system can be used in summer for cooling the indoors in a simple and inexpensive way: In this process, cold water circulates through the pipes, lowers the temperature of the floor, ceiling or walls, and thus the rooms by up to 6 °C, without the occurrence of any draughts.

However, the performance of an embedded cooling system cannot be compared with an air-conditioner. It also depends on the temperature difference between the supply and return flow of the cooling water. While the temperature difference during heating operation is usually around 8 °C, embedded cooling with a spread of less than 5 °C should be used.

Embedded cooling systems are designed to make use of natural heat sinks such as ground water or ground, because of the small temperature difference required between the cooling water and indoor air temperature (e.g. 18 °C cooling water supply temperature). This makes the cooling operation extremely energy efficient.

Fig. 72: Embedded heating/cooling provides cosiness and comfort also in old buildings

Fig. 73: Embedded heating/cooling may be used variably

Fig. 74: Cosiness and comfort in multiple areas of application through embedded heating/cooling

Avoiding condensate formation

A controller which covers both the heating and cooling functions must be installed to regulate the system temperature during cooling operation. It ensures that the system temperature of embedded cooling systems always remains above the dew point, so as to prevent condensate formation on distribution pipes and heat-transmitting surfaces. In addition, exposed cooling water pipes should be insulated. Condensate formation occurs on cool surfaces when their temperatures fall below the dew point, namely the temperature at which a relative humidity of 100 % is reached when the air cools.

The different typical designs of the embedded cooling system in the living areas of a residential building or office building reach on average a cooling capacity of about 35 W/m² in the floor, about 35–50 W/m² in the wall (depending on the layout) and about 60 W/m² in the ceiling (depending on the layout).

Conclusion

The heating load of a building is always fully covered by using an embedded heating/cooling system. In summer, the room temperature can be reduced to the extent that comfortable conditions are achieved again. In this way, it is possible that the room air temperature is at a feel-good range all year round.

Fig. 75: Double function: Heating and cooling in the ceiling area

Efficient, comfortable and sustainable

Thanks to the latest technologies, heating systems are becoming increasingly economical and efficient in terms of energy consumption. Be it natural gas, oil, wood, electricity or solar energy: Radiators can be integrated in any heating system regardless of the energy carrier, and are reliable, sustainable and future-proof.

Comfort and design provide a feel-good ambience

In order to benefit sustainably, heating surfaces that can react quickly to changes of the heat demand are required. This is met by modern radiators with low installation depths, low water content and high transmission areas. The variety is huge and ranges from products for low-temperature areas, e.g. ranging from use of a heat pump to adaptation to district heating systems. With the appropriate design, the right installation and the optimum technology, the indoor air temperature can be adapted instantly to the wishes of the residents creating perfect cosiness through radiant heat. Thus, energy can be saved both in construction of new buildings and renovation.

The quality of heat transfer is not only determined by the output of a radiator.

The heat can be optimally delivered only if the radiator is also mounted in the right place. The classic space under the window is still recommended: It makes sense from an energy perspective, and also offers residents maximum design freedom for an optimally customised solution. For efficient heat dissipation, the radiator should not be hidden behind furniture or curtains.

Comfortable temperature exactly to the degree

A heating system works through the interaction of many components – from the heat generator over thermostatic valves to the individual radiators. Maximum efficiency of the system can be achieved when all components are precisely matched with each other in terms of both energy and hydraulics.

An important role in this is played by thermostatic valves that keep the indoor heat constantly at the desired temperature. For this purpose, they have to rely on the correct differential pressure on the radiator which is determined by hydraulic balancing: It ensures a uniform flow through the heating system and improves controllability. It also eliminates noise and helps to reduce the consumption of energy and operating current.

Fig. 76: Numerous design options and intelligent accessories

Fig. 77: Simply upgrade modern radiators for individual living comfort

In order to achieve maximum heat dissipation with reduced water flow, modern thermostatic valves and fittings for hydraulic balancing, support the heating system in exactly setting the individual "feel-good" temperature also at different heating times. Time-controlled thermostatic valves preset the time at which the radiator should start with the heating – exactly to the desired temperature. An automatic shut-down is included.

Beautiful design and intelligent features

The many variations in shape, colour and design allow builders and designers an attractive, individualised interior and create freedom of design for the residents since the radiators fit seamlessly into the architectural environment. New radiators are available in almost all RAL colours – chrome variants are also possible. Those, who delight in the extraordinary, can also choose a powdered matte or stainless steel finish. Additional features and smart accessories such as towel bars or racks, hooks or even integrated lighting create feel-good accents.

Often radiators are also used as design objects or as mirrors, which fit into the ambience and match with the colour and design of the room.

Between modernisation and comfort

Most items are subject to ageing – this also applies to heating systems. Mainly the quality and functionality are affected. With advancing technical service life, often more energy is being consumed, components wear out and the comfort decreases. Therefore, modernisation of existing equipment aims at increased efficiency through energy-saving operation and optimum heat transfer using modern radiators.

When planning the modernisation of heating systems, owners compare especially the costs and benefits. This is because renovations, disturbances, dirt and noise are often unavoidable during modernisation.

Nowadays, planning and construction of new radiators takes into account the fitting accuracy to the existing connections, so that the replacement of old radiators with new high-performance radiators is no longer a problem in practice. Simple and quick installation of the radiators is the rule: empty, unscrew, screw, fill – done!

Fig. 78: Radiators allow attractive, individual interior design

The simple solution is in the air: Fresh air supply with comfort gain

Comfort without limitations

Ventilation systems supply fresh external air in a controlled manner to living rooms. Usually, they are equipped with multi-level control and perform several functions at once:

- They exchange exhaust air with unpleasant odours and perspirations with fresh air, and thus guarantee hygienically necessary air exchange.
- They reduce CO_2 and the so-called "VOC content" in the air. The abbreviation "VOC" refers to volatile organic compounds, namely chemicals that are released from, e.g. building materials, adhesives and paints, but are also found in tobacco smoke and exhaust fumes.
- They provide effective protection against unpleasant sounds and noise from the outside.
- They improve air quality and reduce humidity. This protects the building stock and helps to prevent ventilation-related mould formation. At the same time, the reduced humidity curbs propagation of house dust mites. (Mites are the most common allergens in the interior.)

If desired, the external air can be cleaned additionally by a pollen filter, which limits the exposure to pollen and allergens largely.

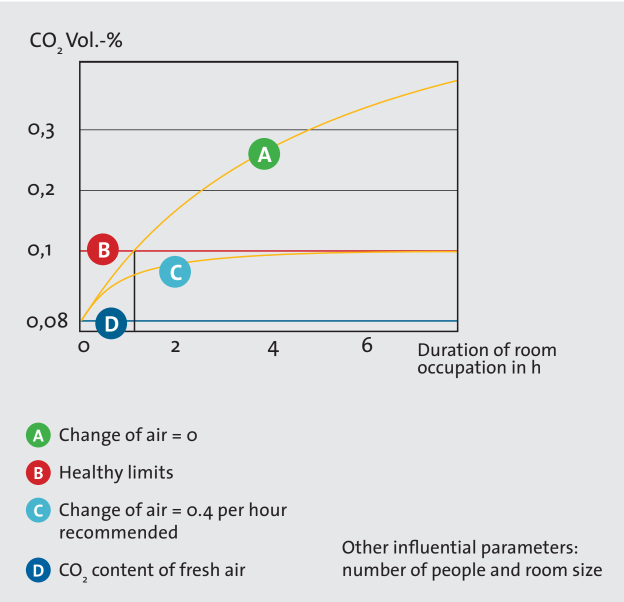


Fig. 79: Increased CO_2 concentration caused by an inactive person

Thus, living room ventilation systems offer numerous opportunities to find a customised solution for each individual requirement.

Systems with heat recovery

You can't do without ventilation. As a rule, it is associated with thermal loss because fresh air flows from the outside into the building. Only automatically operating ventilation systems can guarantee optimum balance between the required external air supply and minimal thermal loss.

Maximum energy savings results when the energy of the warm exhaust air is used to preheat the cooler external air (heat recovery). Modern systems are able to recover up to 90 % of the heat present in the exhaust air. To this end, plate heat exchangers, hydraulic circuit, rotary and counter-current heat exchangers and exhaust air heat pumps are used.

The minimum requirements for ventilation systems with heat recovery are clearly defined: Ensuring humidity protection and the necessary minimum air exchange, efficient heat transfer of at least 75 %, power consumption of less than 0.45 Wh/m³, exhaust air and external air filtration to ensure hygiene, condensate drain and overflow outlets between supply and exhaust areas.

Specific requirements

If a ventilation system with heat recovery is used, condensate which must be discharged is formed in the heat exchanger.

In addition, the heat exchangers should be protected against frost by means of, e.g. pre-heating battery, brine or geothermal air exchanger. As a welcome side effect, its use also reduces the heat demand. Underground heat exchangers are also able to control the temperature of air to a pleasant level both in summer and winter.

