EFFICIENT SYSTEMS AND RENEWABLE ENERGIES FOR THERMAL COMFORT

ehi

association of the
European Heating Industry

The Association of the European Heating Industry (EHI) represents and promotes the common interests of 30 market leaders producing thermal comfort equipment [heating systems, burners, boilers, components, radiators and renewable energy systems] and 13 national industrial associations from the EU Member States, Liechtenstein and Switzerland. Today they represent more than 90% of the European market in this field. In the fast growing solar thermal sector our members' market share has gone beyond 50%. The industry has total sales of more than 20 billion euro and employs 120.000 people.

The European policy to reduce energy consumption and greenhouse gas emissions and to ensure sustainable development has to include measures to reduce the end use of energy in buildings. Heating is one of the key elements to achieve the ambitious energy and CO_2 saving targets.

This brochure gives representative examples of modern heating solutions and modernisation work. These demonstrate the potential for energy savings that can be achieved with modern, highly efficient heating products and renewable energies. It shall provide all interested parties with comprehensive but understandable information about possible solutions.

I hope you will enjoy reading. May this brochure provide you with all necessary information to detect the huge impact of modern heating solutions on energy saving.

Klaus Huttelmaier
Chairman EHI

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The sector's leading industrial association

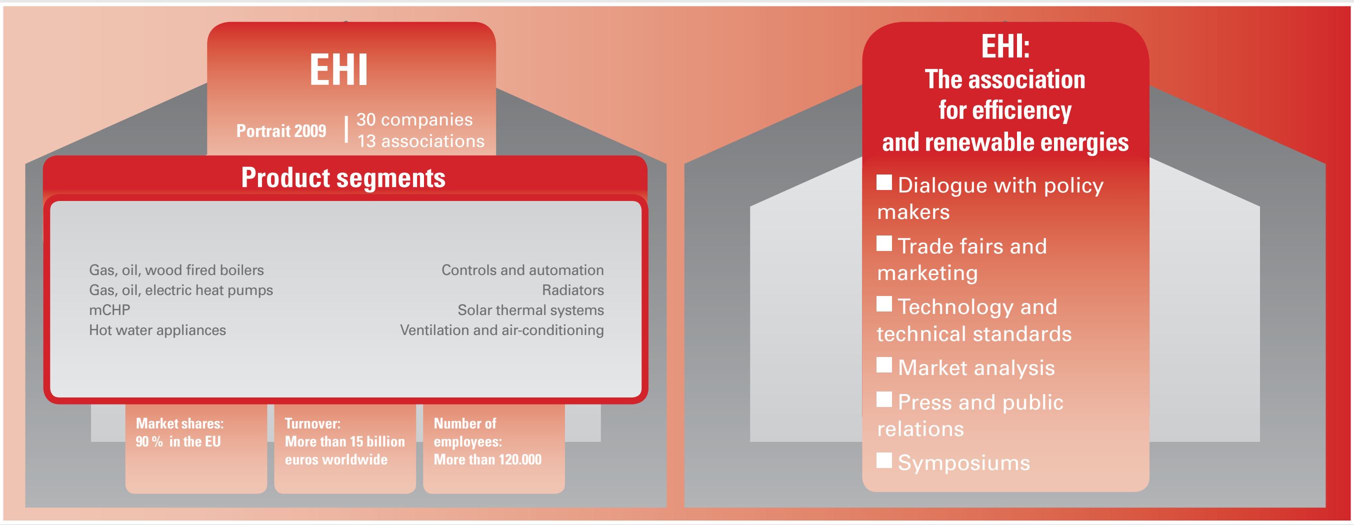
Manufacturers of high-efficiency systems for heating, hot water provision in buildings are organised in the EHI – association of European Heating Industry. These manufacturers produce modern wood, oil and gas-fired boilers, heat pumps, solar installations, control and regulation mechanisms, radiators and burners, heat stores, heat pumps and other ancillary components. They generate a turnover of more than 20 billion euros and employ some 120,000 staff worldwide. Because of the relative high investment in research and development the member companies of the EHI enjoy a leading position in international markets and are technologically ahead of the field.

Fuels in flux

Responsibility for the environment, the efficient use of scarce energy resources as well as rising energy prices have caused public interest to focus more strongly on energy-efficient systems and the use of renewable energies in the heating market. By modernising the way energy is used in the existing building stock with energy-efficient heating systems, combined with renewable energy sources, very considerable savings in energy and potential reductions in CO_2 can be achieved. The energy efficiency of the existing building stock is around 50 %, according to information supplied by the European Union (source: Green Paper on "Energy Efficiency or Doing More with Less"). So buildings consume twice as much energy as is technically feasible.

Double strategy: efficiency and renewable energies

Responsibility for the environment, the efficient use of 40 % of Europe's energy consumption is accounted for by the building stock. A good 85 % of that serves to heat the building and to provide hot water. This, in turn, corresponds to around a third of the total energy consumption in Europe. Increasing the efficiency of existing installations in buildings can achieve energy savings of 30 % and more. In order to meet the targets set, the quota of modernisation work needs to be doubled. Alongside these measures fossil fuels should be gradually substituted by increasing use of renewable energies. With this strategy, the proportion of biofuel in the heating market should be boosted by at least 10 %. At the same time, the modernisation rate for thermal insulation of building envelopes should be increased.



Energy feedstocks

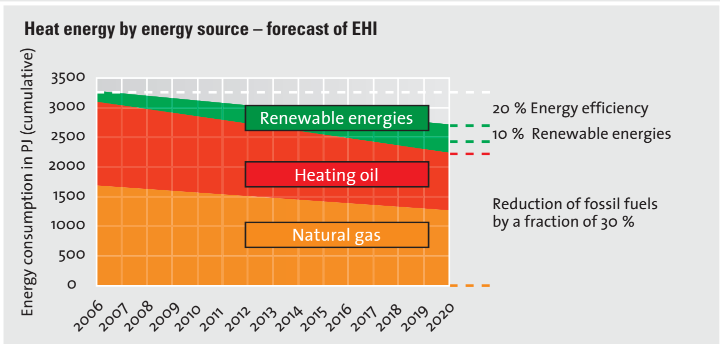
Rising energy consumption, which has more than doubled in the last ten years worldwide, as well as the increasing dependence of many countries on imported energy has brought the security of energy feedstock supplies into the public eye. Two fifths of all the people on the earth use traditional biomass as the principal means of satisfying their energy needs. In this regard, an adequate and affordable energy supply which, at the same time, pays due regard to environmental acceptability, constitutes the most important area for a future-proof energy strategy.

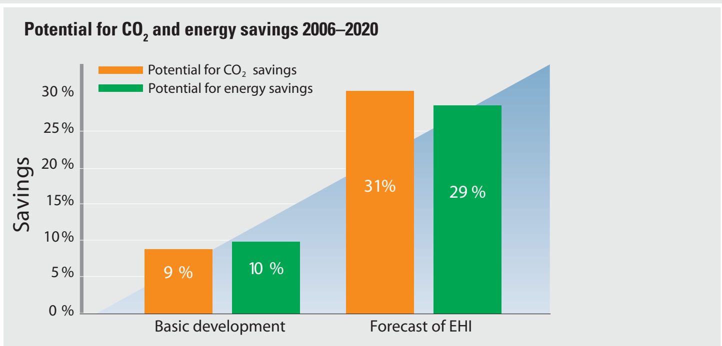
Changes in energy consumption

Forecasting the development of energy consumption is fraught with uncertainty. In their reference scenarios, most studies assume a worldwide rise in consumption of about one third by the year 2020.

Reducing dependence on imports

Fossil fuels will remain the main sources of energy over the coming decades as well. They are definitely available and will be able to meet the worldwide demand for energy. International conflicts, however, show us how vulnerable our dependence on energy sources can be. The answer to the questions that emerge from this is that we must enhance energy efficiency in the heating market and thereby substantially boost the proportion of renewable energies.





Possible potential for CO_2 and energy savings when doubling the speed of modernisation

EHI predicts:

- that measures taken so far are inadequate
- that integrated rafts of measures must replace measures taken in isolation
- that a doubling of the rate of modernisation by 2020 will lead to average savings of 30 % in terms of energy and carbon dioxide emissions

Urgent measures required immediately

- Doubling of the number of condensing boiler; linked with solar thermal energy or hot water and heating
- Threefold increase in the use of renewable energies
- Doubling of energy savings through modernisation of the building envelope

Medium-term measures

- Blended heating oils to include bio-heating oil
- Biogas fed into the natural gas network
- Encouragement for innovative installations and system technology

THE EU’S 20-20-20 STRATEGY

20 % Increase of efficiency

20 % CO_2 reduction

20 % share renewable energies

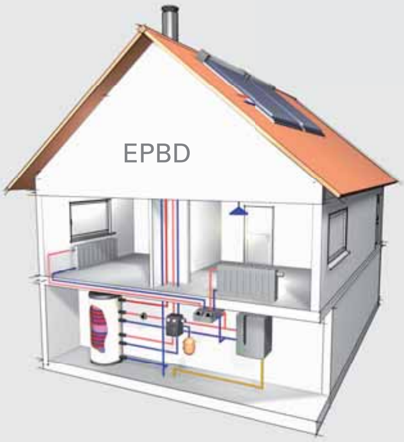
by 2020

Relevance for Buildings and Products

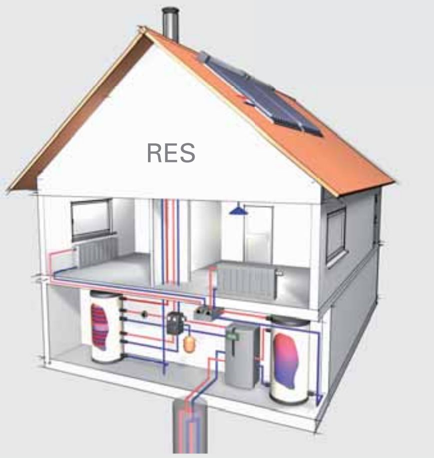
Energy Performance of Buildings Directive, EPBD

Directive for Ecodesign requirements for Energy related Products

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



Possible energy efficiency label for boilers



- Methodology for calculating the energy performance of buildings
- Minimum requirements for the energy performance of buildings
- Energy certificate and consultancy
- Inspection of heating and cooling systems

National goals of the share of renewable energies including national action plans

Raising energy productivity

Energy productivity in the EU is intended to double by 2020. That is a very ambitious target and demands a large number of measures. New and especially energy-efficient technologies, specifically in heating technology, are an indisputable component of the solution.

According the European Union's "Green Book", Europe's dependence on energy imports will rise from today's 50 % to over 70 % in 2030. Other forecasts predict dependency as high as 80 %. These prognoses, alarming as they are for strategic, economic and ecological reasons, caused the European Parliament in March 2007 to introduce the so-called "20-20-20" EU targets, which are to be met by 2020:

- reduction of carbon dioxide emissions by 20 % as compared to 1990
- increase in the proportion of renewable energies used to 20 % of total energy consumption
- rise of 20 % in energy efficiency

One of the keys to implementing these ambitious goals turns out to be the existing building stock in Europe, which is completely outdated as far as energy use is concerned. According to the Green Book on "Energy Efficiency or Doing More with Less" from 2005, what is termed the "energy efficiency of buildings" stands at just 50 %. This means that the building stock in Europe uses twice as much energy as it needs to, given the current state of technology. If Europe's building stock were brought up to modern technical standards – with due regard to the building envelope and the systems engineering – then Europe could save nearly 20 % of its imports of fossil fuels as a result of increases in efficiency and the use of renewable energies.

Meanwhile, the EU is further developing climate and energy action plans.

Three EU directives are of particular significance for existing buildings:

• Energy performance of buildings (EPBD)

The Energy Performance of Buildings Directive sets a general European framework for determining minimum energy standards for buildings in member states. The exact minimum standards and methods of calculation are to be decided by each individual member state. Moreover, the directive obliges member states to legislate for regular inspections of heating and air-conditioning systems. In addition, home-owners and tenants should be aware of the so-called "energy passport" concerning the energy performance of a newly built, newly sold or newly rented building. The recast EPBD was published on 18 June 2010.

• Ecodesign of energy related products

The ecodesign directive lays down minimum requirements for the ecological properties of energy-using products. For instance, central heating boilers, domestic hot water systems, pumps, ventilator fans, as well as air-conditioning and ventilation systems, all come under the terms of the directive. The minimum requirements for individual products are currently being worked out by the European Commission.

•Energy labelling directive

The Energy labelling directive complements the ecodesign directive by promoting the apliances that go beyond the minimum requirements. Applicances are rated in seven classes, indicated by coloured arrows. The directive was published on 18 June 2010.

• Promoting the use of renewable energy sources (RES)

The RES directive intends to boost the proportion of renewable energies used in the EU substantially. Member states are under an obligation to implement measures which will ensure that the proportion of renewable energies in the EU should rise to at least 20 % by 2020. In line with so-called "burden sharing", individual requirements are prescribed for each member state.

Implications of the directives for the building sector:

The heightened demands on the overall energy efficiency of buildings as a result of the requirements of the Energy Performance of Buildings Directive (EPBD), the establishment of minimum standards for energy-using products and the ambitious targets for raising the proportion of renewable energies are driving the consistent improvement in the quality of buildings as regards energy use.

The significance of this for installation engineers is that, in future, only the most up-to-date technology, combined with renewable energies, will be able to be installed. The heating requirement of buildings will drop from today's average of 250 kWh per year and square meter to 70 kWh per year and square meter or even less.

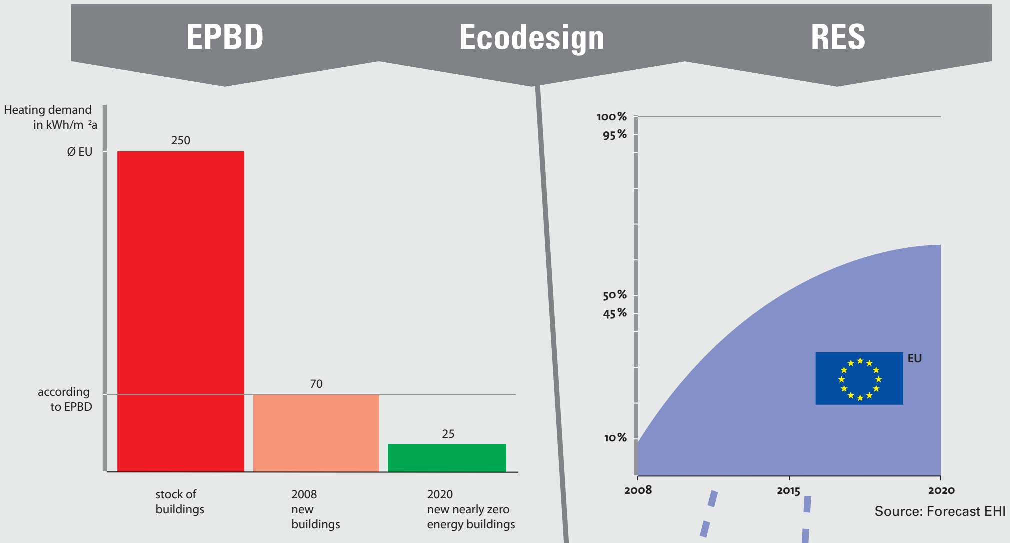
These EU prescriptions are already being reflected in current market developments. In some areas, the market for efficient heating systems that are combined with renewable energies is already showing significant signs of dynamic activity. In Germany in 2008, for instance, 45 % of all newly installed heating systems were linked in with renewable energy sources. This figure has risen by 13 % in less than two years. Similar developments can also be observed in Italy, France, Great Britain and Spain.