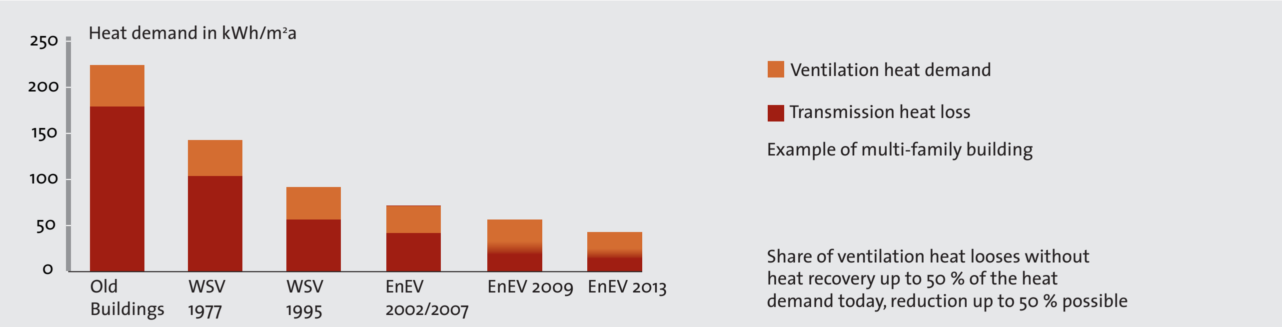


Fig. 80: Energy share of ventilation heat loss in heat demand

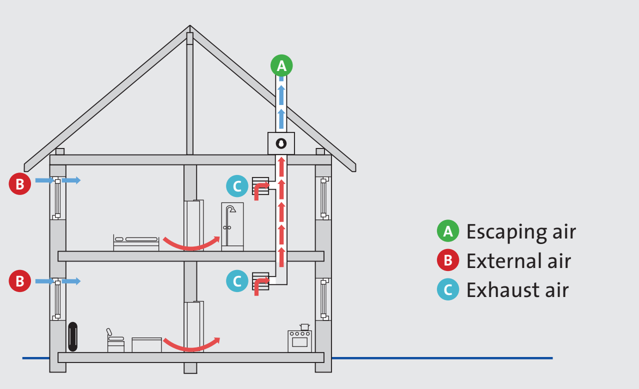


Fig. 81: Exhaust air system, centralised without heat recovery

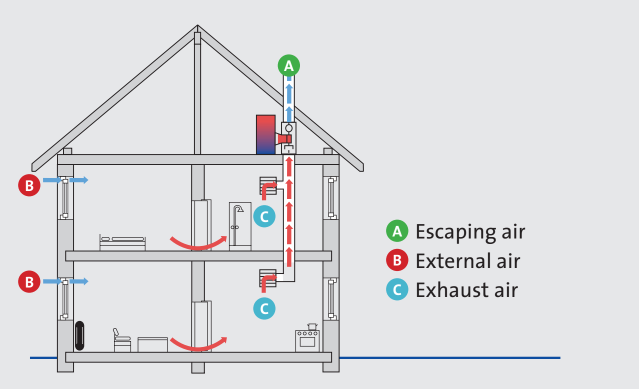


Fig. 82: Exhaust air system, centralised with heat pump

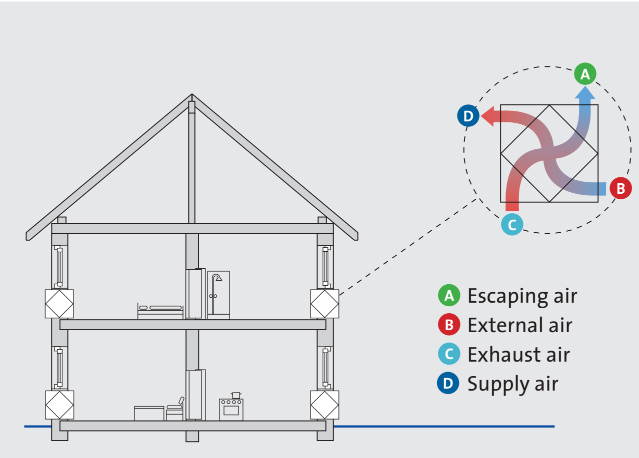


Fig. 83: Ventilation system, remote with heat recovery

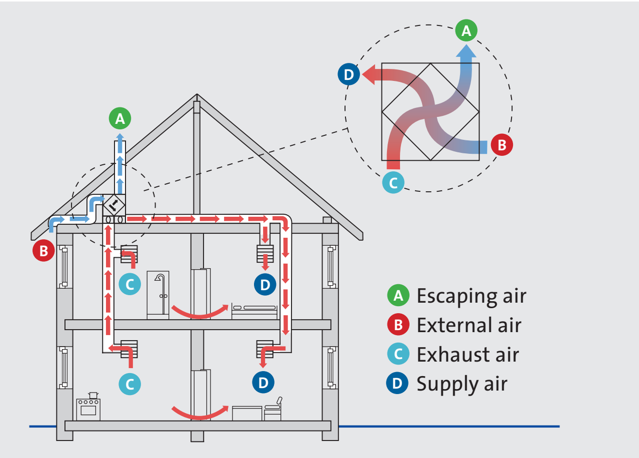


Fig. 84: Ventilation system, centralised with heat recovery per living unit

Comfortable indoor climate through energy-saving ventilation system

Mechanical ventilation systems are distinguished between decentralised and centralised ventilation systems with or without heat recovery.

Decentralised ventilation of individual rooms

This is the flexible solution: Several decentralised ventilation units are distributed in a living unit. A central air-distribution system can be omitted.

Centralised exhaust air system with heat recovery

The exhaust air from kitchens and bathrooms is extracted here via a central fan. The cold fresh air flows over external air valves into the outer wall of the living room and bedrooms. The correct direction of flow is important: The air is directed out of the living room, bedroom and children's rooms in the direction of the wet rooms (kitchen, bathroom and toilet). The external air supplied is heated by the existing heating system. An air distribution system is not a must.

Centralised ventilation system with heat recovery

Centralised ventilation devices only work in conjunction with an air distribution system: While one fan transfers the external air into the building, another one sucks the hot exhaust air from the rooms. A heat exchanger ensures that the heat from the exhaust air is transferred to the external air coming in. In this way, up to 90 % of the heat is recovered and used to heat the external air. The effect: Up to 50 % of the heating energy can be saved.

Centralised exhaust air system with service water heat pump for heat recovery

In this system, the ventilation system is combined with a service water heat pump for heating and domestic hot water preparation: The exhaust air flows through the heat pump. A refrigerant removes the majority of the heat energy from the exhaust air flow, and evaporates as a result. Thereafter, the refrigerant is compressed in a compressor, so that the stored heat energy can be delivered to the service water. Here, a system variant with auxiliary heating is possible.

The low-energy house

In a low-energy house, the heat demand is greatly reduced right from the beginning through air-tight type of construction and very good insulation. This also applies to renovation and modernisation measures, in which the windows are replaced and additional insulation is applied.

The air assumes major importance in renovation and new construction: The air-tight type of construction ensures that moisture can hardly escape; moreover, high air quality can no longer be ensured by the remaining infiltration air exchange.

Only the apartment ventilation systems ensure adequate air exchange. At the same time, they reduce the energy consumption and heating costs through additional reduction of the ventilation heat losses.

Planning early and saving

Builders and home owners should inform themselves promptly about modern and reliable ventilation systems, while planning or upgrading a building. Thus, the energy-saving potential is optimally utilised and costs are minimised.

In any case, a ventilation concept should be created in advance: In doing this, it is checked whether a ventilation-related measure is necessary in new building construction or renovation, and if yes, what measure is relevant.

Benefits at a glance

In addition to high energy and cost savings, users of ventilation systems can also enjoy a higher comfort level: Modern systems ensure optimum air quality and a comfortable indoor climate with excellent sound insulation at the same time. Other advantages are thorough sanitation, pollution reduction and protection against pollens, mites and mould formation. Proper ventilation also protects the building stock in the long term.

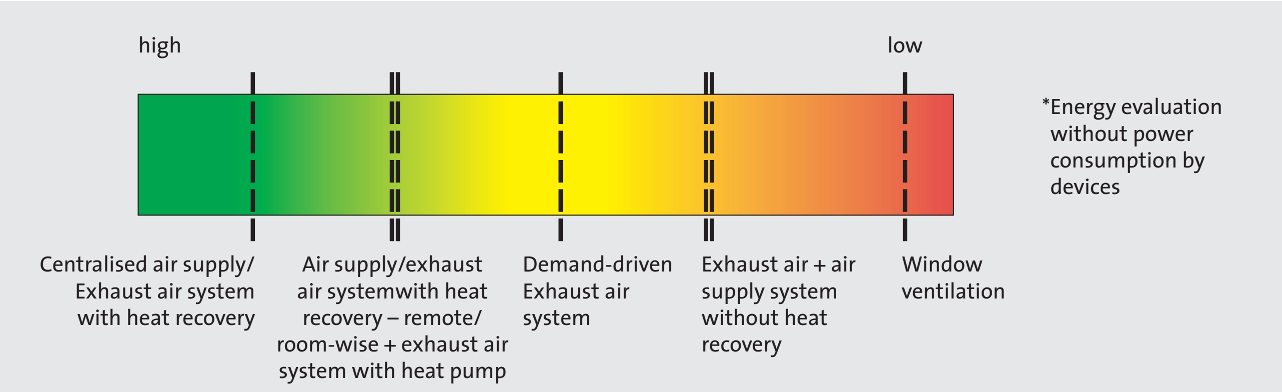


Fig. 85: Reduction in the ventilation heat losses*

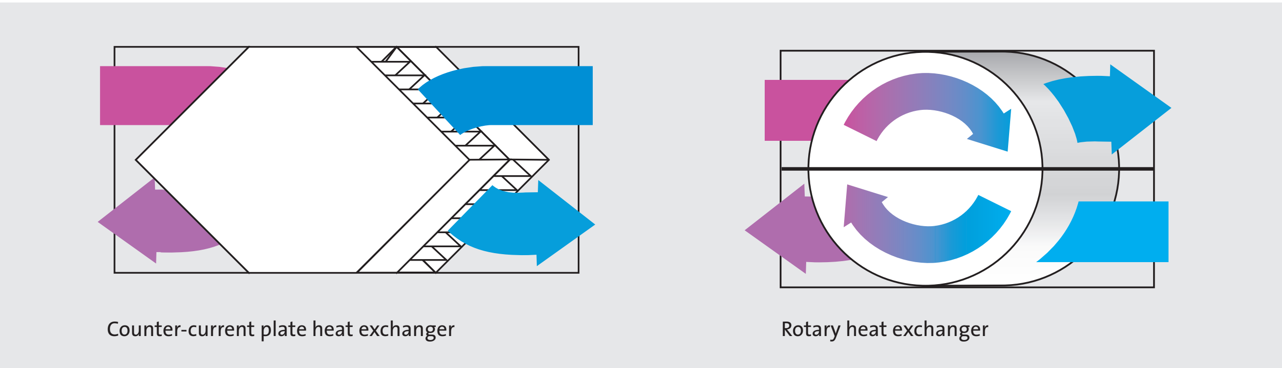


Fig. 86: Improvement of comfort in winter is possible through moisture recovery from the exhaust air

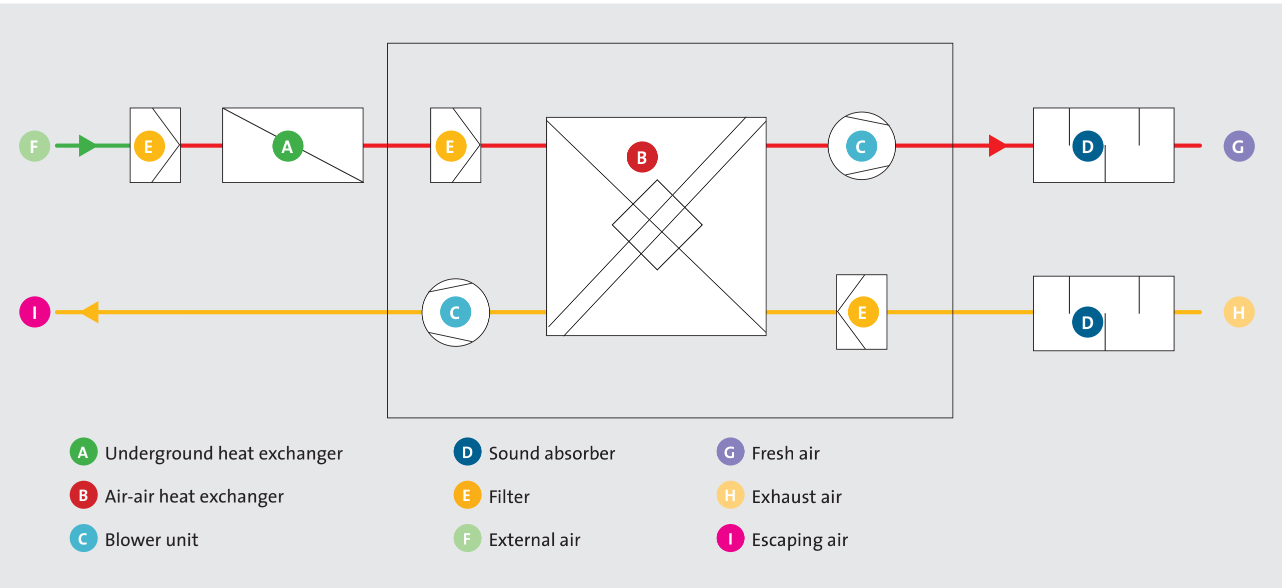


Fig. 87: Diagram showing the principle of controlled ventilation

THE STORAGE TANK AS A CENTRAL UNIT OF AN OPTIMISED HEATING SYSTEM.

Hot water for all purposes

Domestic hot water storage tanks act as a central component of a modern heating and hot water supply system in residential and office buildings. They can perform different functions due to their great diversity of types.

In drinking water storage tanks, e.g. the domestic hot water which is needed for showering, bathing or cooking is collected.

Buffer storage tanks ensure heating water supply to the heating system over a long period. This allows coupling of heat from renewable energies and CHP systems.

So-called combined storage tanks combine both functions.

Modern hot water storage tanks have high energy efficiency. They are characterised by minimal heat loss and optimised heat transfer and temperature gradient. All the hot water storage tanks on the market meet the highest standards of domestic hot water quality and sanitation.

Heating domestic hot water

Hot water storage tanks for domestic water heating prepare the domestic hot water required in the household or in a building, so as to make it available round-the-clock. There is a distinction between monovalent and bivalent domestic hot water heating.

In the monovalent domestic hot water heating, the domestic hot water is heated in the storage tank by a heat exchanger. This is supplied with heat by a centralised heat generator such as a gas or oil-fired boiler.

On the contrary, in the bivalent storage tank, the domestic hot water is heated by two heat exchangers: Heat recovered from solar energy is introduced via a heat exchanger to the lower portion of the hot water storage tank.

With sufficient exposure to sunlight, the total storage volume can be heated renewably. In the upper part of the storage tank is a second heat exchanger, by means of which the standby part of the storage tank is maintained at a constant temperature through reheating by the centralised heat generator. This ensures the supply of domestic hot water even if the solar energy supply is insufficient.

For hygienic reasons, either standard or stainless steel tanks coated with enamel or plastic, are used for drinking water storage tanks. Built-in sacrificial anodes or impressed current anodes protect the enamelled storage tanks additionally against corrosion at the defective spots in the coating.

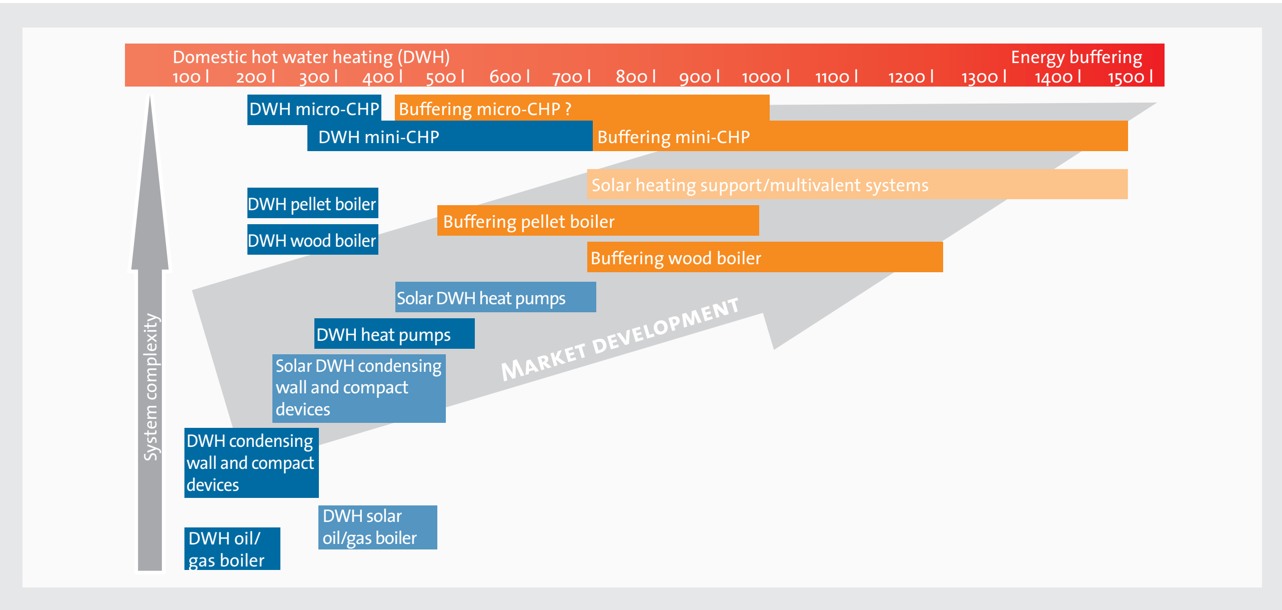


Fig. 88: Market development of storage tank systems and sizes (Apartments, up to three units)

Storing thermal energy

A buffer storage tank in a heating system is a heat storage tank, which is filled with hot water for heating. It can combine heat from various sources and discharge the heat at intervals.

A buffer storage tank helps compensate for differences between the amount of heat generated and consumed, and thus, level out power fluctuations in the heating system. Thanks to it, heat generation can be operated largely independent of consumption, resulting in better operating characteristics and greater energy efficiency for many energy sources. The continuous thermal loss through the outer surface of the storage tank can be minimised through good thermal insulation and avoidance of thermal bridges.

Multitalent combined storage tank

Combined storage tanks allow domestic hot water heating and energy storage in a single device. With integration of solar thermal energy, combined storage tanks are used for both heat storage for auxiliary heating and preparation of domestic hot water. It is distinguished between different types of domestic hot water heating.

Tank-in-tank system

Inside the buffer storage tank, which takes up the heating water, there is a second smaller inner tank for domestic hot water. Thus, the solar system can heat the heating water and domestic hot water in one step. The heating water in the outer jacket of the storage tank is heated by a heat exchanger using solar energy. This heat reaches the domestic hot water via the surface of the inner storage tank.

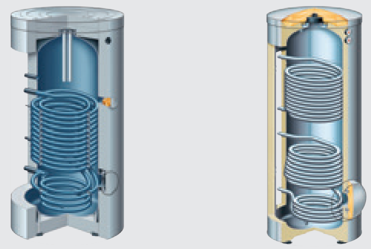
Combined storage tank with fresh water unit

Here, the domestic hot water heating is via an external heat exchanger: If domestic hot water is required in the kitchen or bathroom, cold water flows through a high-performance plate heat exchanger, which is located outside of the storage tank. There, it is heated by the heating water, which is prepared in a buffer storage tank, directly to the desired hot water temperature.

Combined storage tank with built-in internal heat exchanger

In this model, the domestic water is heated by an internal heat exchanger: The solar thermal system loads the combined storage tank via a heat exchanger in the lower region of the device. If the solar radiation is not enough for domestic hot water heating, reheating is done by the centralised heat generator in the upper region of the storage tank.

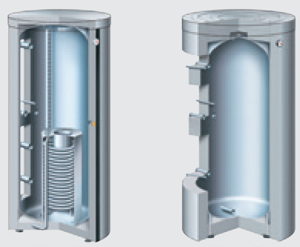
If sufficient energy is available in the storage tank, the supply of the heating circuit is also via the storage tank. The centralised heat generator is turned on only when the temperature set for the heating circuit in the storage tank is undershot.



monovalent
(one heat exchanger)

bivalent
(second heat exchanger
for solar contribution)

Fig. 89: Domestic hot water



Buffer storage tank

Fig. 90: Energy storage tank

Domestic hot water storage tank on the inner side(tank-in-tank system)

Heat exchanger on the outer side (fresh water station)

Internal drinking water heat exchanger

Fig. 91: Combi storage tank (domestic hot water heating + energy storage)

Refurbishing chimneys with stainless steel

The increased demand for heating systems with solid fuels place chimneys once again in the focus of builders and planners.

The flue systems of heating systems need to be optimally adapted to the type of firing. The use of stainless steel in flue systems is highly popular today: The material is durable, requires little space and can be used in all structural conditions. Flue systems made of stainless steel are suitable for both new constructions and subsequent integration, and for both the interior as well as the exterior.

Stainless steel exhaust air systems, the flexible solution for all heating systems.

Meeting all requirements

Besides high temperatures, flue gas pipes are also exposed to chemical attacks caused by the flue gases – it is especially about the acids in this case. If the dew point is undershot, these acids act aggressively on the flue gas pipes through condensation. However, contemporary stainless steel flue gas systems easily cope with the condensing operation of heating systems used today.

At flue gas temperatures of about 40 °C and below, falling below the dew point temperature leads to formation of condensate in the flue gas line. This moisture collects on the base of the chimney in a drain pan, and is discharged from there.

Suitable for every heating system

Stainless steel flue systems have many capabilities and are suitable for all approved fuels.

Various manufacturers offer systems that differ in the pressure and temperature range. Designs that withstand the maximum flue gas temperatures of 200 °C are suitable for oil-and gas-fuelled fireplaces. If a solid fuel system, such as a wood burning stove or a split log boiler is to be connected, the flue gas line should be designed to withstand a temperature of 400 °C in vacuum.

In a pellet-fired heating system, the formation of condensate inside the chimney has to be taken into account because of the low flue gas temperatures. Therefore, the flue system must be insensitive to moisture. If very high demands are placed on the pressure resistance due to the operation of a cogeneration of heat and power system, or the connection of an emergency generator or combustion engine, there are special systems for overpressure of 5,000 Pa and flue gas temperatures up to 600 °C.

Systematic sound insulation

Sounds within the centralised heating system are often transmitted as structure and airborne sound. The noise originating from heating systems, cogeneration of heat and power systems and emergency generators can be curbed effectively with flue sound attenuator: Transmission of noise into the flue system, and thus to the building structure and to the outside is effectively reduced by a structure-borne sound absorber on the connecting tubes of the fireplace, and a flue sound absorber in the connector.