It must be borne in mind, however, that this development starts, to some extent, from a relatively low baseline. EHI reckons that in the EU the proportion of newly installed and modernised heating systems, which include the use of renewable energy sources, will rise to 50 % by 2015.

Challenges for the sectors in Europe:

The industry will change its production over completely to sophisticated, highly efficient systems which make use of a high proportion of renewable energies. These systems are show-cased in our examples featured at the end of this brochure.

The installation trades will have to get to grips with ever more complex systems and diverse technological solutions. This will demand additional qualifications, a change in marketing approach towards the end-consumer and a positive strategy aimed at encouraging technical solutions, which link efficiency and renewable energies.



Percentage of new heating installations per year incorporating renewable energies

Fit for today and our future through energy efficiency and renewable energy sources

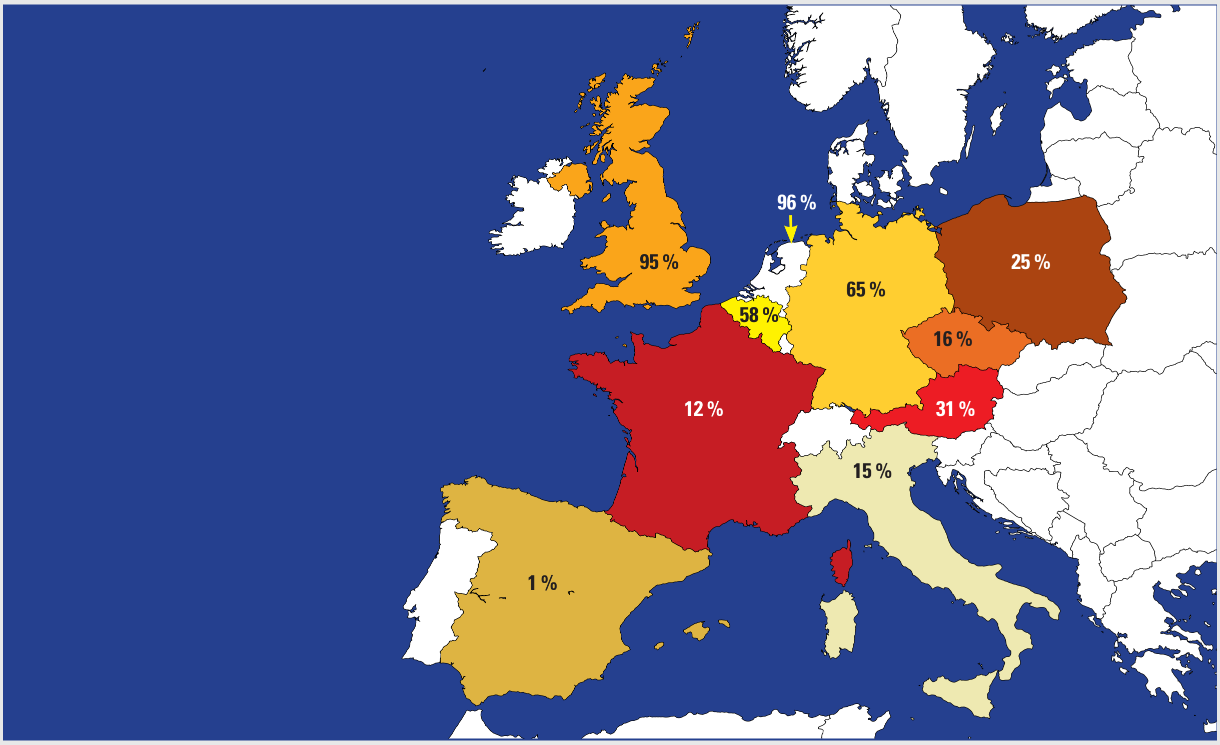
Outlook: research and development of new systems and technologies to increase the energy performance of buildings

Getting energy costs under control with high-performance heating systems

In line with the international agreement on climate protection, the European Union has pledged to significantly reduce the production of CO_2 emissions: the level is to have dropped by at least 20 % by the year 2020. CO_2 emissions are responsible for climate change and result mainly from the burning of fossil fuels such as coal, natural gas or (petroleum) oil. However, these fuels provide the mainstay for the production of power and heat, as well as of a large number of industrial goods. One aim of European policy is thus to reduce energy consumption and to contribute to more efficient energy use in the future. One example of this is the introduction of EU labels, which rate household appliances according to the energy they use, thus making energy consumption more transparent.

Change as opportunity

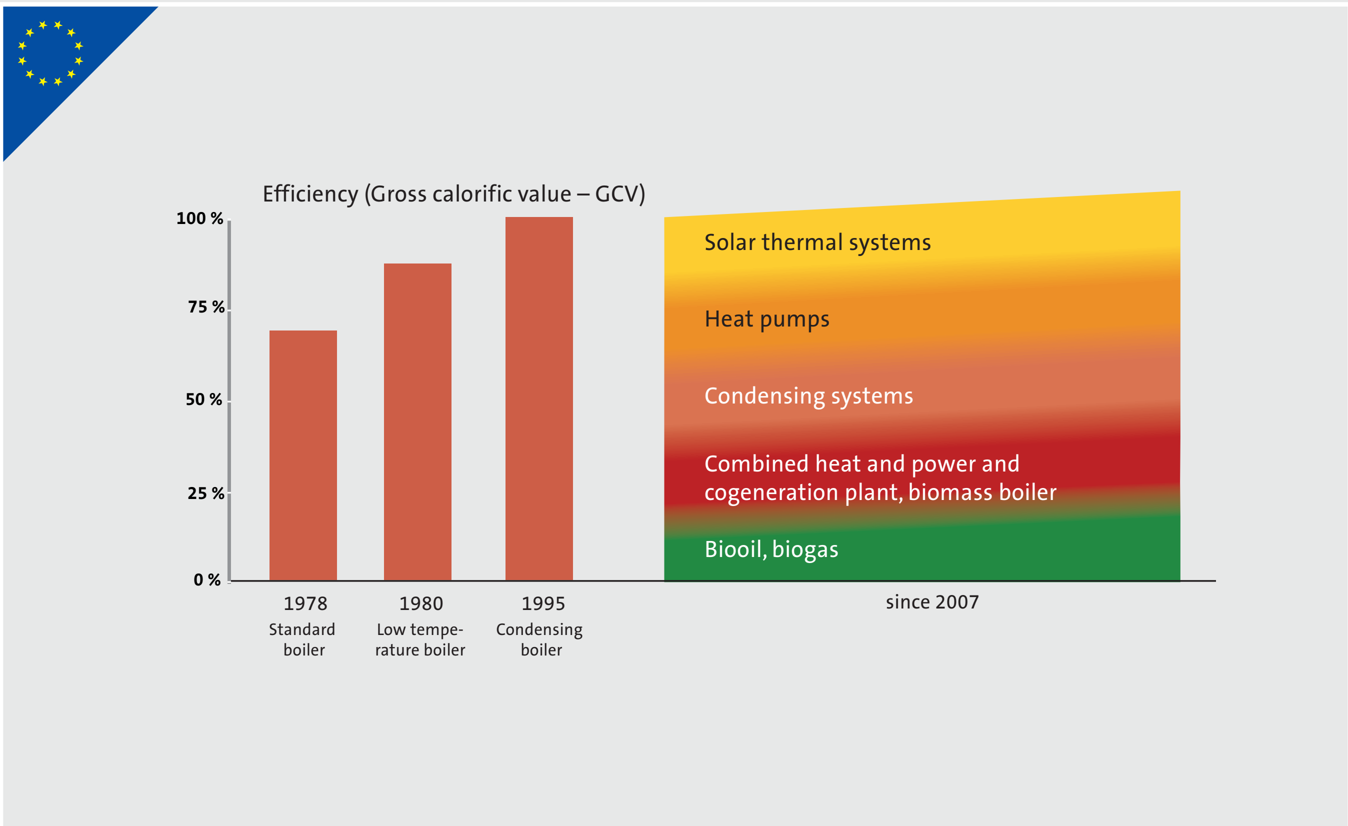
Alongside the requirements for climate protection, there is another development which is driving the



Number of condensing boilers sold as a proportion of sales of heating units in selected European countries in 2008.

energy market: the enormous hike in energy prices in recent years. However, every change also gives rise to opportunity: the legal requirements and the high price levels have both contributed to the consumer's setting greater store by high-performance systems for their heating and domestic hot water systems. These systems promise to relieve the high energy costs – for users in industry and the service sector, as well as in private households.
Moreover, the prices for fossil fuels have brought about another development: in many heating systems, renewable feedstock, such as wood or biomass (in the form of liquid fuel or gas), are increasingly being used. These exhibit relatively stable price structures. In the same way, people are increasingly turning back to solar and environmental energy sources.

These market developments confirm the need for further research into the potential for renewable energies and the need to press ahead with these developments. For adequate high-performance alternatives ought to be available before fossil resources are completely exhausted.

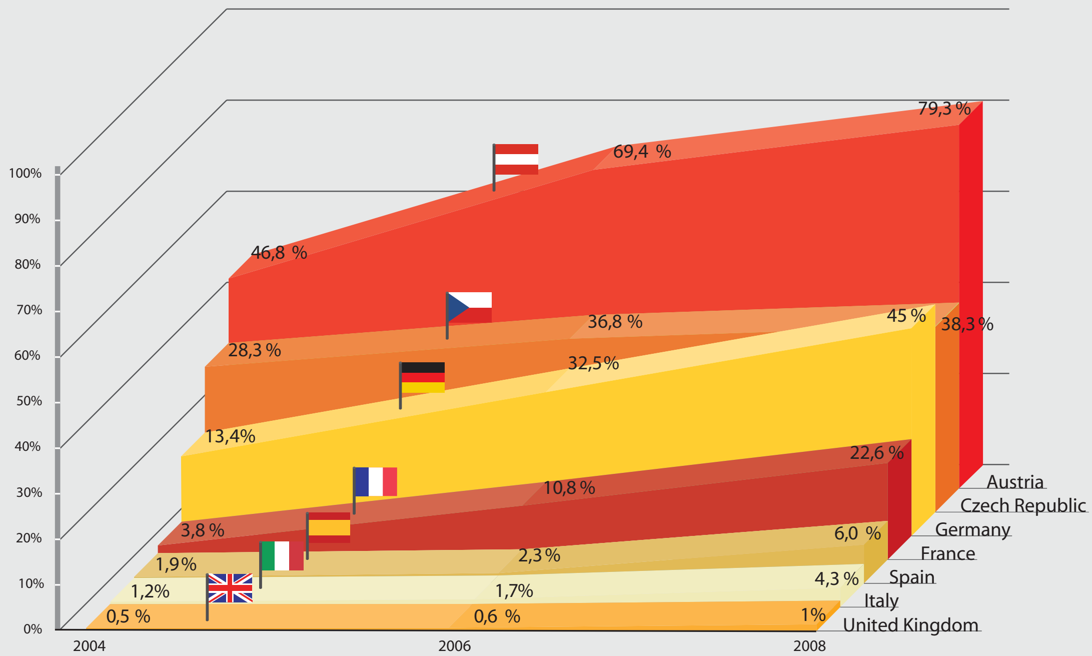


Technological development

The building sector as a driver of innovation

The building sector is ideally placed to help implement the European targets on climate protection, for the lion's share of end energy consumption in Europe – round about a third – is used for heating and hot water. This means that measures aimed at energy efficiency pay off especially well in the building sector – for example retro-fitting modern heating systems, making use of renewable energies and indeed renovating the building envelope.

The enormous amount that has been done in the last decades in the field of heating technology has favoured these developments: the efficiency of modern oil and gas central heating boilers has been taken almost to the physical limits of feasibility. Modern heat pumps, wood-fired central heating boilers and block cogeneration plants are all being used. In many cases, these technologies are already linked with solar thermal systems. Mixing bio-oils with heating oil and feeding biogas into the public natural gas network is already common practice.



Development of renewable energies in the heating sector in selected European countries

TECHNOLOGIES

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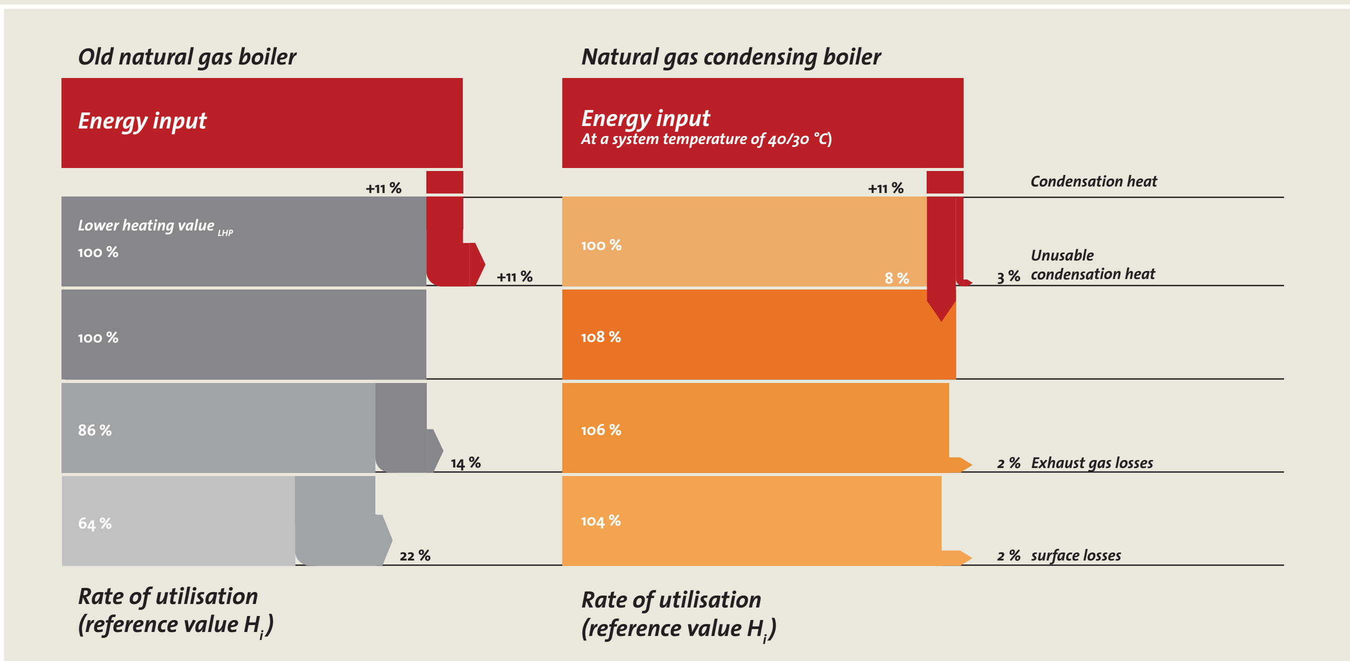
Efficient heat generation

Modern condensing boiler technology, running on natural gas, contributes to savings of energy and costs for the supply of heating in the home. Natural gas-fired condensing boilers work very efficiently because they also use the energy contained in the combustion exhaust gases. Anyone opting for natural gas condensing technology is choosing a particularly environmentally-friendly and convenient form of heat generation. Modern condensing boilers are capable of generating the necessary heat for central heating and for domestic hot water in an ecologically sound and resource-friendly way. Because of these advantages, condensing boilers run on natural gas are often the first choice both for new installations and for the refurbishment of existing central heating systems. Europe in 2008, some 310,000 natural gas-fired condensing boilers were sold.

Condensing boilers cover almost all output ranges. Wall-mounted units deliver up to 100 kW. Connected one to the other in a cascade system, the output can be increased to several hundred kilowatts. Floor-standing units can supply nominal outputs of more than 10,000 kW.