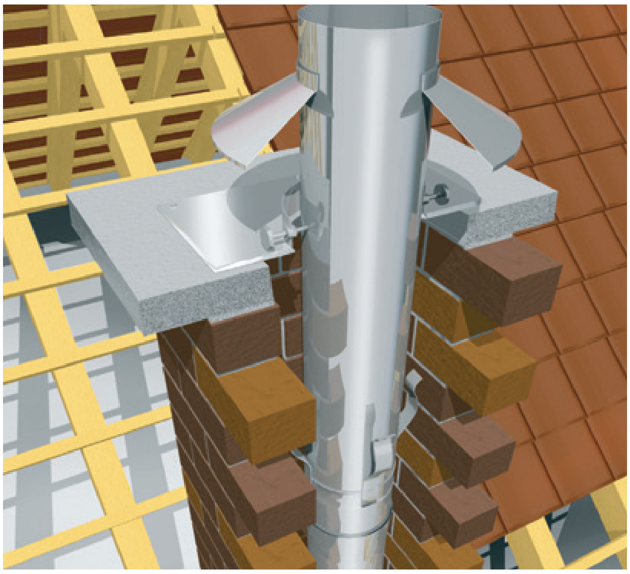


Fig. 92: Existing chimneys

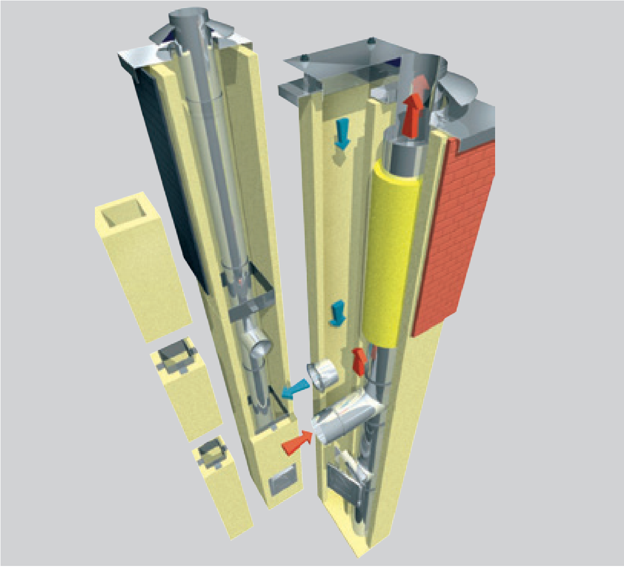


Fig. 93: Air/flue systems

Fig. 94: Stainless steel flue gas systems in firing systems operated by combustion engine

Fig. 95: Stainless steel flue gas silencer for oil and gas fireplaces

Single-walled, double-walled and flexible

Flue systems made of stainless steel are available in single and double-walled designs. They are suitable for both interior and exterior installation and are often used deliberately as an architectural feature in buildings. Single-walled stainless steel flue systems are inexpensive and easy to install. Depending on the design, they are suitable for operation at low and excess pressures in conjunction with gaseous, liquid or solid fuels.

The biggest limitation is the relatively high minimum distance to other flammable components that needs to be maintained. Therefore, single-walled solutions are usually installed in chimneys, which already have a fire protection function and also allow any rear ventilation required.

Double-walled systems for the inlet and outlet air

Double-walled chimneys made of stainless steel can be mounted both within the building as well as on the outer wall. Their flexibility in terms of alteration, extension or dismantling represents another advantage of light chimneys They are also suitable for retrofitting, if no suitable chimney is nearby.

Double-walled chimneys can also be used for operation independent of the indoor air: In such air/flue systems, the warm flue gases and the cool fresh air for the heating system are led via two separate pipelines. Thus, the residual heat can be removed from the flue gases.

Separate air/flue systems can be installed in ducts, stoves or chimneys as part of the modernisation measures. In new buildings, they are created newly as a system chimney.

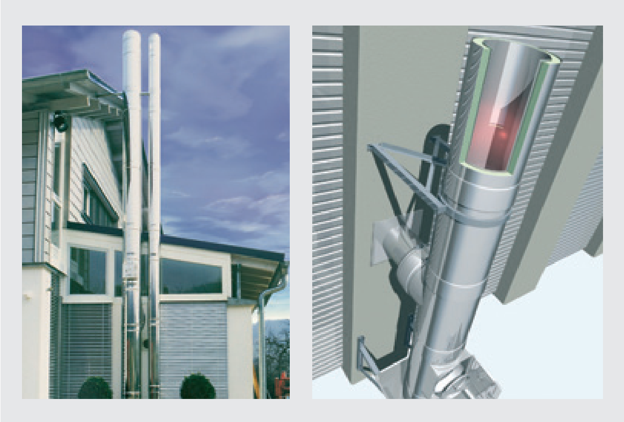


Fig. 96: Double-walled systems

Flexibility in focus

Flexible piping systems made of stainless steel are used especially if inclined guides are necessary for chimney restoration or unfavourable, for example, rectangular dimensions exist. Flexible piping systems are manufactured in single or double-layered design, and thus have a corrugated or smooth inner surface. Special folding and joining techniques allow safe and yet flexible pipe runs.

Storing heating oil safely

Heating oil can be stored in different ways. The personal preferences for the installation site, the individual structural conditions and economic considerations are decisive.

Modern tank systems for heating oil ensure maximum security of supply and economic independence. They form an ideal basis for economic supply of heat.

The fuel storage in a separate tank offers operators of oil heating systems the free choice of suppliers and the opportunity to purchase cheaply, because the consumer is free to decide on the timing of delivery.

New tank systems: Double-walled, flexible and space-saving

Modern heating oil tanks are double-walled tank systems that do not require more collection space. The factory production ensures an extremely safe tank system that guarantees the secondary protection required by law for the storage of heating oil for decades. The previously required collection space for single-walled tanks can be used elsewhere.

Requirements

Heating oil can be stored either underground or aboveground. An oil storage tank is considered to be underground, if it is completely or partially embedded in the ground.

Heating oil storage in underground double-walled steel tank is very rare in the private sector. Aboveground storage in the basement is common. Formerly, there used to be a separate heating oil chamber (walled collection space); today storage is in the boiler room itself. Basically, the legal requirement of secondary protection that is achieved by the double-walled characteristic of the tank system with an additional leak detector or leak detection system applies here.

The previously usual, single-walled tanks made of metal or plastic, which require a collection chamber for secondary protection, are still found in the old stock of many cellars. However, this collection chamber is deemed as an acceptable secondary protection only if the sealing surface is made of approved materials. Moreover, the masonry should be sufficiently stable and the collection chamber should be maintained leak-proof continuously.

For over 40 years plastic storage tanks are used for heating oil. They are mainly installed in the cellar or boiler room. Today, there are about 6 million fuel oil storage tanks in the cellars of German single and multi-family houses.

From 1970 to 1990, single-walled plastic storage tanks, which were mounted in walled collection troughs were sold for the storage of heating oil. Since 1990, factory-made, double-walled and odour-proof tanks have established themselves in the market and replaced the old single-walled tank completely.

The replacement of single-walled tanks is recommended by experts and competent bodies after 30 years of service life. This is mainly because the on-site collection troughs do not correspond to the safety requirements regarding leakproofness and often, structural characteristics do not correspond after that period.

Investigations of the TÜV in Bavaria and Hesse have proven: More than 80 % of the tested collection areas did not show the required secondary protection any more.

Today, a modernisation backlog can be seen in the heating oil tanks: Around 45 % of all plastic storage tanks are 25 years old or more.

By buying a modern double-walled heating oil tank, consumers invest in a high-quality product that guarantees easy and safe supply even in the future. This modernisation measure is usually even associated with significant space savings through the easy installation in the boiler room that is possible now.

Counting on double-walled safety tanks

The principle of double safety applies to storage of heating oil. Thus, a collection space is required by law for single-walled tanks: It prevents release of oil in the water in case of any leakage. This collection space must be oil-tight, have an approved coating and be accessible for inspection. Moreover, the masonry should be structurally sufficiently stable in the case of a leak. The single-walled tanks should be mounted at a sufficiently large distance from the walls to allow inspection.

Double-walled heating oil tanks come with the capability of absorbing oil spills completely, already delivered ex-factory. Moreover, they can be mounted in a considerably space-saving manner: Clear advantages that are responsible for market penetration.

Double-walled heating oil tanks are available in different designs – as sheet metal-jacketed plastic tanks with optical leak detection as well as with internal and external plastic tanks with the possibility of translucent leak detection.

All double-walled tank systems have a long service life and provide maximum safety without any maintenance costs, which is unavoidable in walled collection areas. Practice proves that collection areas often lose their protective properties after years of use. Therefore, double-walled tank systems clearly offer safety.

Small dimensions, high flexibility

Modern insulation and increasingly efficient heating systems ensure continuous reduction in fuel demand in a lot of buildings. This also reduces the storage quantities of heating oil.

New tank systems require less space, home owners gain valuable space. Thanks to the compact dimensions, subsequent integration is also possible. In addition, today's tanks are approved also for heavy heating oil and for oil with biological additives under construction and water law. The tank systems are equipped with limit switches and partly with other safety equipment to prevent an overfill when refuelling.

Several automatic monitoring devices ensure easy and safe control. The heating oil storage can be controlled at all times at the level indicator.