Well-established technology

After more than twenty years gas condensing boilers are now technically very sophisticated. This applies in terms both of their convenience and their noise levels. Moreover, their modern design means that appliances fit unobtrusively into their surroundings. Given their very low-noise and odourless operation these units can be installed without difficulty in almost all areas of a building. They need little space and fuel does not need to be stored near them. Moreover, even very erratic output requirements for heating and hot water can be efficiently met.



Efficiency comparison between old boiler and natural gas condensing boiler

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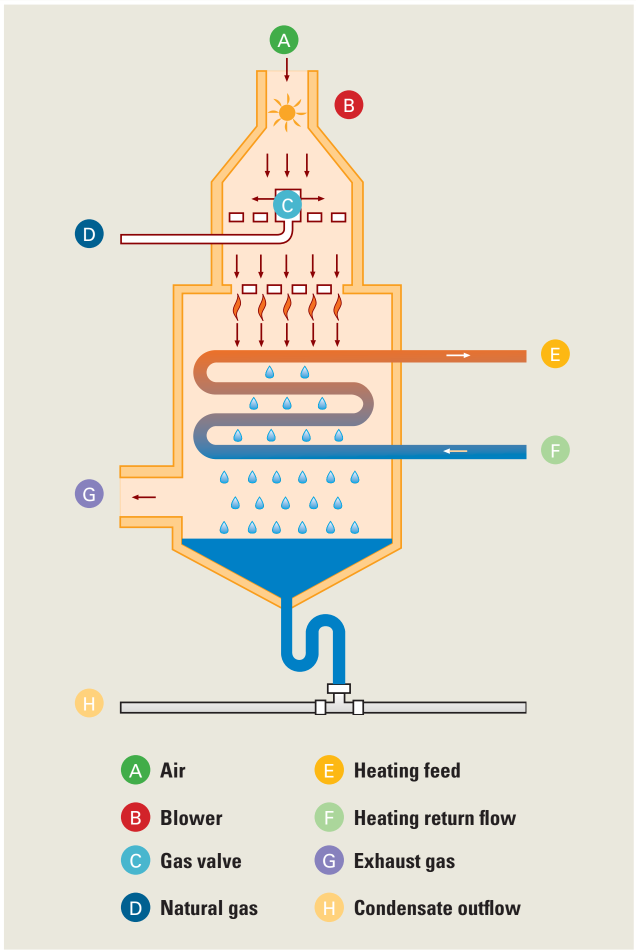
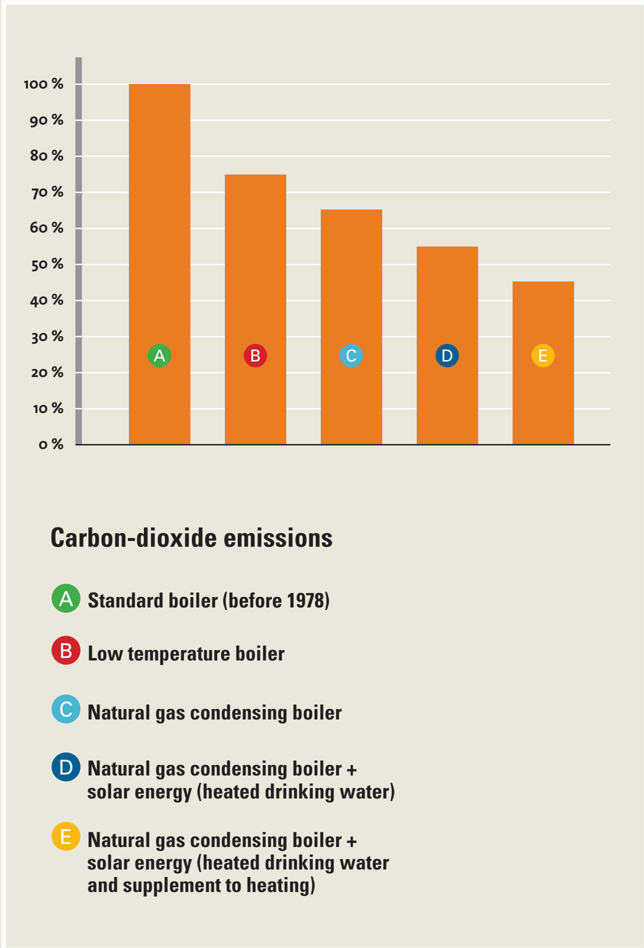
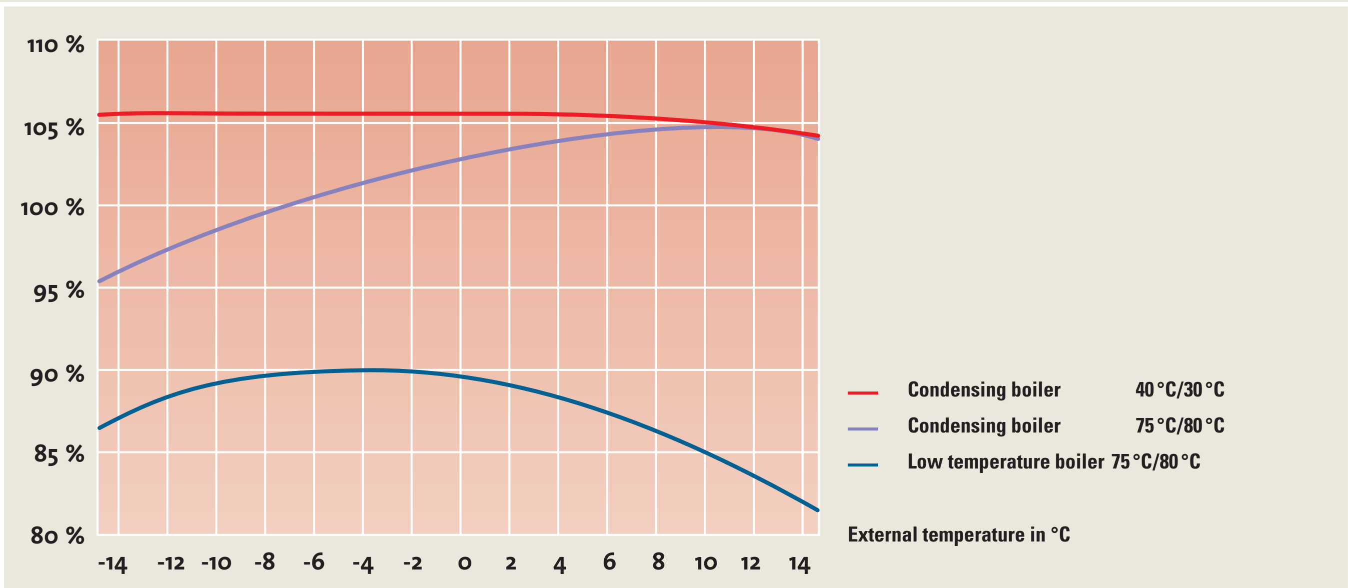


Diagram of a condensing appliance



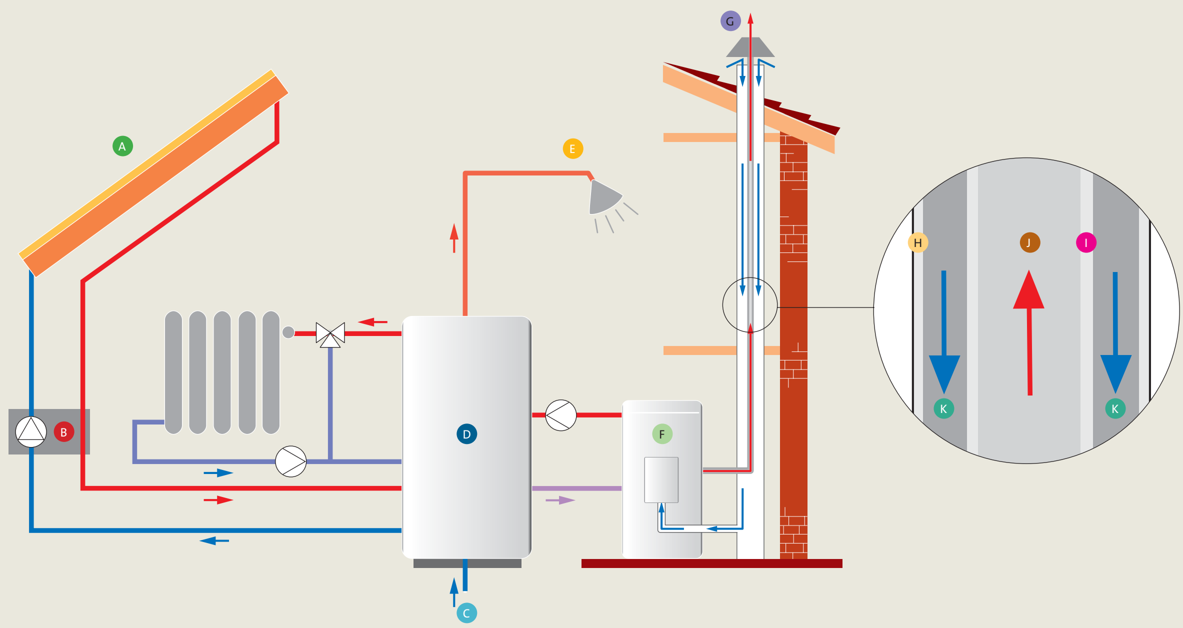


Effectiveness comparison between condensing and low temperature boiler

Optimum use of fuel

Heating oil contains hydrogen which, on combustion, is turned into steam. If the exhaust gases from the combustion process are cooled, the steam contained in them condenses and the heat from the condensation process can be used. The flue gases must be cooled to below the so-called "dew-point temperature", in order for them to condense. The dew-point temperature is dependent on the hydrogen content of the fuel and hence on the steam content of the flue gases. With EL heating oil (extra-light) the dew-point temperature is about 47 °C. By using the latent heat of condensation, the efficiency of a heating system can be significantly improved. In practice this results in the production of 0.5 to 1 l of condensate per kg of heating oil. Because of the relatively low temperature of between 45 and 50 °C of the resultant flue gases, flues for their removal can be made of plastic tubing.

Modern condensing boiler technology can therefore extract energy from the fuel being used in the most efficient way. This enables oil-fired condensing boilers to reach 98 % efficiency when measured against the higher heating value (gross calorific value) of the heating oil, a value which represents the physical limit of what is possible. A traditional boiler does not make use of this additional heat and it thus goes to waste; in these cases the energy contained in the condensate is discharged into the environment via the chimney or



Combination storage system for domestic hot water and heating supplement

- A Collector
- B Solar station
- C Cold water inflow
- D Warm drinking water storage
- E Warm water
- F Oil-fired condensing
- G Air-exhaust-gas-system for operation independent of room air
- H External pipe
- I Humidity resistant internal pipe
- J Exhaust gas
- K Combustion air

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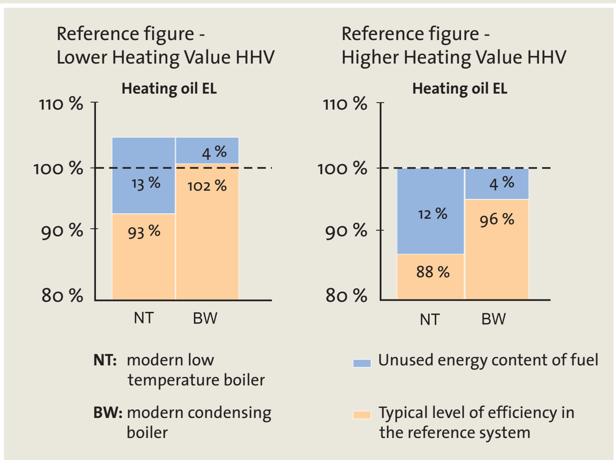
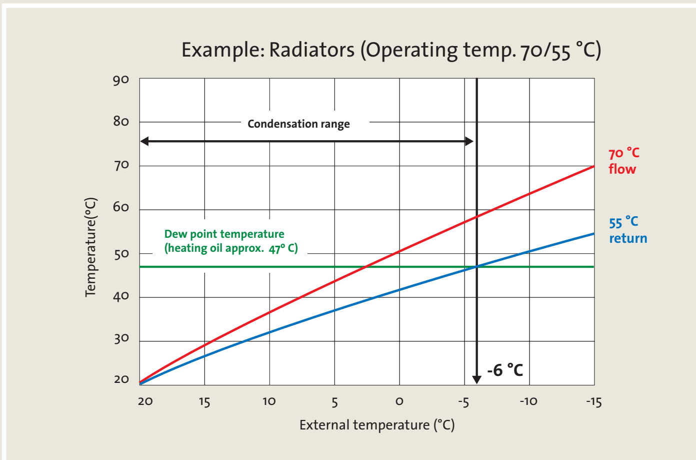
flue-pipe. Oil-fired condensing boiler technology thus achieves the highest efficiency with the lowest fuel consumption and minimum emissions.

Clean for the environment

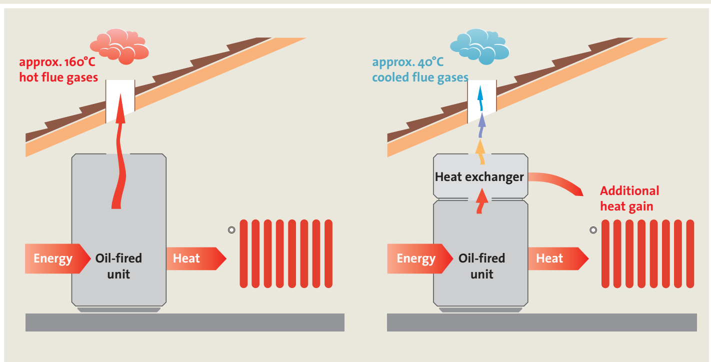
Low-sulphur heating oil is a quality fuel, which conforms to laid-down standards and which demonstrates several essential advantages over normal heating oil. It means that noxious substances in the flue gases are reduced to a minimum. Moreover the condensate does not need to be neutralised. That is why it is recommended by all the leading heating appliance manufacturers. Low-sulphur heating oil is ideally suited to the requirements of condensing-boiler technology and offers advantages for low temperature boilers as well. Low-sulphur heating oil burns very cleanly and makes for consistently good heat transfer in the boiler. This results in boilers which demonstrate continuously high levels of efficiency and a high degree of reliability. Low-sulphur heating oil will attract tax advantages in many countries as against conventional heating oils. With this, policy makers intend to encourage the use of low-sulphur heating oil and thus establish an important pre-requisite for the more widespread use of oil-fired condensing boiler technology. In addition oil-fired condensing boiler technology combines splendidly with solar-thermal energy. The solar collectors supplement the domestic hot water system and, depending on the design of the system, also contribute to heating the building.



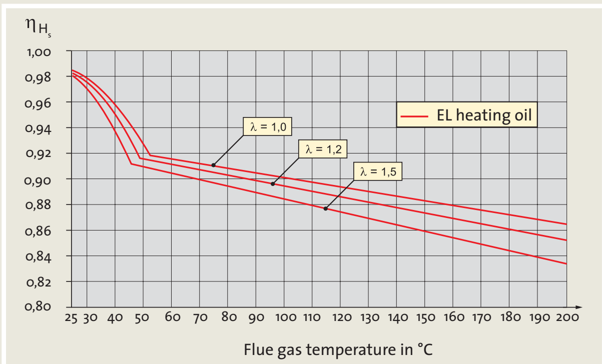
Efficiency levels for different reference values



Effect of heating system temperature on condensation



How does condensing boiler technology work?