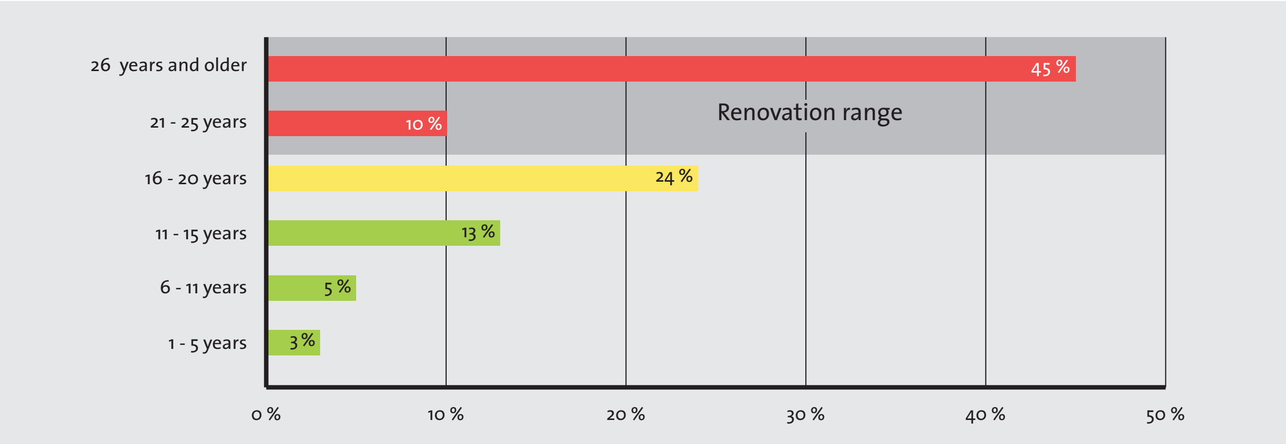


Fig. 97: Age structure of plastic storage tanks in the market since 1970

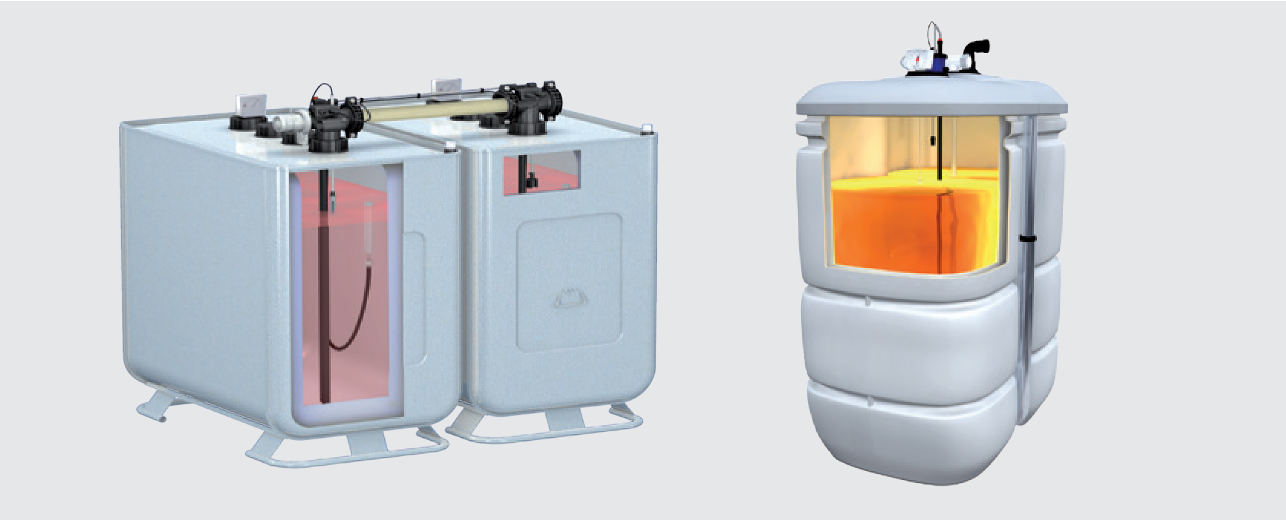


Fig. 98: Modern single and double-walled safety tanks

Intelligent control of the heating system: Anytime, anywhere

Technology that thinks along

Today's heating systems are based on smart systems that make life very comfortable. It has long been taken for granted in many households that the bathroom heating turns on automatically before the alarm rings in the morning and one can shower at a comfortable room temperature. The temperature in the living area can be set such that the personal feel-good temperature in the evening has already been reached. And it almost goes without saying that the heating at night is at a low point – by itself.

One cannot imagine modern heating systems without an intelligent control technology any longer: This is based on innovative microelectronics and provides an optimal combination of all heating components – including boilers, burners, heat pumps and radiators. It ensures that the desired temperature is achieved by the heating system. This is the case even when the window is opened for a short while in between or icy ambient temperatures require a higher degree of temperature.

The technique is so simple to use and as energy efficient as never before. The fact that consumers can heat in certain areas in a very targeted and demand-driven manner, the control technology sustainably helps to reduce operating costs. A display shows the consumption values, records operating conditions and indicates when service is needed.

Residents can perform corrections to the set programs easily – if one wishes to have a warmer temperature suddenly or a sudden cold snap is looming outside. Should there be a fault, it will be immediately displayed on the screen. The information will help the heating technician to identify the cause directly and fix as soon as possible.

Heat at the press of a button

Today's heating systems offer much more than those of previous generations: They allow central control of the preparation of domestic hot water, heat output and ventilation.

These modern systems produce hot water when needed, not only for heating but also heat up the water for the kitchen and bathroom.

Moreover, these systems are bivalent, i. e. operate simultaneously with two energy sources. Renewable energies are often used, for example, the solar thermal energy. The control technology couples the energy of the solar collector into the system. If the system does not deliver enough thermal output due to bad weather conditions, the heater steps in, regulated by the control technology in the background. The control technology takes over the control of quite different heating systems, such as micro or mini-CHPs, which generate power and heat simultaneously by the principle of cogeneration of heat and power. Control technology feeds, among others, the surplus electricity into the local grid, which should be of interest to house owners insofar, as they get paid for their excess power.

Remote-controlled heating systems

Today's control technology for heating systems offers many opportunities to generate and use heat efficiently. However, their potential can be exploited fully only in combination with modern communications technology: So it is already possible to control the heating system in the basement via radio from the living room, with a remote control that one is used to for a long time from televisions, DVD players and stereo systems.

The technician requires only a laptop for system diagnosis. Because the communication technology transmits disruptions, failures or other incidents automatically to the installer, landlords can be unconcerned in winter: The technician immediately receives the necessary information to get the situation under control from his desk. He can take all the necessary steps through online access. In this way, unnecessary maintenance visits can be avoided and the availability of the system is increased without any extra effort and costs for the operator.

Efficiently managing the energy consumption

A modern heating system can now be controlled by a central computer that manages all data, programs and information. In principle, such an "on-board computer" can be intuitively operated via a touch screen. Here, residents can create heating profiles for each room, set a base temperature or adjust the valves on the radiators. Sensors detect the ambient conditions, which are evaluated by the system and implemented accordingly. Thus, the control and communication technology facilitate an energy management system that is tailored precisely to the needs of residents.


Independence
Efficiency
Comfort
Reliability
Intelligent control and communication technology
Heat generation
Renewable energies
Demand-driven temperature control
Diagnostics

Major output

Large firing systems

The BDH energy efficiency initiative with dena: Efficient heat supply systems cut costs

A significant volume of process heat is required in numerous technical methods and processes in industry, which must be produced using substantial energy and at a high cost.
Comprehensive energetic optimisation of the heat supply system can markedly reduce energy consumption and cost in the firing system – by 15 percent on average. These kinds of energy efficiency measures are highly profitable and generally redeem their cost within one to four years.

OPTIMISATION POTENTIAL IN THE MAJOR OUTPUT RANGE: 30 TWH COULD BE SAVED EACH YEAR

High energy consumption of process heat

Various sources of energy are used to generate process heat (for example electricity, oil and gas); there are also very different ways of transporting the process heat (as warm water/hot water, as steam or as hot air), and it is required in a whole range of temperatures.
Each year, approximately 400 TWh of final energy is used in Germany in order to supply thermal processes. The economic potential for energy savings in thermal processes used within industry and commerce is at least 30 TWh per year (7.5 percent). Further 96 TWh are required each year in order to heat rooms, of which roughly 18 percent could be reduced by increasing energy efficiency.

Steam and hot water production

Accounting for in the region of 30 percent, the production of steam and hot water in boiler systems is among the most widespread methods of generating process heat.
These days, 80 percent of all industrial heat and steam generation systems in Germany are over ten years old and can no longer be seen as cutting-edge technology. In these old systems, the deployment of efficient technologies alone would produce annual energy savings of 9.6 TWh. This adds up to two percent of total energy consumption of process heat in Germany. Including heat recovery, this means that energy consumption in the generation of steam and hot water can be cut by 15 %.

Analysis of potential savings

Based on certain information provided by the Association of Chimney Sweeps (ZIV), TÜV and the companies organised within BDH, it is fair to assume that almost 300,000 technical firing systems with a performance ranging between 100 and 36,000 KW of combustion heat output are in service on the German heat market for larger buildings and the industrial sector. In technical terms, 80 % of these systems are no longer state of the art.
The following calculations were made on the basis of approx. 250,000 identified systems. There is a high potential for savings:

- Reduction in annual consumption of heating oil: 810,000 t/a
- Reduction in annual consumption of natural gas: 4.43 billion m³
- Reduction in CO_2 emissions: 16.3 million t/a
- Reduction in nitrogen oxide emissions (NO_x): 34,885 t/a
- Reduction in the installed electrical output: 398 MW

Using 2008 as a basis, this constitutes a possible reduction in heating oil consumption of 3.3 % and a reduction in natural gas consumption of 4.6 %. In total, the use of efficient technology in the largest technical firing systems can lead to annual final energy savings of 175 PJ.
Including heat recovery, the energy consumption required to generate steam and hot water can be cut by an average of 15 percent. The maximum reductions in energy and costs are achieved if the components of the entire heat supply systems are streamlined and designed within an integral, tailored framework.

Procedure for system optimisation

Measures to enhance energy efficiency within the heat supply system should always be considered as elements of optimising the overall system. The greatest enhancements in energy efficiency can be achieved by streamlining all components and by implementing optimisation in system control and management. An initial stage should see a detailed analysis of the system's

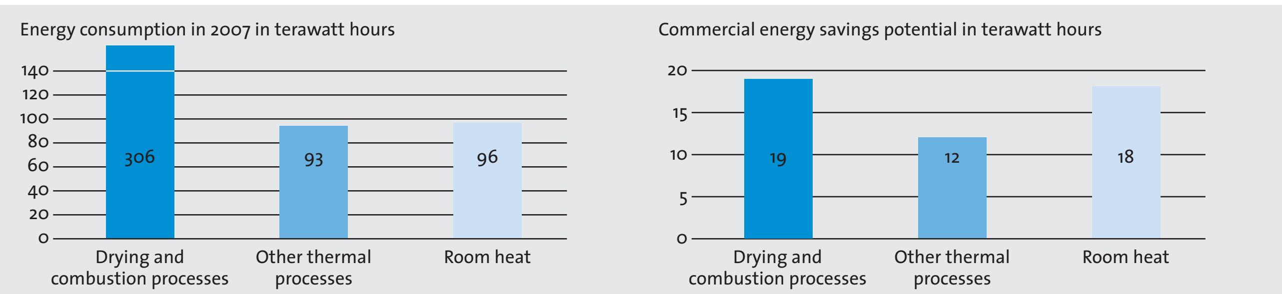


Fig. 99: Energy consumption and potential energy savings in industrial process heat applications

current state of energy consumption, the heat demand and the individual components within the system. Subsequently, a review of individual component energy efficiency should be conducted in order to replace old components whenever necessary. Further savings can be achieved by optimising the control and management of the firing system.
Whenever constructing new systems, even the preliminary plans should take care to ensure energy efficiency of the components and the overall system.
As things stand, roughly 40 percent of the energy used in the generation of industrial process heat is lost unused in the form of waste heat. In the event that upstream measures to reduce thermal loss have been exhausted, it is certainly worthwhile to exploit the waste heat by means of heat recovery. It is helpful in this context to create a heat circuit diagram, presenting all temperatures and the heat volumes transported and transferred within the process.
A pinch analysis can then be used to ascertain the most efficient method in each case of exploiting the waste heat available.