Efficiency of combustion related to Higher Heating Value [HHV]

Wood: nothing closer to heart and home

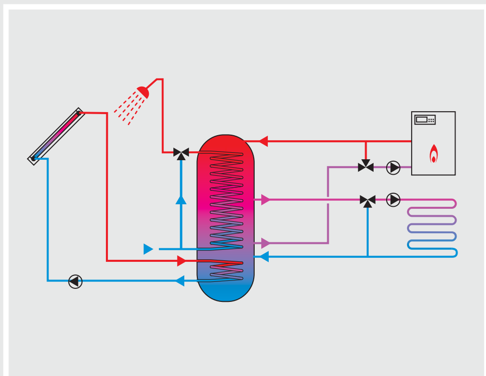
At a time when traditional fuels such as heating oil and natural gas have shot up in price, wood is once more gaining increasing popularity for heating purposes. It demonstrates many qualities which makes it of interest, not only as a source of energy, but also as far as protection of the environment is concerned: wood grows in our own forests and can be harvested relatively easily and at relatively low cost in terms of energy, because the cost of transport is largely non-existent. Since, every year, more wood grows than is harvested, the supply is secure for a long time to come. Because of the large amount of forest, wood can be harvested locally, and this strengthens the local economy and secures local jobs.

Wood can be used for heating in a wide variety of forms. Wood pellets are enjoying increasing popularity. These are pressed from untreated wood waste. They are manufactured by first drying sawdust and shavings from the wood processing industry. These are then compacted under high pressure and finally cut into lengths of between 5 and 10 cm. Pellets have a heating value (energy content) of approximately 5 kWh/kg. The energy content of one kilo is equivalent to half a litre of heating oil.

Heating technology for all output levels

In principle modern pellet-fired heating systems are designed in such a way as to give reliable

Wood and wood pellets are CO_2-neutral fuels



Technically coordinated utilisation of the sun and wood as energy forms allows them to complement each other perfectly

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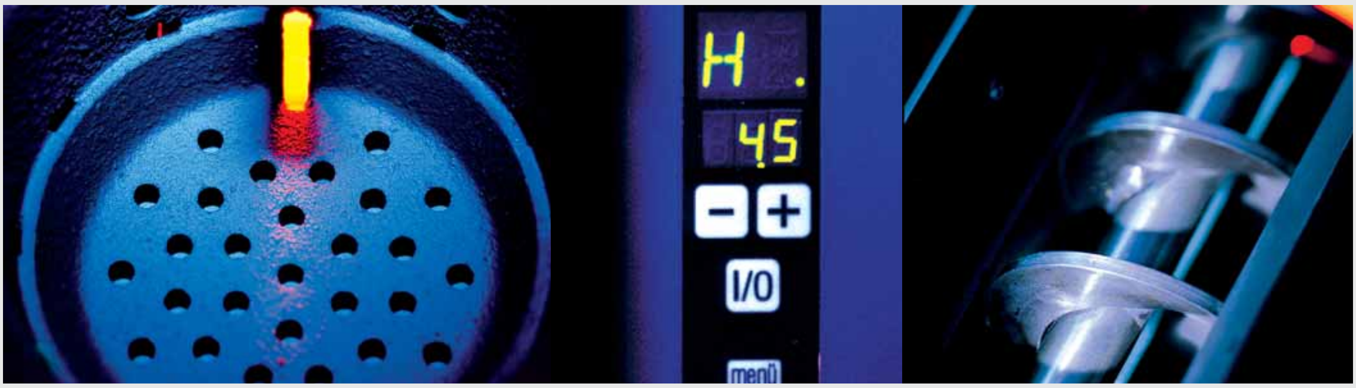
and fully automated service. There is a distinction to be drawn between pellet burners (pellet stoves) and pellet-fired central heating systems. There are two types of pellet burners: one using the ambient air and the other using a boiler principle. The “air process” operates on a principle similar to that of the free-standing woodburner. It is used principally for heating individual rooms and as supplementary or transition heating to cover peak loads. These free-standing stoves which radiate heat directly have a maximum heat output of 8 kW. Alternatively there are units designed for operation with central heating systems, which have outputs of 8 kW and more, and which can be used to heat detached or semi-detached houses, but can also supply whole apartment blocks or groups of dwellings. For this a boiler principle is employed; the burner has an integrated water jacket (heat exchanger) and boilers such as these can be successfully combined with other types of heat generation system or solar-thermal energy.

Central heating systems using wood pellets are very convenient to run: they are comparable with oil and gas fired heating systems both in terms of operation and servicing. Hybrid and combination systems can also be fed with other forms of firewood such as wood chips and split logs. Pellets are stored in a tank or in a storage room and fed to the boiler with a delivery system – trickle feed, air-suction or augur.



Fully automatic regulation ensures effective burn off and a high level of efficiency

Central heating with wood

Wood is the oldest energy source known to man and, as a fuel, is on the up and up. Thanks to modern heating systems, houses, or even whole housing complexes, can be supplied with heat automatically and in an environmentally friendly way. The various wood-fired heating systems recommend themselves because of their convenience of operation; they require a minimum of effort to keep them going. And they use wood as the energy source – in the form of split logs, pellets or wood chips.

The right solution for every need

There is a variety of systems on the market when it comes to wood-fired central heating systems. Wood gasification boilers use split logs, giving high levels of efficiency and relatively low emission figures. In this case, a fan creates the right amount of draught for combustion purposes. Once the boiler is filled, it will burn for several hours at a time. Pellet-fired boilers offer the greatest efficiency and the lowest emission figures compared to other forms of wood-fired boiler. As far as convenience is concerned, they are comparable with traditional oil or gas-fired heating systems, since they are automatically fed, are fed with hot air and are self-cleaning with built-in riddles. All modern wood-fired boilers are fitted with anti-burn-back protection to prevent fire “creep” back into the storage room.
Wood-chip boilers are also automatically operated, with combustion being regulated by a lambda sensor. Here too, only limited amounts of ash are

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produced. Wood-chip heating systems are suitable for larger installations – supplying heat to schools, swimming pools, or apartment blocks for instance. The price of wood-chips is lower than that of wood pellets, although a larger store room is required. These systems are available in almost all output ranges from 4 kW to several MW.

On the side of the environment

One of the main reasons why wood is so appealing as a source of energy, is that it is CO_2-neutral when burned. The amount of CO_2 released when it burns corresponds exactly to the amount the tree fixed when it was growing. If the tree were left to rot in the forest, the same amount of CO_2 would be released – and to no purpose. Moreover, every litre of heating oil replaced by wood saves 3 kg of CO_2, which would otherwise have found its way into the atmosphere. In addition wood ash can be used as a fertilizer, which once again completes another natural cycle in the wood chain. Using wood as an energy source represents a high level of local value creation, since the purchasing power remains with the locals – and so do the jobs. Not only that, consumers can benefit from state subsidies that are available for people using sustainable raw materials.

Pellet delivery by tanker

Completely automatic feed system for wood chip boiler

Operation

Heat pumps are mostly electrically powered, but can also be gas powered. They harvest the low-level heat energy in the earth or the environment to provide space heating. A heat pump with a performance factor of 4.0 generates 4W of heat from one W of drive power. Some utilities offer special tariffs for heat pump operation, an added economic attraction. Even in colder climate countries such as Sweden, Switzerland and Austria, heat pumps have established themselves as a viable heating technology.

The heatpump cycle

A heat pump operates like a refrigerator in reverse. A refrigerant extracts low-temperature heat from the environment (ground, water or air), which causes the refrigerant in the system to evaporate. The refrigerant is then compressed. In a condenser heat is released. This heat is transferred to the water circulating in the heating system.

Effective distribution

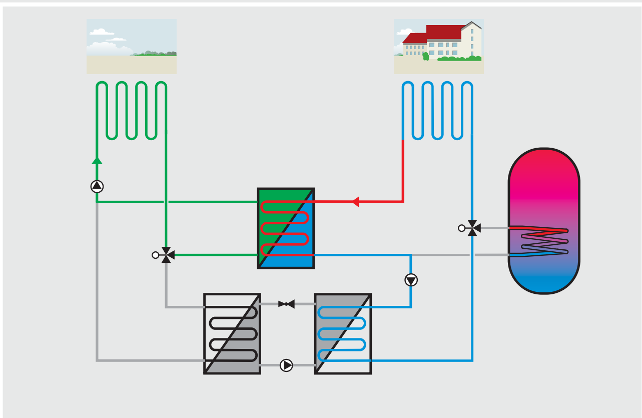
Heat pumps work more efficiently when combined with distribution systems that work at lower temperatures.

Practically emission free – with renewable energy

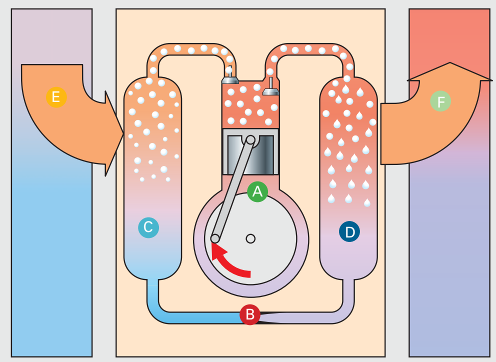
Heat pumps can be driven from electricity produced from renewable energy sources such as wind power or photovoltaics and operate practically emission-free.

Closed-loop heat pumps: brine/water

Closed-loop heat pumps are the most common type. They use a closed loop of pipe containing a water and anti-freeze solution to extract heat from



Operating mode "cooling"



A Compressor

B Expansion valve

C Vaporiser

D Condenser

E Heat absorbed

F Heat discharged

How the heat pump works

Examples of modernisation
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the ground or ground water. The heat is transferred to water for distribution in the building. Hence: “brine/water”. High yearly/seasonal performance factors – 3.8 to 5.0 – can be achieved. The heat can be extracted from the ground or ground water using vertical collectors in boreholes or loops of pipes laid horizontally below the surface of the ground. They are available with or without integrated hot water storage.

Open-loop heat pumps: water/water

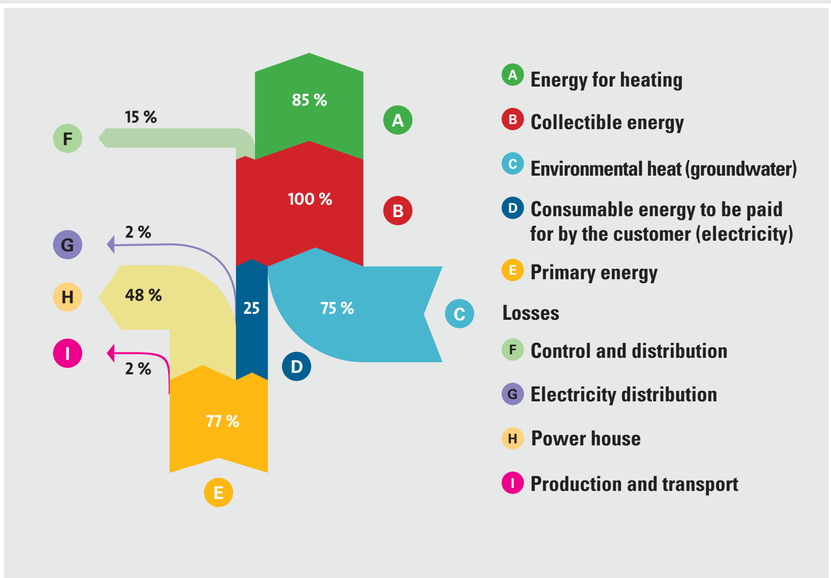
Open-loop heat pumps achieve the highest yearly/seasonal performance factors – 4.0 to 5.0 – because they use the almost uniformly level temperature of bodies of water. The water from the source is pumped through the actual heat pump itself where its heat is extracted. Evaporators need to be rustproof. Water/water heat pumps come with or without hot water storage tanks. Building cooling is also possible.

Air-source heat pumps: air/water

Air-source heat pumps extract environmental heat from the air. They can achieve yearly/seasonal performance factors of 4.0–5.0. They are particularly suitable for installation in existing buildings. There are no earthworks necessary and thus they are easier to install. The air/water heat pumps can also be switched to operate in cooling mode.

Particular requirements for ground-source heat pumps

Sufficient open land area must be available – to sink boreholes, but more so if horizontal collectors are to be used. Permits are often necessary.



Energy flow – electric heat pump

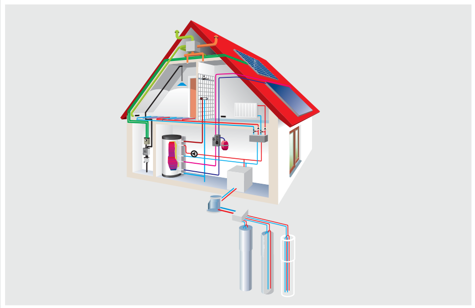
Sources of heat

The higher the temperature of the heat source, the more efficiently the heat pump will operate. The source temperature should vary as little as possible over the year. The easier it is to access the heat source the lower the investment costs for the system will be.

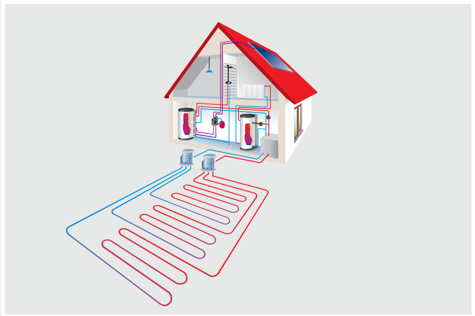
Horizontal ground collectors buried in soil

Horizontal ground collectors are thin coils/loops of polyethylene pipe. These are buried horizontally 1.2 to 1.5 m below the ground (in a garden for example). The coils/loops are placed in rows 0.5–0.8 metres apart from each other. Generally, one 25 square metres of ground is required to produce a kilowatt of heat.

Bore-hole for geothermal heat exchanger



Geothermal heat exchanger



Ground collector

Air/Water heat pump placed outside

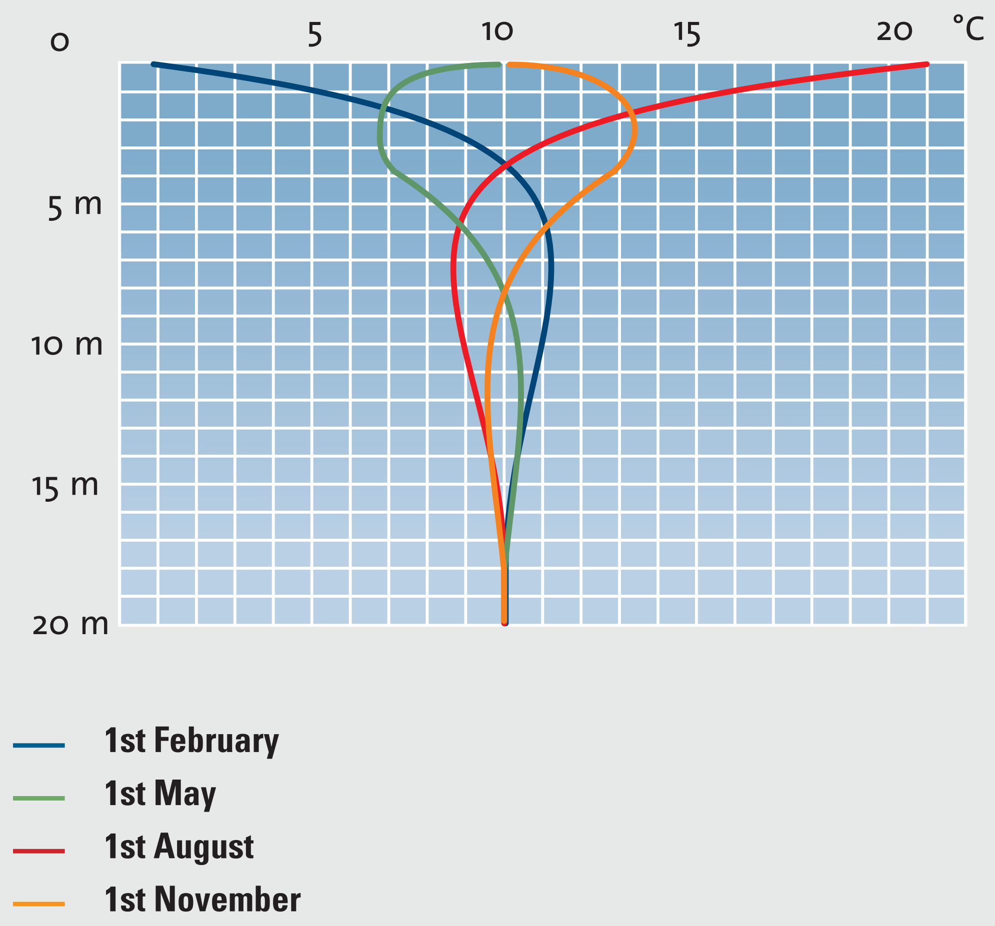
Examples of modernisation
Page 58–59

Vertical ground collectors in boreholes

Vertical ground collectors are double "U" pipes made from polyethylene. They are placed in boreholes at depths of 30–100 metres. At these depths the year-round temperature is about a constant 10 °C – relatively high. Approximately 50 W of heat can be extracted per metre of pipe. This type of system can also be used for building cooling.