Optimising the overall system

Before optimising the individual components of a heat supply system, it is important to first initiate measures to minimise the heat demand and losses. Here, the following applies: Electrical energy has greater value than steam; steam has greater value than warm water. Therefore, depending on the requirements on hand, the supply medium with the lowest possible value should be selected in each of the respective process stages. Effectiveness can be increased from 10 to 15 percent simply by using warm water instead of steam. In many cases also, a reduction in the temperature of the supply medium enables the use of heat recovery and the cogeneration of heat and power for further savings in the energy demand.
In order to minimise losses, the heat insulation on the heat producers, the pipes and also the heat storage should be analysed and improved wherever necessary.

Exploiting heat recovery

Measures targeted at heat recovery maximise effectiveness in the overall system and therefore the system's energy efficiency. Generally, the following applies: Heat recovery is all the more sensible the greater the difference between waste heat temperature and the required temperature.
Thermal potential should be used locally and as directly as possible. For instance, waste heat can be used to heat industrial or process water, as domestic hot water, to preheat combustion and drying air or as room heat. It is also worthwhile to use an economiser, for example to preheat the feed water.

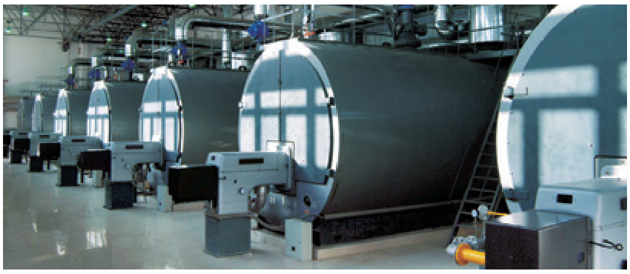


Fig. 100: Heating system consisting of seven hot water generators with a total output of 105 MW

In condensing technology, an additional heat exchanger is fitted downstream from the economiser, cooling the flue gases to below the condensation temperature of water. This means that the condensation heat of the water contained in the flue gas can also be exploited.

Using energy efficient components

Equally, the target in using energy efficient components should at all times be the optimisation of the overall system. This is achieved by effectively streamlining all new and existing components.
Modulating (controllable) burners can be operated in many partial load ranges and are far more efficient than burners that are fired up and shut down individually.
Flue gas temperatures and energy consumption can be reduced using boilers with large heat transfer surfaces.
It is sensible to use energy efficient condensing boilers in warm water systems, as their deployment leads to significantly lower flue gas temperatures. Furthermore, their effectiveness is substantially higher.
Speed controlled drive motors for forced air burners and pumps also permit pronounced savings in energy consumption.

Optimising management and control

Large firing systems should always be tailored to suit the actual heat demand. For instance, a multi-boiler control ensures that only the required number of boilers are operated at any given time. Installation of flue gas sensor control ensures continuous measurement of the flue gas composition. Air intake control takes place in line with the best possible oxygen ratio in the flue gas at any given time (O_2 ratio). Simply cutting the O_2 ratio by just one percentage point leads to an enhancement in effectiveness of between 0.5 and 1 percent, depending on the age of the system.
Controlling and managing other combustion parameters such as CO content, flue gas temperature, soot figure or combustion chamber pressure and the installation of automatic flue gas or combustion flaps can cut the energy consumption still further.

Smart grid/smart home

With gas into a renewable future

On the way to production-oriented consumption

Previously, the current flowed mainly in one direction: from the power plant to the consumers. However, more and more current flows from small, decentralised generators into the public grid today, for example, from photovoltaic systems, wind turbines, cogeneration heat and power plants or biomass power plants.

While PV systems produce a lot of electricity when the sun shines, the wind strength increases the output of the wind power plants. But during "dark doldrums" the plants remain still.

NETWORKED LIVING: SMART GRID/ SMART HOME PROVIDES EFFICIENT ENERGY MANAGEMENT

As a consequence, there are massive supply fluctuations. These are difficult to predict and must be collected by an adapted power consumption (Demand Side Management/Load Management).

Already, the power grids temporarily reach their load limits. The grid stability is no longer guaranteed, renewable plants must be shut down temporarily.

In the future, the entire energy system would need to be adapted to the new conditions. There is a need for a paradigm shift: Away from consumption-oriented generation and towards production-oriented consumption.

Systematic energy management

Smart power grids ("smart grids") stabilise the grid. They allow better coordination of production and consumption. High performance and comprehensive solutions of modern information and communication technology are required for smart energy management. A crucial prerequisite for balancing production and consumption is better storage capacity. They can be used to bridge periods without wind or solar power and intercept power peaks.

Both electrical and thermal storage tanks can be used for stabilisation of the total system. These are systems that convert electrical energy into heat or cold and store it, such as heat pumps, domestic hot water storage tanks, freezers or refrigerated warehouses. With as high as 500,000 systems already existing today, heat pumps offer much potential for use in Smart Grids. As a switchable and controllable system, they can flatten out local power peaks in power generation and store the environmental energy in the form of heat energy.

In the end, more electricity can be used effectively from renewable sources and the regenerative value of the heat pump can be increased further. The electricity and heat market are connected in a meaningful way. Decentralised mini and micro-CHP systems can also contribute to grid stability due to their quick standby feature.

Smart meters

Smart electronic meters provide customers and energy suppliers a number of advantages over conventional Ferraris meters: They provide customers a direct overview of consumption and cost and thus, contribute to a more energy-efficient behaviour. In addition, a short-term, for example, monthly invoicing can be agreed with the utility provider. Moreover, the customer can shift their power consumption comfortably, and without a second meter, to the times when lower rates are charged.

The utility companies also benefit: Load planning can be improved. Attractive tariffs represent easy incentives to shift the use of electricity to times of low load.

Electronic meters form the junction between the building's energy management and the Smart Grid. This makes them an indispensable part of the new energy landscape in the long term.

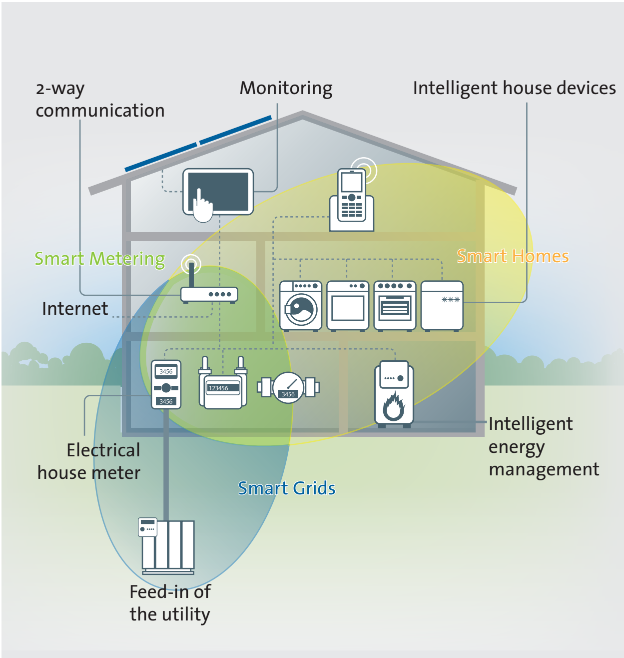


Fig. 101: Smart Home diagram

Smart home: Your home thinks along

Smart building energy management systems in the "Smart Home" optimise energy consumption in the flat and the apartment house.

Networking and communication of all relevant applications and systems in buildings facilitate maximum energy utilisation of all components fully automatically and without loss of comfort. And the systems are capable of doing more: Networking with modern communication and information systems also increase comfort and safety in the building.

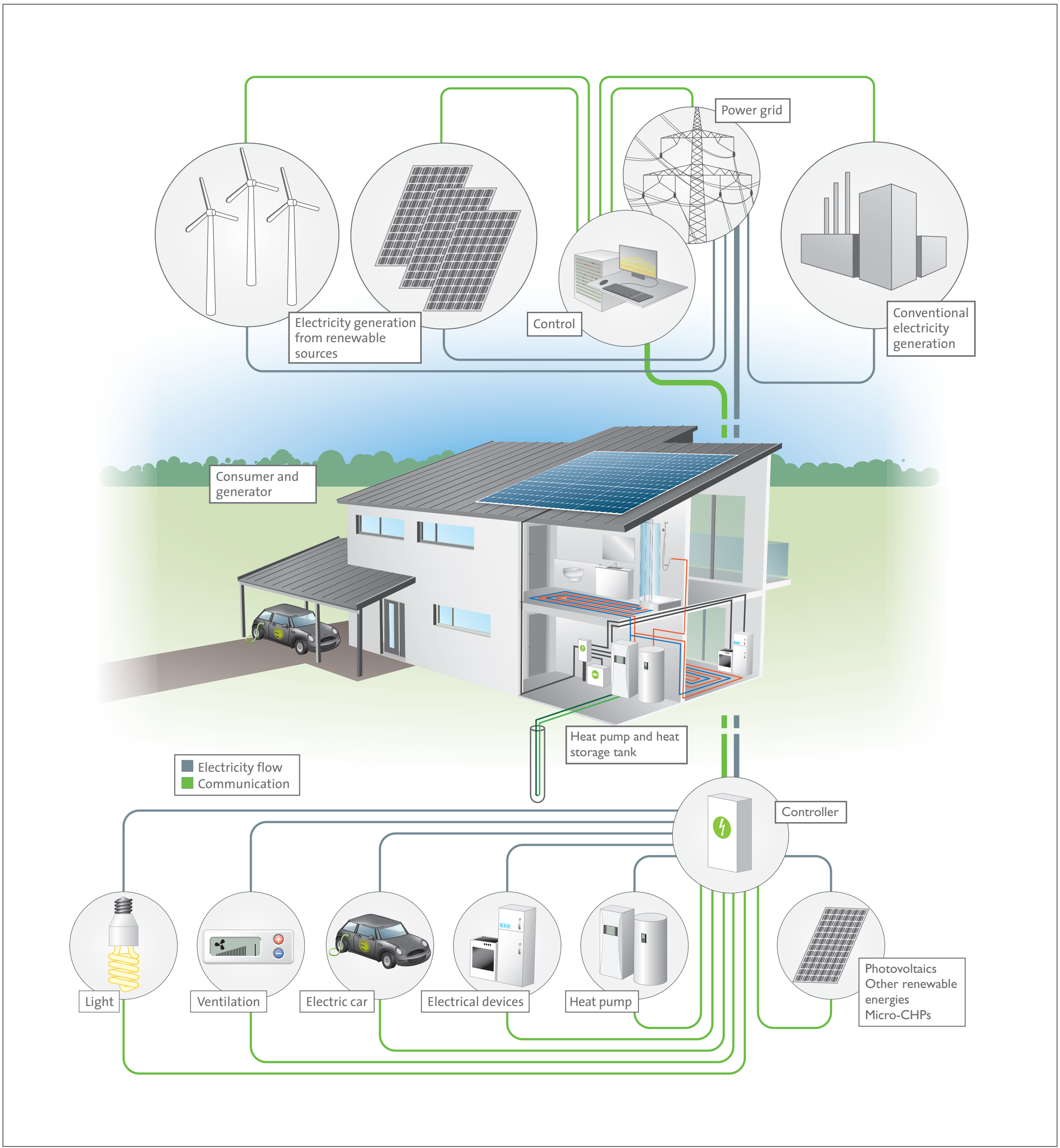


Fig. 102: Smart Grid diagram

Long-term reserves

Natural gas is the third most important energy source in the world after crude oil and coal. The share in the world primary energy consumption currently stands at 24 % – and is growing. A trend that will also continue in the future: The economically exploitable global reserves can be expected to sufficiently meet the energy demands also in the long term; moreover, with the rising gas prices, the resources that were uneconomical before become exploitable now.