Air-source heat pumps

Air-source heat pumps use the air as a source of heat. Building permits for earthworks (which may be necessary) can be avoided. This kind of heat pump can be a preferred option in renovation projects. The heat pump plant can be installed both inside or outside the building.



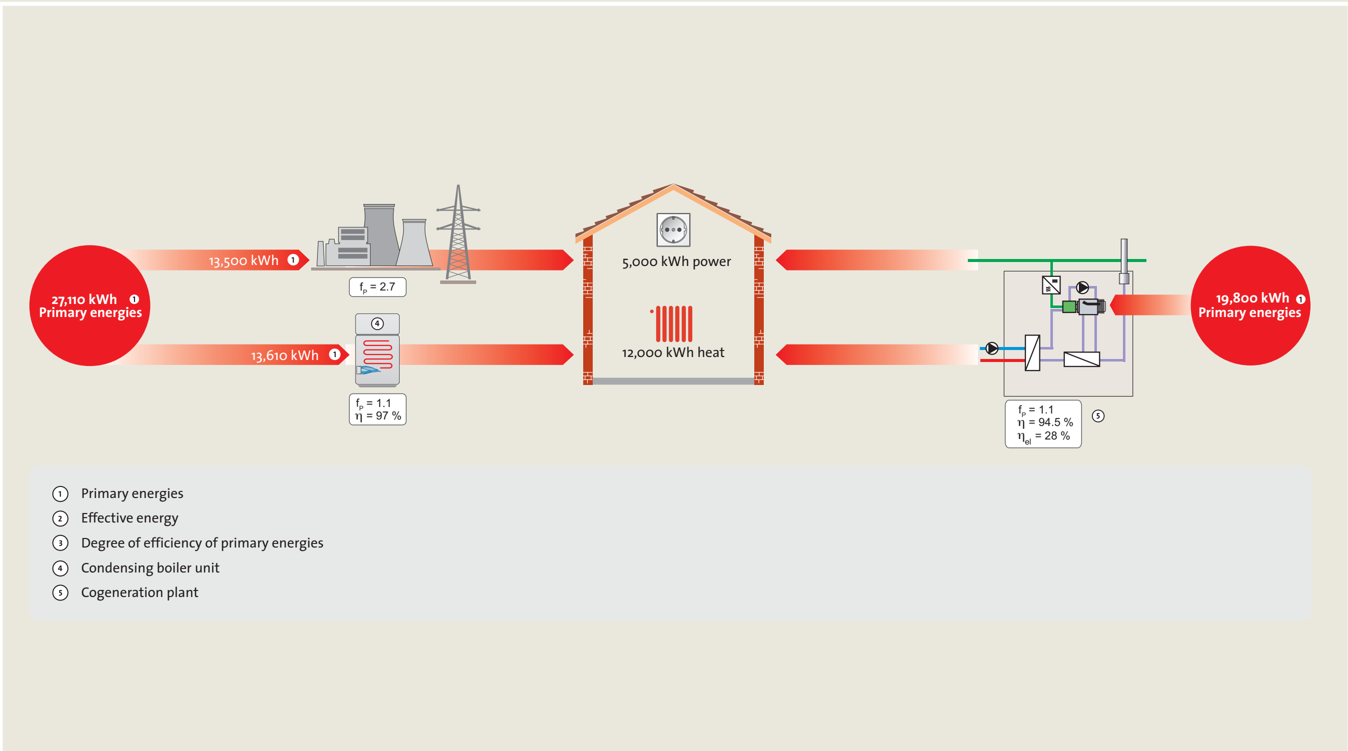
Temperature pattern under the surface of the ground

More than just a heating system

In heating systems, the primary energy source is converted into heat. In contrast to this, combined heat and power generation (CHP) produces both heat and electricity in the one independent appliance. By using the primary energy source economically in this way, cogeneration of heat and electricity not only contributes to an overall reduction in energy consumption, but it also contributes directly to the protection of the environment. That is why there is active state support for combined heat and power generation. In addition, there are special payments for any unused electricity that is fed into the national grid.

Current state of technology

As far as the basic technology is concerned, a distinction is to be drawn between internal and external combustion engines (Otto engines and Stirling engines), steam expansion engines and fuel cells. Combustion engines and steam expansion engines represent the current state of the art in terms of technology. Stirling engines, like fuel cells, are currently undergoing trials. The fuel used, such as natural gas or heating oil, drives a combustion engine with a power generator coupled to it, thus producing electricity. In future, it is entirely conceivable that renewable energy sources such as biogas, vegetable oil, wood pellets and indeed bio-ethanol



Energy balance for cogeneration of heat and power

Examples of modernisation
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will be able to be used. The process heat released by the motor is used for space heating and for domestic hot water. The electricity produced is used as required and any excess power fed into the national grid. Decentralised cogeneration of heat and power is a highly efficient way of supplying both space heating and electricity.

The right solution for every requirement

Consumers have a choice of different CHP solutions from outputs of just a few kW to several hundred MW. Whilst so-called "micro-CHP" units with power outputs of up to 5 kWel are used for detached and semi-detached houses, "mini-CHP" units of up to 50 kWel have been developed for small apartment blocks and business premises. No district heating network is required for these smaller CHP units. Industrial premises and also larger housing estates, hospitals and schools use larger CHP units or block cogeneration plants with outputs starting at around 50 kWel. In these applications, CHP systems can supply up to 100 % of the heat and 80 % of a building's power requirements; moreover, CO_2 emissions can be reduced by up to 40 %.

In future a large number of block cogeneration plants working together as a "virtual power station" will help smooth out voltage fluctuations in the public power supply .

Example of installation

Share of domestic hot water energy consumption

An estimated 10-20% of the overall energy consumption for heating purposes within EU is used for domestic hot water (DHW).

Differentiation of domestic hot water systems

The main task of all domestic hot water systems is to provide the user with the desired comfort, which means delivering a minimum requested amount of hot water with a minimum temperature.

Appliances for providing a more or less constant supply of domestic hot water are commonly known as water heaters or DHW systems. The choice of applicable systems depends on the detailed requirements and the situation on-site. Basically it is possible to differentiate the systems into two general principles:

1. On-demand water heater
2. Storage water heater

On-demand water heater

On-demand systems heat water instantly as it flows through the aRosyppliance (also known e.g. as tank-less water heater). The temperature difference between cold (inlet) and hot (tap) water and the required flow rate (e. g. for hand washing, showering or bath) define the necessary heat power.

Small tank-less water heaters could be located right where the water is used and are only linked with this one tap.

Larger tank-less water heaters are also common in centralised systems such as single flats up to one or two family houses. Common energy sources are gas or electricity.

Appliances which are capable of supplying both space-heating and on demand DHW are known as „combi" boilers.

Gas Instantaneous Water Heater

Electric Water Heather

Storage Systems

Direct heated storage tanks are a combination of a vessel with e. g. a gas or oil burner, electric resistance heater or an air source heat pump.

Where hot water space heating appliances are used, drinking hot water cylinders are usually heated indirectly by primary water from the appliance or by an electric immersion heater (often as back-up to the boiler).

Indirect heated storage tanks (unvented cylinders) incorporate one (ore more) internal heat-exchanger which could be connected with any appropriate heat source like heat pumps, gas, oil or biomass boilers, solar panels, district heating or combinations of those.

Specific storage technology is the "stratified storage tank" (often use in solar DHW supported systems). This technology is specifically designed to force the effect of difference in mass between cold and hot water to prepare a specific "hot" area on upper part of the tank. This "hot" or "process" area provide the user with domestic hot water, while the lower "cold" area contains the heat exchanger (or directly) fed by the input of the solar panel. Between cold and hot area is a second heat exchanger which could – if necessary – heat up the solar heated water to the desired temperature of the domestic hot water.

Cross-section common domestic hot water tank

Cross-section stratified storage tank

Technology that thinks

Behind today's heating are intelligent systems, which make life very pleasant. It has long been taken for granted in many households that the bathroom heating comes on automatically in the morning before the alarm clock goes off, so that people can take a shower in a warm room. The temperature in the living area can be set so that the temperature at which individuals feel comfortable is reached before they get home. And it almost goes without saying that, at night, the heating drops to its lowest level – all by itself.

Modern central heating systems are no longer imaginable without intelligent control technology. This is based on innovative micro electronics and ensures the optimal interplay between all the heating components – including central heating boilers, burners, heating pumps and radiators. It ensures that the desired temperature is achieved by means of the heating system – even if, in the meantime, a window has been opened briefly or the icy outside temperature means that the room temperature needs to be turned up.

The technology is so easy to use and more energy efficient than ever. Because consumers can target heat to just those areas where it is needed, control technology helps to reduce running costs on a long-term basis. A display makes the fuel economy data clear, registers the operating status and indicates if any maintenance is needed. Occupants can easily carry out modifications to the programme – in case they suddenly want it to be warmer or because a sudden cold snap has arrived. If any fault should occur, this is immediately shown on the display. The data help the heating engineer recognise the cause quickly and easily and rectify it as soon as possible.

Heat at the press of a button

Today's heating systems offer significantly more than earlier generations: they now mean that domestic hot water, heating output as well as ventilation can be controlled centrally.

These modern systems generate hot water not only for the heating circuit as and when required, but they heat water for the kitchen and the bathroom too. In addition, they can be run as bivalent systems, that is to say they can be run with two energy sources at the same time. In many cases, renewable energies are used – solar heat, for example. Control technology integrates the energy from the solar thermal installation into the system. If the equipment is not producing enough heat because of adverse weather conditions, then the heating cuts in, activated by the control technology running in the background.

Control technology can regulate a wide variety of heating systems – even including micro or mini block cogeneration plants, which, based on the principle of combined heat and power generation, produce electricity and heat at the same time. Amongst its other functions the control technology sends any surplus electricity to the local grid. This should be of interest to homeowners, since it means that they receive payment for their surplus electricity.

Intelligent control and communications technology

Remote controlled heating systems

Today's control technology for heating systems offers a variety of ways of generating and deploying heat efficiently. It is, however, not until it is used in combination with modern communication technology, that its potential can be fully exploited. Indeed it is already possible, today, to control the heating system in the cellar from the living room – with a remote control unit, as we have long since been used to doing with the television, DVD player or stereo system. Service personnel now just need a laptop to identify any problems with the system. And because communication technology can automatically send details of faults, shut down or other incidents to the engineer, the house owner can relax in the face of winter: engineers immediately have all the information necessary for them to resolve the situation from their desk. With online-access, they can take all the necessary steps. This avoids unnecessary servicing and increases the availability of the heating system – without costing the operator any additional time or money.

Managing power consumption efficiently

Nowadays, a modern heating system can be controlled by a central computer, which manages all the data, programmes and information. Basically, an "on-board computer" of this kind lends itself to intuitive use by means of a touch screen. With it, residents can create heating profiles for individual rooms, set a minimum temperature or adjust the radiator valves. Sensors detect the ambient conditions, which the system evaluates and reacts to accordingly. Thus control and communication technology makes possible an energy management system, which is exactly tailored to the needs of the occupants. Heating systems with control and communication technology can be set up by remote control. More over, the technology

Service using a laptop

allows the system to be optimised very easily, as well as documenting all performance data. A further benefit is that the oil tank can be monitored via the central computer and, if any additional frost protection is needed before the onset of winter, that, too, will be flagged up. In addition, almost all of these systems are equipped with integrated gas and smoke alarms as standard.
The major advantage of this technology is that it operates without the need for any additional cabling; all commands, such as "on" or "off", "raise temperature" or "lower temperature", are transmitted wirelessly from the sender to the receiver. There is no need for long control cables or for complex and expensive wiring. The remote control sender is battery operated so that it is very easy to install. With the remote control unit, existing switching functions and combinations of switches can be quickly and easily modified to encompass additional functions. If one particular process no longer suits, it can be simply reprogrammed without the need for any building work.

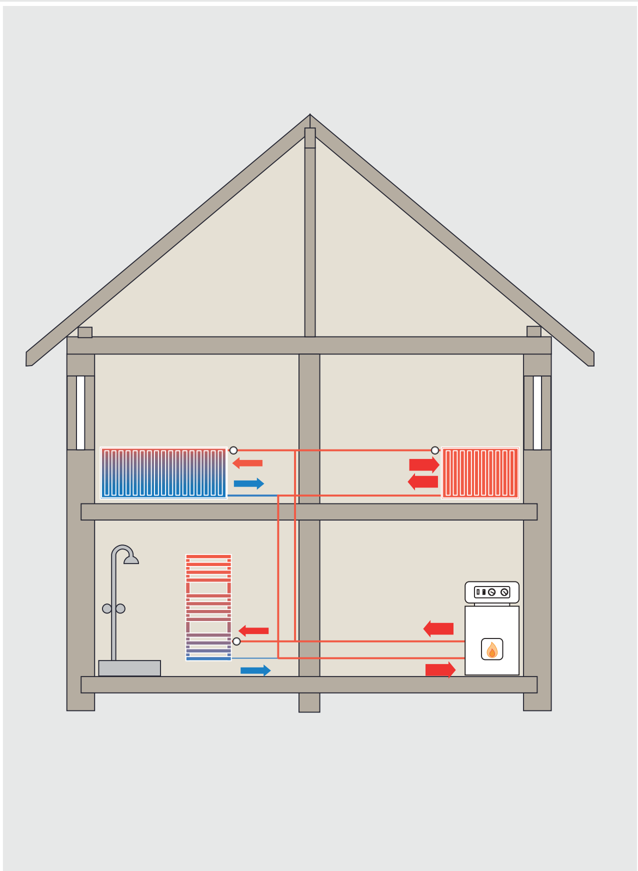
Remote diagnostics

The link between heat generation and heat emission

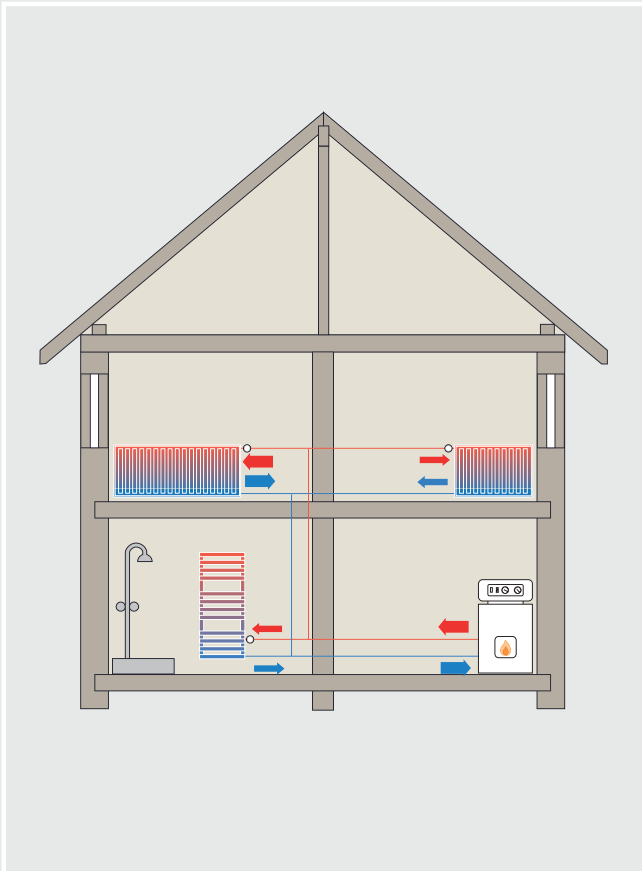
An efficient supply of heat is only possible if the heat is optimally distributed throughout the building and in the individual rooms. This is achieved using pipework, valves, pumps and control technology. These components have a crucial impact both on operating costs and on the comfort and enjoyment of the home environment. The key pre-requisite for this, however, is the hydraulic balance of the whole heating system.