Combination of heat and electricity through CHP supports the energy transition

With natural gas and its infrastructure, much more can be achieved for the energy supply of the future: Gas technologies are ideally suited to efficiently integrate renewable energies into the energy systems.

Besides biogas, it is mainly about the conversion of excess renewable electricity into hydrogen or methane.

This technology known as "Power to Gas" (abbreviated form: P2G) allows the storage of large amounts of electricity from surplus arising from power generation through wind or photovoltaics. Another example is the liquefied natural gas (LNG), which will continue to ensure safe and reliable gas supply in the future.

Strengthening the power grid – using synergies between electricity and gas

More and more power in the EU comes from renewable sources, such as wind power and photovoltaics. In 2011, the share of renewable energies in gross power generation in Germany was already at around 20 %.

In 2020, this could be over 30 %; according to the energy concept of the German government, as high as 80 % of the electricity supply should come from renewable sources by 2050.

Therefore, the German electricity industry must contend with the challenge of fluctuating power generation from wind and photovoltaics: Electricity generated from renewable energies is ultimately highly dependent on weather conditions.

On days with strong winds, the power grid cannot store the renewable electricity completely even today – wind power plants must be shut down partially. A growing problem in the face of rapid extension of wind power with sluggish expansion of power grids. This is noticeable especially in North Germany, where most of the wind farms and at the same time, a very weak grid is found.

The expansion of renewable energies requires modern storage techniques that will help in adapting the fluctuating power supply to demand. To this end, energy storage means that can store and release large amounts of energy in the short and long term are used.

Electric storage means, such as batteries are still only conditionally suited to meet these criteria. Pumped storage hydro power stations can be hardly built in sufficient quantity.

P2G makes it possible to compensate for the power fluctuations: The renewable electricity is converted into hydrogen or methane and can be distributed with natural gas through the existing gas grid.

Leaving aside a few exceptions, hydrogen may already be mixed in single-digit percentage quantities to the natural gas. There are no restrictions whatsoever for methane.

Power to gas: Gas from electricity

In the P2G technique, water is split by means of electrolysis using excess renewable electricity provided, for example, by wind. This produces oxygen and hydrogen. The latter can be directly fed into the gas grid and mixed with natural gas. We have already had experience with high hydrogen concentrations in the past; eventually, the town gas used in the gas supply until the 1990s contains up to 50 % hydrogen.

On this basis, the process of methanation can be used: A chemical reaction of hydrogen with carbon dioxide produces methane, the main component of natural gas. The efficiency in converting electricity to hydrogen is approximately 80 %, it is less in methanation.

The generated gas is mixed with the natural gas at the end. The challenge of storing electricity is solved elegantly by upgrading the existing natural gas infrastructure to a storage medium for renewable electricity.

Another variant of the manufacturing and supply of renewable gas is practised successfully for about 6 years now: Biogas. Because natural gas and biogas contain methane, biogas can be brought to the quality level of natural gas through treatment and also fed into the existing gas grid. Meanwhile, 101 biogas feeding plants are in operation, currently 26 plants are under construction, they are supposed to be put into operation this year.

Key technology of cogeneration of heat and power

The wind and solar energy stored in gas by means of P2G can be converted on demand and at intervals decentrally anywhere back into electricity and heat. Cogeneration of heat and power (CHP) are best suited for this, because electricity and usable heat are generated at the same time.

CHP can be used very flexibly: In the power-controlled mode of operation, CHP technology has a balancing effect on the power grid and among others, may effectively absorb peak loads from the wind energy and photovoltaics supply to the local grid. Through the smart use of waste heat, e.g. for building air-conditioning in summer and building heating in winter, the efficiency is kept high throughout the year. This makes the CHP technology complementary to renewable energies.

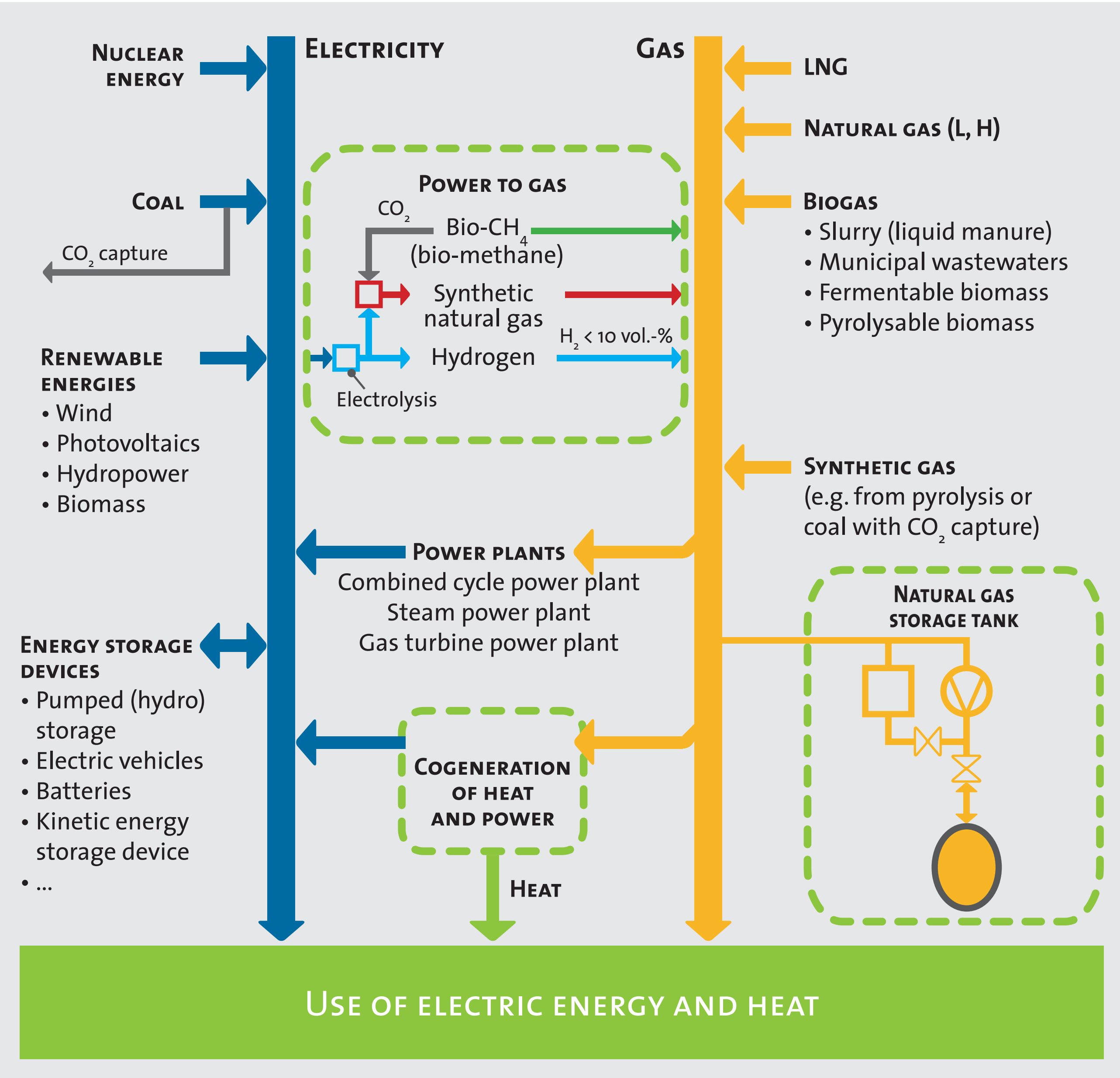


Fig. 103: Power and gas grid synergies

Standardisation

Standardisation in the area of heating, ventilation and air-conditioning technology

Questions and answers

Standardisation in the field of heating, ventilation and air-conditioning technology is done in the Standards Committee for Heating, Ventilation and Air-conditioning Technology (NHRS) of the Deutsches Institut für Normung e.V. (German Institute for Standardisation), "DIN". The NHRS processes all standardisation applications in the field of heating and indoor air-conditioning systems and their components (including the control, protection and safety devices). Some of the fundamental questions should be addressed in the following, because the topic of standardisation can lead to uncertainty or misunderstanding in many users.

Standards support access to global markets

Fundamental purpose

Through standardisation technical standards are defined and made available for everyone. This allows a large group of users to resort to the same know-how (for example, dimensions and tolerances, or testing and safety requirements).

Why participation in standardisation work is worthwhile

Active participation in standardisation work provide many advantages to users and final consumers, as well as manufacturers, designers, executors and authorities. Besides the information advantage over future technical regulations, which contributes significantly to the planning security, the following points can be named:

- Monitoring trends in the industry
- Good basis to implement the company technologies on the market
- Shaping the future technical regulations
- Prerequisite for the global market access

The liability of standards

Standards do not have any legal liability as such. Therefore, the standards are applied at first for everyone on a voluntary basis. However, the user can be confident of acting in a technically proper manner when observing the standards.

A standard is always mandatory only if it is bindingly cited or included in, for example, laws, ordinances, administrative regulations or contracts.

The tasks of the NHRS

The work of the NHRS is classified under five divisions:

- Division 1 – heating technology
- Division 2 – ventilation and air-conditioning technology
- Division 3 – ICA for heating and ventilation and air-conditioning technology
- Division 4 – facility management
- Division 5 – energy performance of buildings – system standardisation

Each of the five divisions is composed of several working committees, where the actual standardisation work is done. A detailed list can be found on the NHRS website (www.nhrs.din.de). Anyone who wants to participate can send an application for participation at any time to the respective working committee.