Consequence of failing to ensure hydraulic balance

If the hydraulic system is not balanced, the heat will be distributed only unevenly around the building. Sections of the heating system which lie near to the pump with be advantaged by greater supply. In order to avoid partial under-supply, the system automatically boosts the flow temperature. This results in unnecessary fuel consumption. Too high return flow temperatures lower the boiler's ability to exploit the heating value of the fuel to the full, and thus create additional costs in terms of electrical energy. What is more, annoying rushing and whistling noises can be created in the radiators and the thermostatic valves, and the power consumption of the pumps increases steeply.



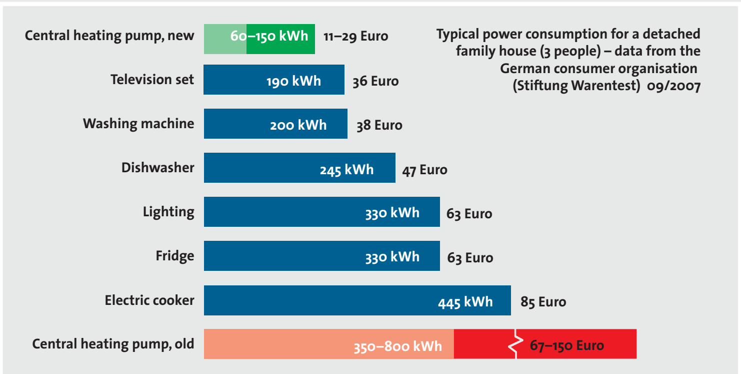
Heat-distribution system not balanced – high return-flow temperatures



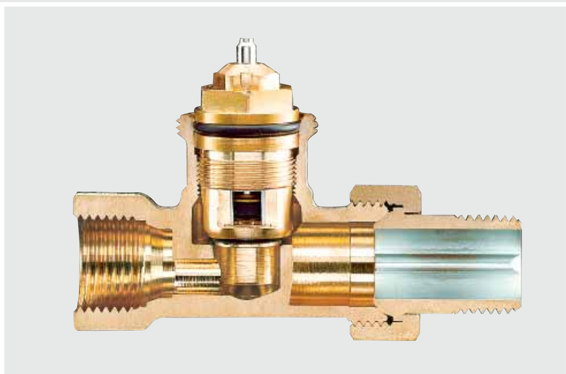
Balanced heat-distribution system – low return-flow temperatures

The advantages of hydraulic balancing

Hydraulic balancing ensures an even flow throughout the central heating system and improves control over the heating. It avoids disturbing noises and assists in reducing the fuel consumption and the operating flow



The central heating pump: from power guzzler to power saver



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

High-efficiency pump in energy efficiency class A

Today's radiators: efficient, comfortable and sustainable

Successfully increasing the efficiency of a whole heating system is dependent on all the components being optimally adjusted to each other in terms of both energy distribution and hydraulic balance. A key aspect of the installation of a heating system is the choice of radiators. Radiators can be integrated into any type of heating system regardless of heating unit, be it gas, oil, wood, heat pump or solar energy; they are thus sustainable and future-proof.
Modern radiators with low system temperatures, in combination with state-of-the-art control technology, save energy and, in addition, create a pleasant room climate. The basic requirement for this is a heating surface which reacts quickly to changes in heating needs. For this reason, radiators feature a slim-line profile and minimal water content in combination with a large heat-transfer surface. Thus the room temperature can be quickly adjusted to changing user needs.

In order to obtain maximum heating effect even when the water flow is reduced, modern thermostatic valves and hydraulic balancing valves help the heating system to maintain exactly the right temperature in individual rooms and at different times.

Modern and attractive looking radiators ...

Between modernisation and comfort

It is not only the fabric of a building that ages; the quality of heating systems is also subject to obsolescence. The result is increased energy consumption and more wear and tear on the components of the heating system; they become inefficient and, as they are all dependent upon each other, this leads to a loss of comfort. The aim in modernising an existing system is to increase efficiency by means of energy-saving operation and optimal delivery of heat through modern radiators.

Alongside financial implications, visual and functional aspects are coming more and more to the forefront. There are other advantages which new radiators offer and which one can enjoy immediately: radiators which serve as features in the interior decor or as mirrors, or radiators which match the design, colour and composition of the room.

When the modernisation of a heating system is being considered, costs and benefits are weighed against one another. However, the building costs, possible damage, incidental mess and noise during modernisation should also be considered. The aim is simple, quick installation of the radiators into the living area: drain them, unscrew them, screw them back, fill them – and they're ready. The planning and construction of new radiators takes into account how well the connections fit, so that exchanging old radiators for new, more suitable models presents no practical problems.

However, it is not just the performance of a radiator that determines the quality of heat delivery. Optimum heat distribution can only be achieved if the radiator is installed in the right place. The traditional place under the window is still to be recommended: here, incoming cold draughts are intercepted and the heat is delivered unimpeded into the room. At the same time, the position can be chosen not only with energy savings in mind, but also for reasons of design.

... embody individual heating comfort

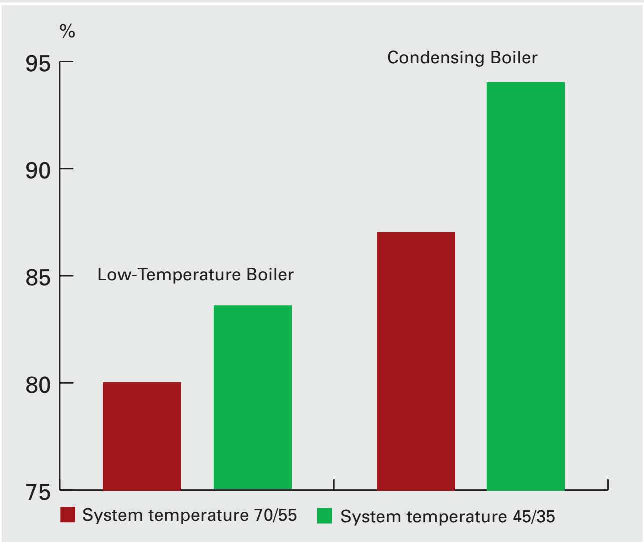
Importance of radiators for the energy efficiency of a modern heating system

For all of the modern heating systems using a condensing boiler and/or renewable energies an emission system with radiators is suitable. But to take advantage of the whole energy saving potential, i.e. of condensing boiler or heat pumps, an adaptation of the system temperature of the heating system is necessary. In general we could say: "The lower the system temperature the better is the efficiency of the heating system", i.e. instead of 80/60°C or 70/55°C better use design temperature of 45/35°C. Due to this modification in most cases replacement of old radiators will be needed. If further modernisations on the heating system will be made, i.e. decrease of the room temperature (energy saving 6% by 1K) or new thermostatic valve with 1K (energy saving up to 5%) an overall energy saving potential of 50% could be achieved. The low inertia of radiator systems and therefore fast reaction to the adaption of temperature changes supports this energy savings. Taken all this into account the costs for the modernisation of the heating system including the radiators will be redeemed in a few years due to the high reduction of energy consumption.

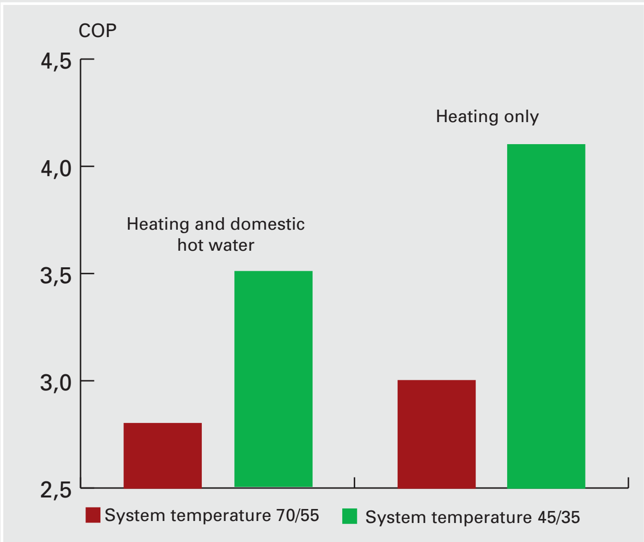
A comparison of a high temperature system (80/60 or 70/55) and a low temperature system (45/35) shows the implications for the energy efficiency and what role radiators play in order to be able to exploit the energy saving potentials when high temperature systems are exchanged and low temperature systems are installed. Investigations show the relationship between heat pumps and radiators. Additionally they calculate the annual COP (coeficient of performance) values taken into account heating only or heating and domestic hot water production (see figures 4 and 5).

Conclusion

Radiators are a high efficient and comfortable emission system. They can be combined with all modern heating technologies and renewable energies.



Boiler efficiency depending on the system temperature.



Efficiency of a electrical ground-source heat pump depending on the system temperature.

Operation

Solar collectors convert sunlight into heat and produce hot water, and, in larger systems, assist the space-heating system. Solar-thermal systems can save significant quantities of energy and reduce CO_2 emissions. Most operate in combination with another heating source (oil, gas, electricity, wood) – the non-solar component only operates when heat demand is too high for the solar system alone to satisfy. Heat storage and distribution systems need to be optimised.

Solar water heating

In a solar water heating system the solar collectors are usually installed on the roof of the building. The circulating fluid in the system, which delivers the solar heat from the collectors to the storage tank, must be both frost and heat-resistant. The heat is transferred to the water in the storage tank via a heat-exchanger. Another source of heat (gas, electricity, oil, wood) is used to heat the water during periods of low solar energy. Other system components are the pump and pump controller, temperature display, expansion vessel and valves.

Topping up the heating system

If, as well as providing hot water, solar energy is to be used to top up the central heating system, the size of the collector surfaces is increased by a factor of about 2 to 2.5. The saving on fuel is somewhere between 10 % and 30 %, depending on the insulation levels of the building. With low energy buildings, savings of up to 50 % are achievable.

Storage

Where solar heat is used to assist a heating system, either a second storage tank (buffer store) or a combination storage can be used. Stratified tanks or cylinders are also available.

Enormous opportunities

Solar-thermal systems for hot water production and space heating assistance are suitable for one-family houses and multi-storey multi-occupancy buildings – high rates of growth can be expected in both these sectors – in both retrofitting and new-build. Solar-thermal systems are also found in hospitals, hotels and sport facilities. Most heating systems can

Examples of flat plate collector installations benefit from solar-thermal assistance. Unit costs decrease with systems size. Subsidies and other financial incentives are accelerating market growth.

Other solar-thermal applications

Solar collectors can provide hot water for both open-air and indoor swimming pools. Significant savings in energy costs can be achieved. In Southern latitudes thermosyphon systems which do not require pumps are used – the insulated storage tanks is situated above the collectors, often as part of a single unit. Solar-assisted industrial process heating is still in its early stages but the potential is enormous. Solar-thermally driven cooling systems – so-called solar air-conditioning – is also a potentially enormous market.

Range of options

Most heating systems, including heat pumps, can be effectively combined with solar-thermal systems. Ready-made solutions are available for most applications.

High quality

Off-the-shelf systems considerably reduce installation times. These pre-assembled systems allow for quick and safe mounting. High quality control and industry standards ensure reliability and energy savings for decades.

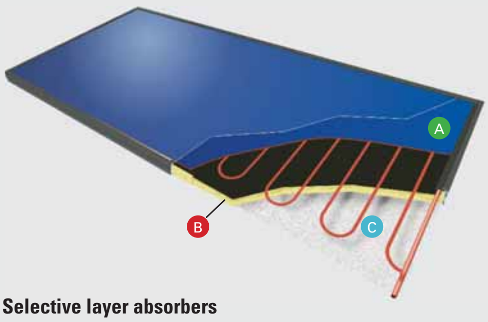
Examples of vacuum tube collector installations

Solar collectors, pumps and fittings

EHI-member companies produce a range of collector types of varying characteristics and sizes. They are high quality and designed to last. The choice of collector depends on the application and architectural considerations. Heat transfer fluids are designed to withstand temperatures of -30 °C and are non-toxic. The efficient circulation pumps and their controllers are very economical to run. All fittings and pipes are suitable for operation at high temperatures.

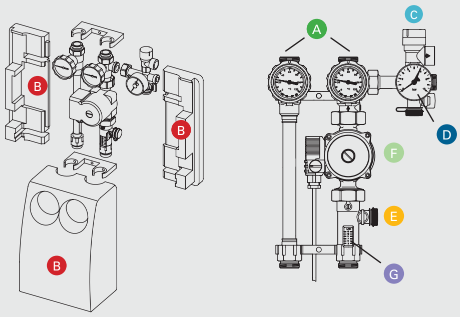
Flat-plate collectors

Flat-plate collectors are the most frequently used type of collector. Selective-surface coated high-performance absorbers ensure optimum yields. Collectors of a large range of appearances and systems for in-roof, roof top or flat roof mounting are available.



- A Selective layer absorbers
- B Insulation
- C Serpentine type collector

Flat plate collector



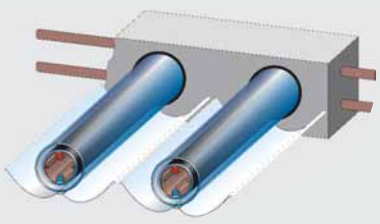
- A Isolation fittings with thermometer
- B Insulation
- C Safety valve
- D Pressure gauge
- E Filler tap (enables filling and emptying of the system)
- F Pump
- G Flow meter

Vacuum tube collectors

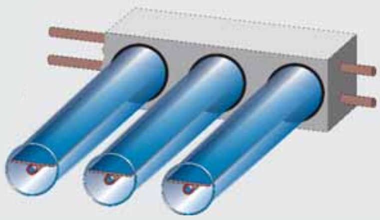
Vacuum tube collectors – a heat pipe in an evacuated glass tube (vacuum) – can achieve high yields and temperatures. Because of their higher efficiencies they require less surface area than flat-plate collectors.

Storage

A range of storage are available (immersion cylinders, buffer tanks, combi-tanks). General indicators of their quality are their slim, tall construction and thick insulation.

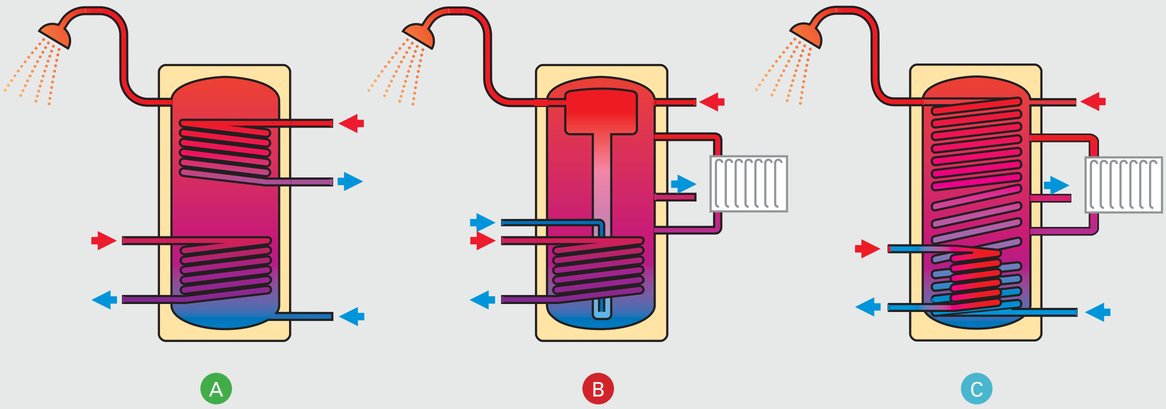


with externally mounted reflector



without reflector

Vacuum tube collector



Solar (drinking) domestic hot water preparation

Combined (drinking) domestic hot water system and supplemented room heating

A Standard solar storage

B Tank-in-tank storage

C Direct flow through heat exchanger

Cooling with the heat of the sun

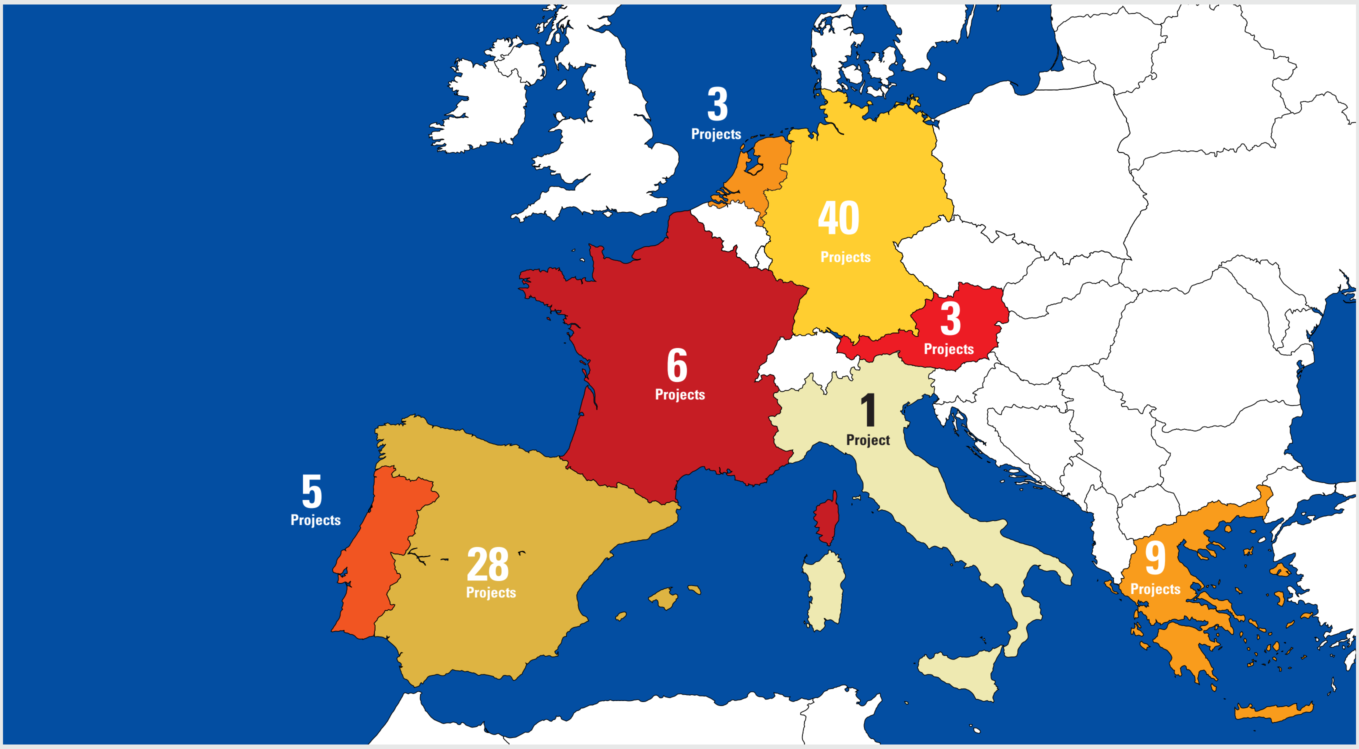
The demand for air-conditioning has been rising steadily for years, not only in Southern Europe, be it for offices, homes or public buildings. At the same time there is a multitude of technical equipment that needs additional cooling in summer, such as computers and industrial installations, as well as foodstuffs.

The greatest need for cooling, therefore, goes hand-in-hand with the highest incidence of sunshine. This is precisely where solar-driven air-conditioning comes into its own: the sun's energy can be used as an energy source for cooling buildings – using today's level of technological development. This recommends itself, because it is specifically on those days when there is the greatest need for cooling, that the greatest gains are possible from the sun's energy. In practice, this means that intermediate storage of energy over long periods is no longer necessary.

The great advantage of solar refrigeration machines lies in the fact that the cooling requirement and the sunshine occur concurrently: so these machines produce the greatest output when it is especially hot.

Reliable and sustainable technology

Traditional air-conditioning systems operate using electrically-driven compressors. The hotter the air becomes, the more the consumption of energy



Completed solar cooling projects in Europe

- In Europe > 200 systems
- Total collector surface approx: 18,000–25,000m²
- Average collector surfaces
  - 3–4 m²/kW for water chillers
  - 8–10 m² per 1000 m³/h for sorption-based air-conditioning systems
- Total cooling performance approx. 7 MW

rockets. This results in massive loads on the national grid, particularly at lunch time. If more solar-driven air-conditioning systems were used, the peak demand for electricity would be effectively reduced. As a result the use of solar-driven air-conditioning could make an essential contribution to relieving the pressure on the national grid and to increasing the reliability of supply.

Solar cooling has long since left its pilot phase behind. Yet, although the technology has been in use for a number of years now, widespread application is still only in the early stages. In Europe, in recent years, new refrigeration units which run on the sun's energy have been developed for smaller scale operation, so that the technology is now becoming of interest for domestic buildings.

The design of a solar-driven cooling system does not differ in practical terms from that of a conventional system. First of all, the cooling performance and load profile of the building must be ascertained. On this basis the output and type of refrigeration unit can be established. Most often it is single-effect chillers that are used for solar-assisted cooling.

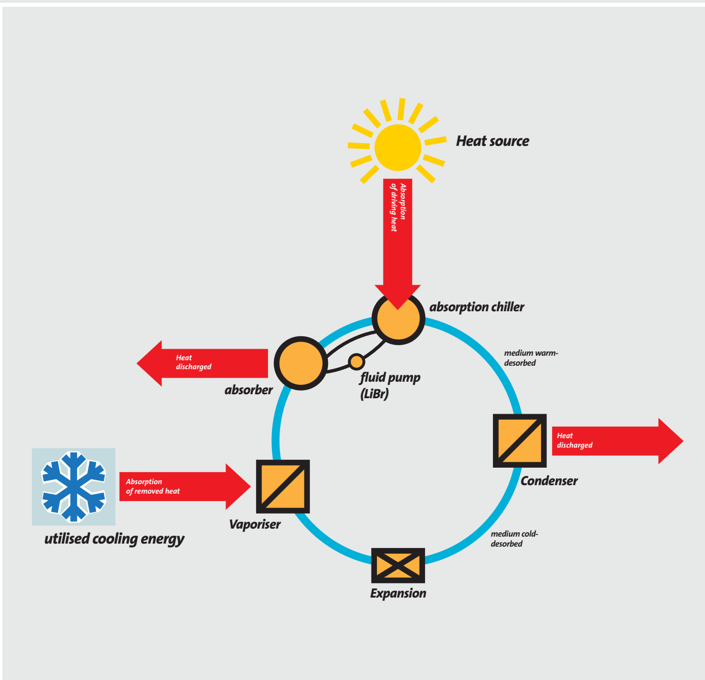
Example of solar cooling

Principle of solar cooling

In an absorption chiller, compression is achieved by the temperature-dependent solution of the refrigerant in another medium. This is also sometimes called thermal compression. The refrigerant is absorbed into a second substance in the solvent circuit at low temperatures and desorbed at higher temperatures. For air-conditioning units, in particular, the usual pair of substances is lithium bromide and water. In this case it is the water which acts as the refrigerant, so that the lowest output temperature for the cold water is limited to about 5 °C. Input temperatures of the heating medium (hot water, steam) at the generator are about of 90 °C, depending on the type and application of the chiller.

These units are, therefore, often used where there is waste heat in the region of 80–120 °C or where a solar heat source is available. As well as those generators that are heated indirectly with hot water or steam, LiBr („litium bromide") absorption chillers, that are directly heated by oil or gas, are also available. The heat ratio for a single-effect absorption chiller under nominal conditions (heat-source temperature: 120 °C, cooling water temperature: 29 °C) is between 0.6 and 0.7. For double-effect absorption chillers it is between 1.0 and 1.3.
Directly heated LiBr absorption systems have cooling outputs of between 10 kW and 2,300 kW. Large single-effect systems are available with cooling outputs from 180 kW to 5,300 kW.

The advantage of the LiBr absorption chiller lies in the low generator temperatures together with the fact that the temperature range which this technology needs to operate can easily be guaranteed with solar units. Moreover water as a refrigerant is completely safe for use in the home. Since the cooling



Basic principle absorption cooling machine

In the absorption chiller the refrigerant water is driven out and evaporated under high pressure by a medium of lithium bromide and water by the use of solar warmth. Under heat emission the water condenses again. The heat is dissipated over a cooling tower. Over the expansion valve the water is supplied to the evaporator (low pressure) and evaporated there under heat absorption (utilised cooling energy). Under heat emission the steam is absorbed by dilution within the absorber and the dilution is pumped again to the absorption chiller (thermal compression). The cycle repeats.

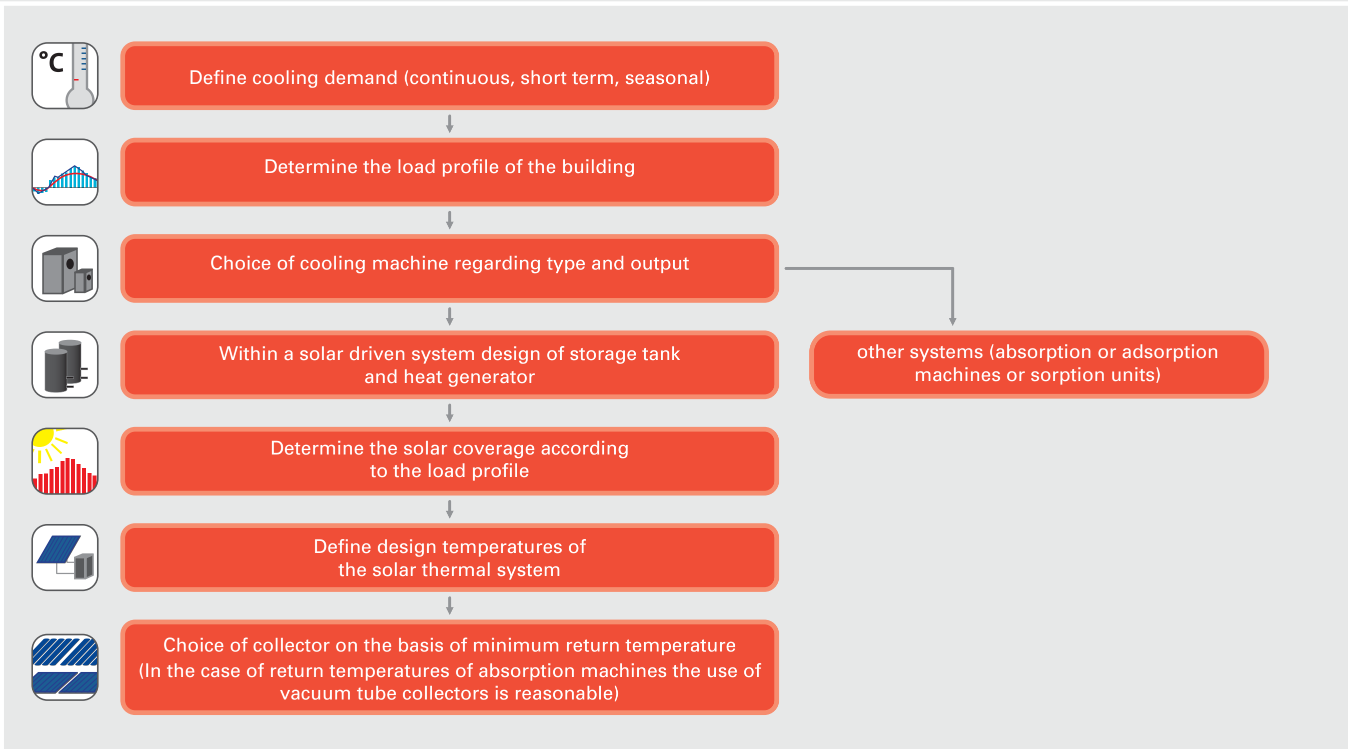
effect occurs at negative pressures, the possibility of any bursts resulting from excessive pressure is excluded, providing that the heat source is protected.