Besides small and medium-sized enterprises, industrial and trade associations, in particular, are deeply committed in matters of standardisation. One of them is the Bundesindustrieverband Deutschland Haus-, Energie- und Umwelttechnik e.V. (Federal Industrial Association of Germany House, Energy and Environmental Technology) (BDH), which brings along a broad spectrum of views and experience in the standardisation work.

Financing

The standardisation work of DIN is not, as often assumed, entirely financed by public funds. At NHRS this is only about 10% of the total budget. The majority, about 53 % comes from the project funds of the industry. Over 37 % is borne by DIN with its own profits and license revenues.

The standardisation work in the NHRS is also being directly sponsored by associations and companies. Therefore, the non-profit "association for the promotion of standardisation work of the NHRS" (VF NHRS) was founded. It takes care of the promotion of science and research in the field of heating, ventilation and air-conditioning technology and the financial support of the NHRS. The BDH is a member of VF NHRS.

Fig. 104: The German Institute for Standardisation in Berlin

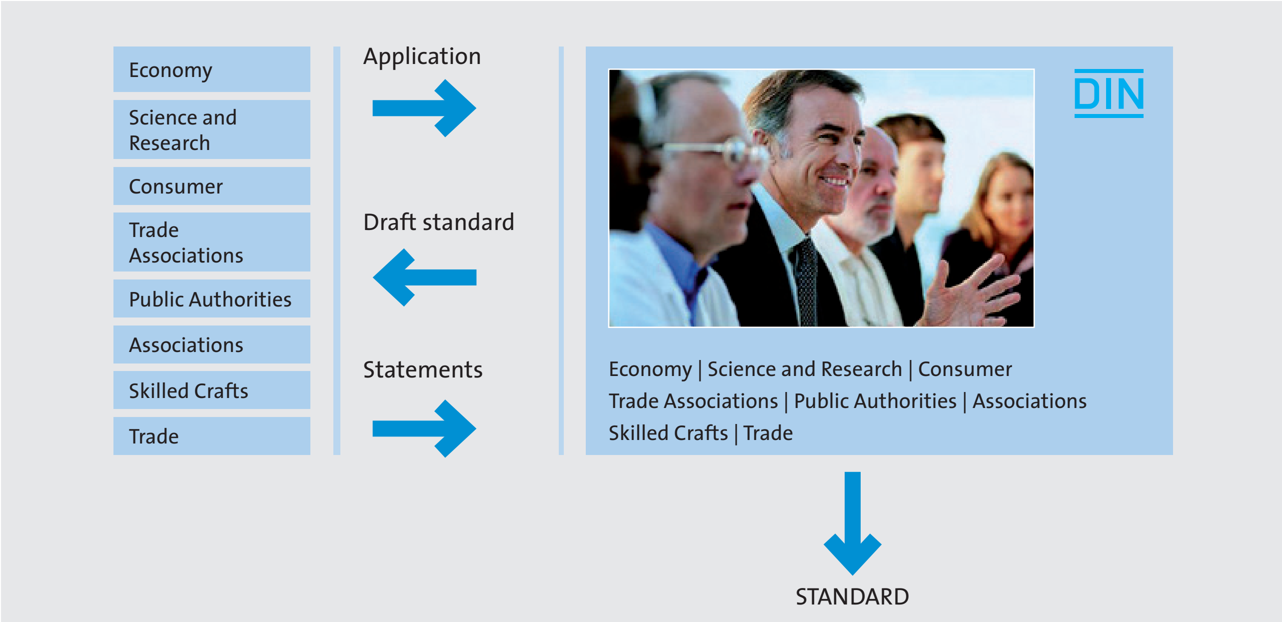


Fig. 105: Participation in the standardisation process

Benefits

In the following, with reference to some industry-specific examples, the benefits of standardisation are shown.

DIN EN 215, Thermostatic radiator valves – Requirements and test methods

This standard specifies requirements for dimensions and design of the connection (continuous and corner form) of thermostatic radiator valves. With reference to DIN EN 215, it is easily possible to get the right connector from the whole lot of manufacturers. Without the standard, there would be many different connection geometries in the market, which would complicate the design of products and systems and the installation of a heating system considerably. Furthermore, DIN EN 215 sets the requirements for mechanical properties, operating characteristics, durability and temperature resistance, as well as the testing methods. If a connector is designed according to DIN EN 215, it can be assumed that there are no problems with the application of conventional thermostatic valves. And of course these definitions not only help customers but also the manufacturers in the development, market launch and application.

DIN EN 12831, Heating systems in buildings – Method for calculation of the design heat load

The heat load calculation, based on the layout of each heating system is carried out today according to the recognised method as defined by DIN EN 12831.

Thus, DIN EN 12831 contributes significantly to the fact that heating systems are designed so that they reach the design internal temperature required. DIN EN 12831 provides a uniform applicable method that allows the comparison of different systems.

So DIN EN 12831, in simple terms, ensures that the heating system is able to heat the flat and apartment house to a comfortable temperature in winter.

DIN EN 12828, Heating systems in buildings – Design for water-based heating systems

Due to the low strain capacity of pipes, the change in volume of the water caused by change in the temperature may lead to a greatly increased pressure even with slight temperature increase. Without additional measures, such as expansion tanks, this increase in pressure leads to the destruction of pipelines and pressure vessels. Diaphragm pressure relief vessels help to compensate for these changes in volume of water in piping systems.

DIN EN 12828 gives clear indications how diaphragm pressure relief vessels must be designed and allows correct dimensioning. Without a correct sizing, there is a danger of pipe break.

Dimensioning according to DIN EN 12828 provides confidence to both the user and the designer: Any diaphragm pressure relief vessel properly designed according to DIN EN 12828 can be considered technically reliable.

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AFG Arbonia-Forster-Riesa GmbH

Alpha-InnoTec GmbH

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www.bmu.de

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BDH
Federal Industrial Association of Germany House, Energy and Environmental Technology

www.bdh-koeln.de

bwp German Heat Pump Association

www.waermepumpe.de

dena German Energy Agency

www.dena.de

DEPV Deutscher Energieholz- und Pellet-Verband e.V.

www.depv.de

DIN NHRS

www.nhrs.din.de

DVGW

www.dvgw.de

Fachverband Gebäude-Klima e. V.

www.fgk.de

geea Die Allianz für Gebäude-Energie-Effizienz

www.geea.info

HEA Fachgemeinschaft für effiziente Energieanwendung e. V.

www.hea.de

HKI

www.hki-online.de

iwo Institut für Wärme und Oeltechnik

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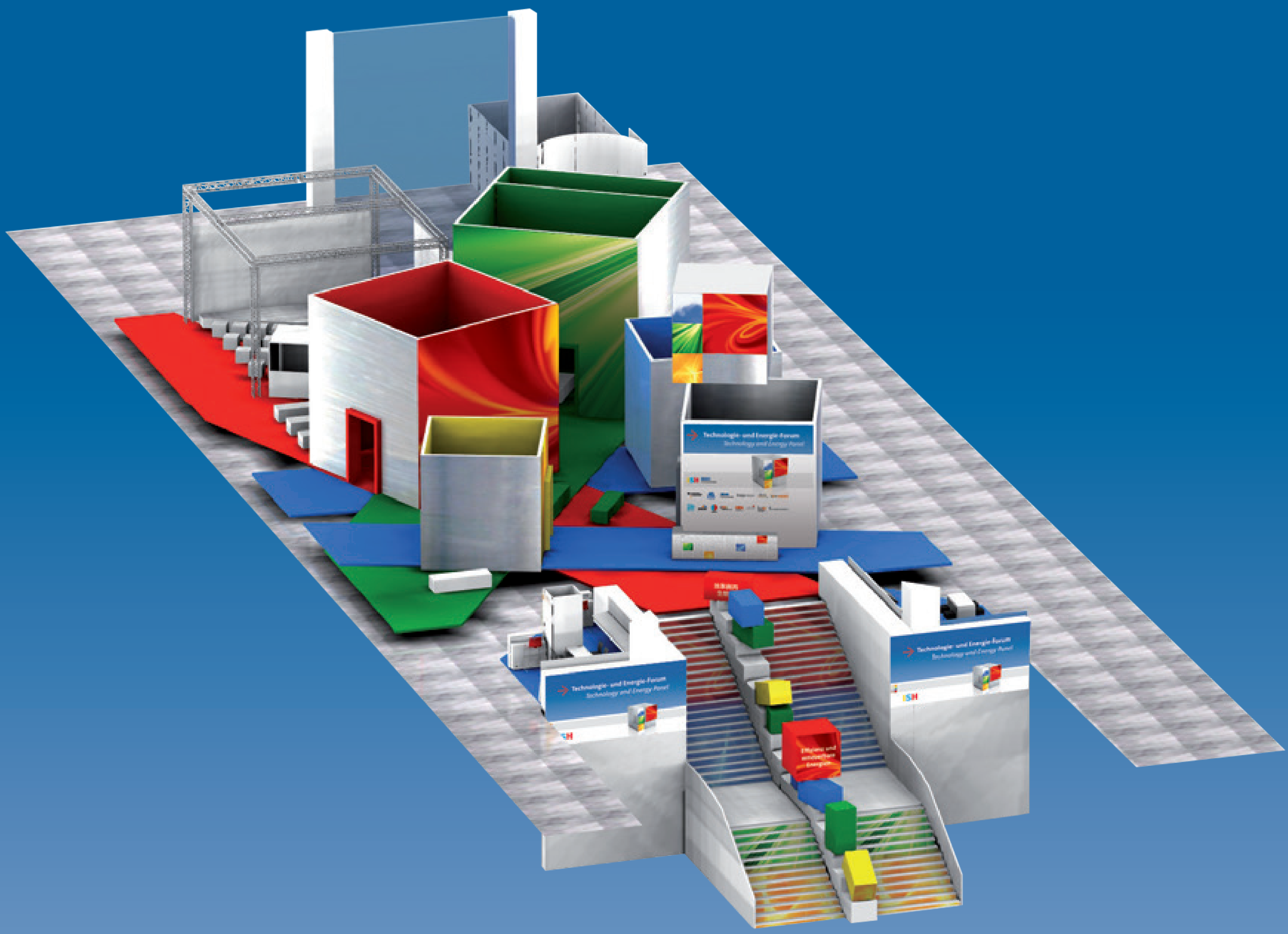

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BDH
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bwp German Heat Pump Association

dena German Energy Agency

DEPV Deutscher Energieholz- und Pellet-Verband e.V.

DIN NHRS

DVGW

Fachverband Gebäude-Klima e. V.

geea Die Allianz für Gebäude-Energie-Effizienz

HEA Fachgemeinschaft für effiziente Energieanwendung e. V.

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