Saving energy with solar cooling

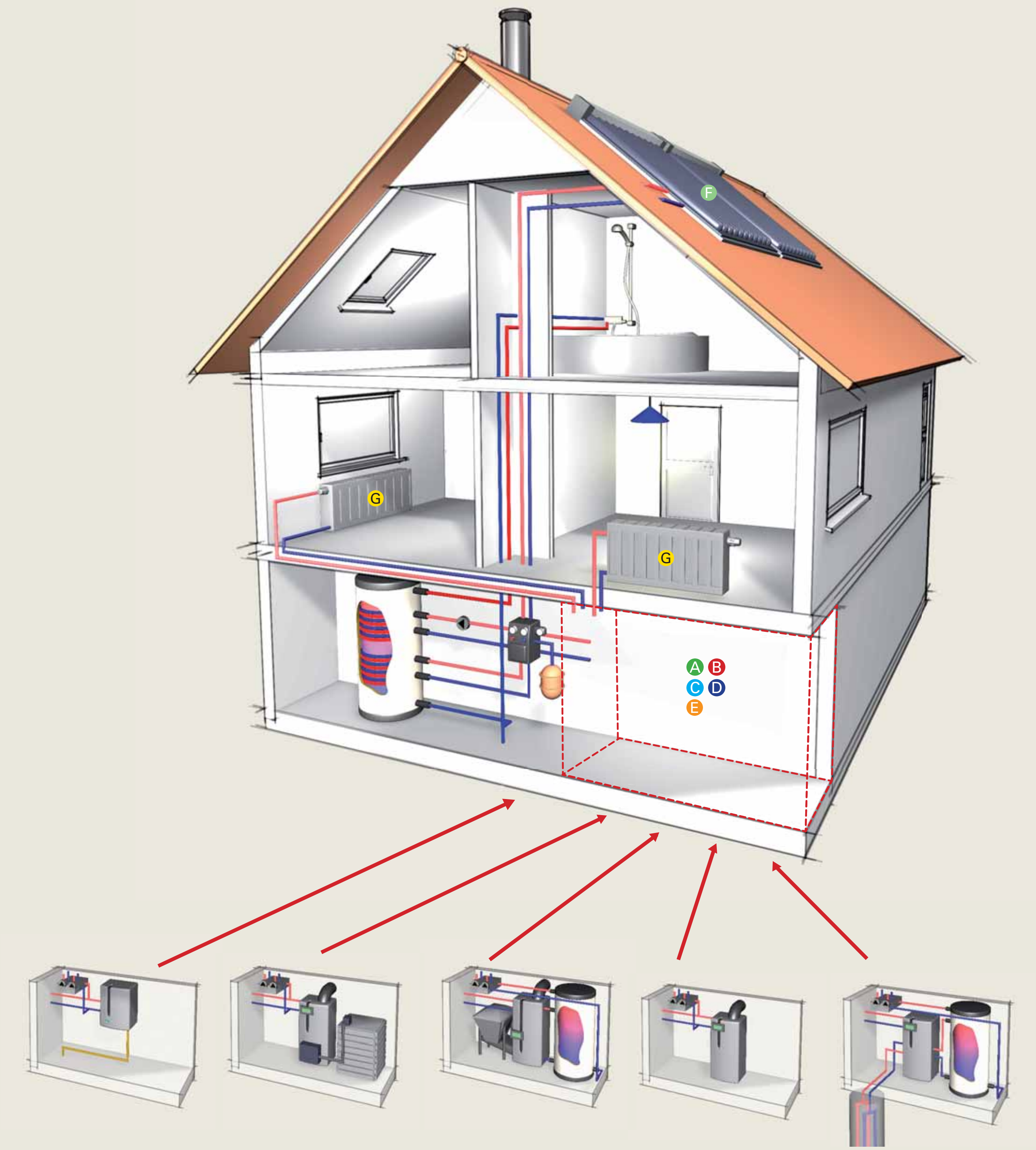
The output of the collectors at these operating temperatures is assumed for design purposes to be approx 500 W/m2. If the unit will permit it, the heat exchanger in the primary circuit should be dispensed with and the heat transfer medium piped directly to the absorber in the chiller. The refrigeration process is designed for very low heat-source temperatures, so that the chiller operates with a relatively poor COP (coefficient of performance). Hence, solar coverage > 50 % needs to be achieved, in order to convert less conventionally generated heat with limited efficiency into a cooling effect. Solar energy for this process is provided using either vacuum tubes or flat plate collectors.

Solar cooling saves electricity: thermally driven refrigeration processes need only around 25 % to 50 % of the electrical power. And with this technology, in contrast to that of solar heating, there are no storage problems: the cooling requirement rises and falls almost simultaneously with the availability of solar energy.

The principle of solar cooling works very efficiently; a great deal of energy can be saved using conventional vacuum tube collectors as well as with a design that requires only low heat-source temperatures. The energy requirement is in direct proportion to the amount of sunshine. Conventional air-conditioning systems are coming in for more and more criticism, not only because of questionable refrigerants (CFCs and HFCs), but also with regard to the CO_2 emissions that are involved.



Planning steps to design a solar cooling system



A Gas condensing boiler

B Oil condensing boiler

C Wood boiler (Pellets, split logs, wood chips)

D Mini-CHP

E Heat pump (Air/water, brine/water, water/water)

Increasing importance of the system as a whole

Modern heating systems are no longer stand-alone systems; rather, they involve a number of systems matched to each other. The energy saving potential of the individual components can only be realised if each component is exactly tuned to fit in with the others. That is why "thinking systems" has become more and more important in terms of advice, planning, installation and servicing.

Efficient systems go together with renewable energy sources in the most varied combinations and in many cases are a sine qua non of being able to use such sources at all. Still, since creating electricity with photovoltaic units is, in principle, independent of any kind of heating system, solar electric power can be generated alongside all other systems.

Interplay of components for greater comfort

Quite independently of heating technology, controlled ventilation units significantly reduce energy requirements and ensure an adequate supply of healthy air in the building. The use of underfloor heating increases the efficiency of central heating units that operate with relatively low temperatures. This is, for instance, the case for heat pumps or top-up heating using solar-thermal energy. But even traditional heaters of all kinds can be combined with modern heating systems. In addition, insulation of the building envelope makes sure that the heat stays where it is wanted – inside the building.

Overview of various components that can be combined:

		F Solar-thermal system	G Radiator
A	Gas-fired condensing boiler	✓	✓
B	Oil-fired condensing boiler	✓	✓
C	Wood boiler (pellets, split logs, wood chips)	✓	✓
D	Mini CHP	(✓)	✓
E	Heat pump (air/water, brine/water, water/water)	✓	✓

EXAMPLES OF MODERNISATION

association of the
European Heating Industry

Detached family house

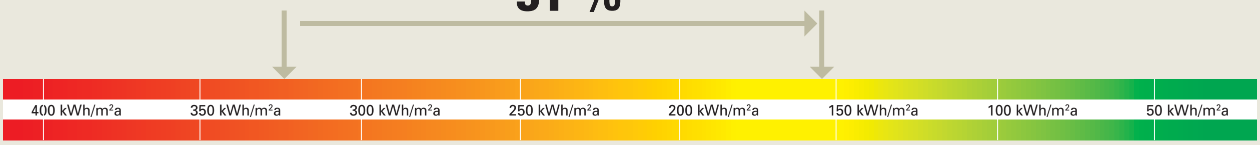
- partially refurbished building, constructed in 1970
- floor area 150 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:

- new gas-fired condensing boiler
- solar-heated domestic hot water and top-up for central heating
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balance
- refurbishment of flue system

Annual primary energy requirement:

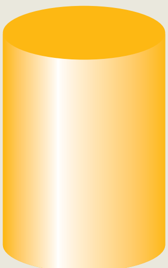
–51 %



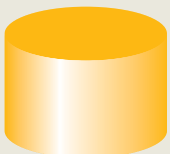
325 kWh/m²a
before refurbishment

158 kWh/m²a
after refurbishment

Annual energy requirement:



4,289 Litre/a (m³/a)
Oil (gas) before refurbishment



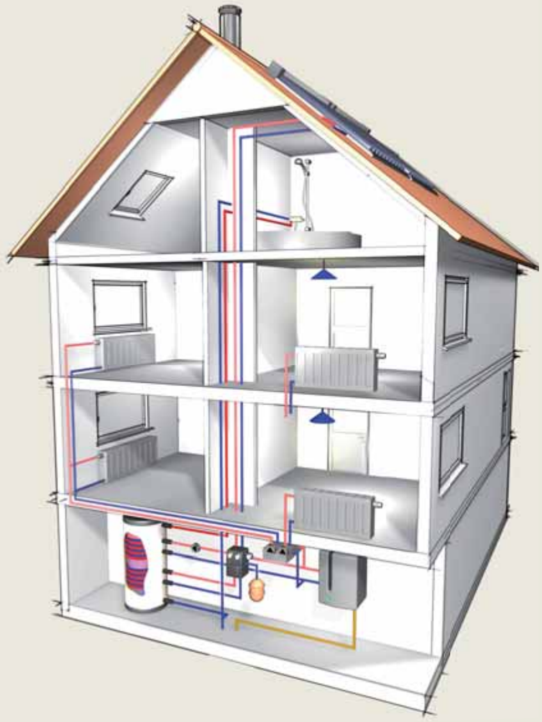
2,014 m³/a
Gas after refurbishment

Further information
Page 14–15

Detached multiple-occupancy dwellings

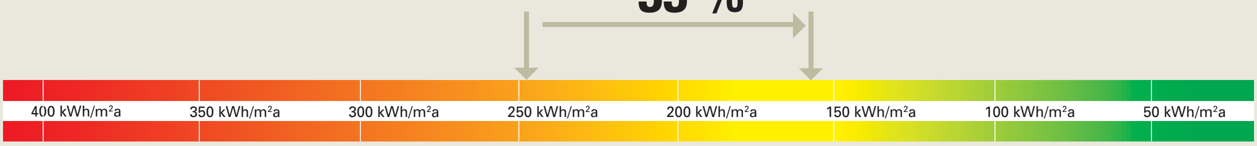
- partially refurbished building, constructed in 1970
- floor area 8 x 82 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:
- new gas-fired condensing boiler
- solar-heated domestic hot water and top-up for central heating
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balance
- refurbishment of flue system



Annual primary energy requirement:

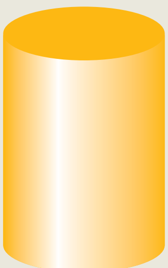
–33 %



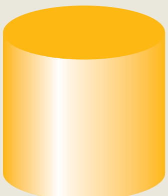
246 kWh/m²a
before refurbishment

165 kWh/m²a
after refurbishment

Annual energy requirement:



14,270 Litre/a (m³/a)
Oil (gas) before refurbishment



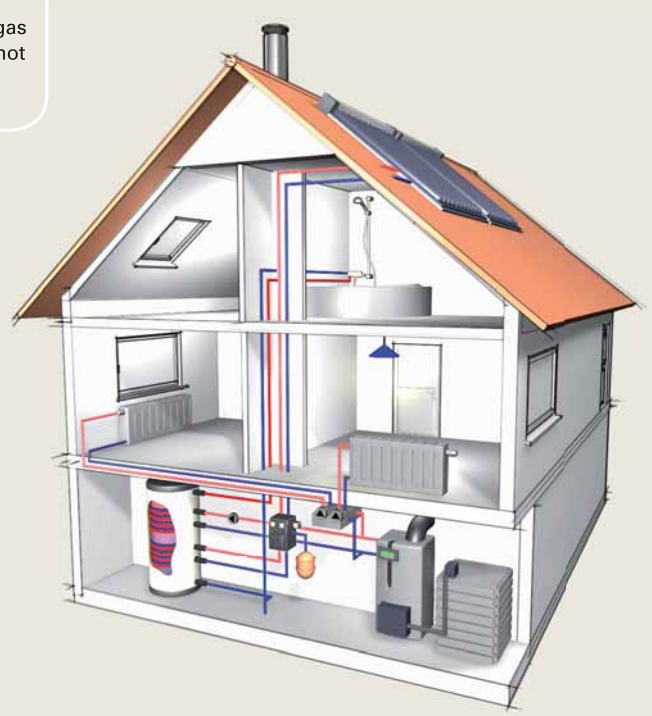
9,463 m³/a
Gas after refurbishment

Detached family house

- partially refurbished building, constructed in 1970
- floor area 150 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

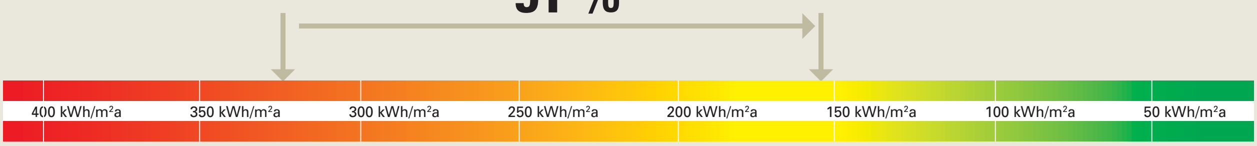
Refurbishment work undertaken:

- new oil-fired condensing boiler
- solar-heated domestic hot water and top-up for central heating
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balance
- refurbishment of flue system



Annual primary energy requirement:

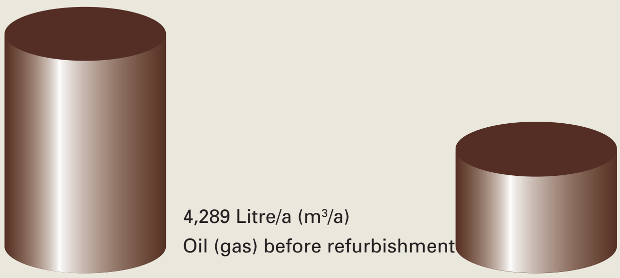
–51 %



325 kWh/m²a
before refurbishment

158 kWh/m²a
after refurbishment

Annual energy requirement:



4,289 Litre/a (m³/a)
Oil (gas) before refurbishment

2,014 Litre/a
Oil after refurbishment

Further informations
Page 16–17

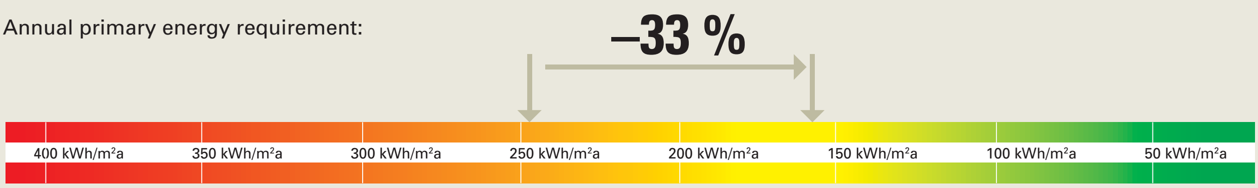
Detached multiple-occupancy dwellings

- partially refurbished building, constructed in 1970
- floor area 8 x 82 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:

- new oil-fired condensing boiler
- solar-heated domestic hot water and top-up for central heating
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balance
- refurbishment of flue system

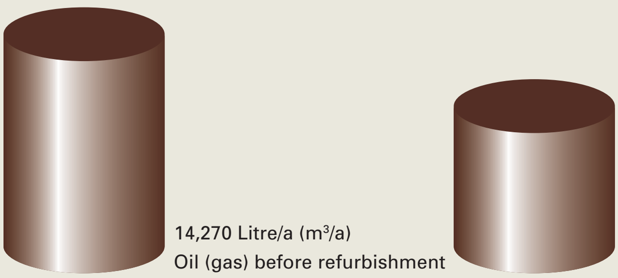
Annual primary energy requirement:



246 kWh/m²a
before refurbishment

165 kWh/m²a
after refurbishment

Annual energy requirement:



14,270 Litre/a (m³/a)
Oil (gas) before refurbishment

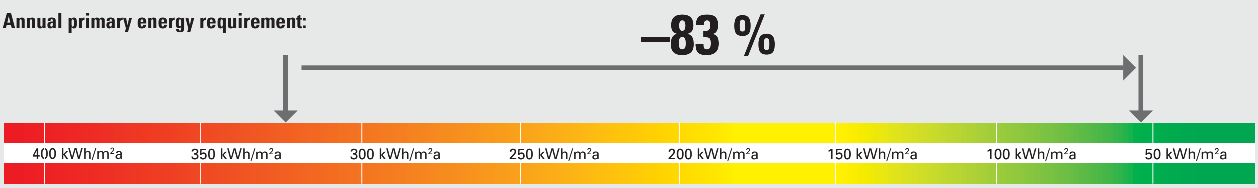
9,463 Litre/a
Oil after refurbishment

Detached family house

- partially refurbished building, constructed in 1970
- floor area 150 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:
- new wood pellet boiler
- solar heating for domestic hot water
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing
- refurbishment of flue system

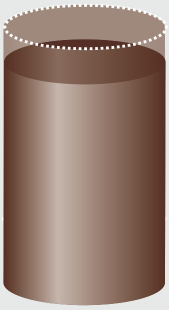
Annual primary energy requirement:



325 kWh/m²a
before refurbishment

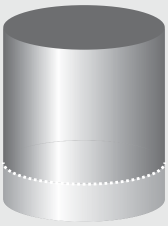
54 kWh/m²a
after refurbishment

Annual energy requirement:



48,662 kWh/a
primary energy
before refurbishment

4,289 Litre/a (m³/a)
Oil (gas) before refurbishment



6,4 t/a
Pellets after refurbishment

8,103 kWh/a
Primary energy after refurbishment

Further informations
Page 18–21

Detached multiple-occupancy dwelling

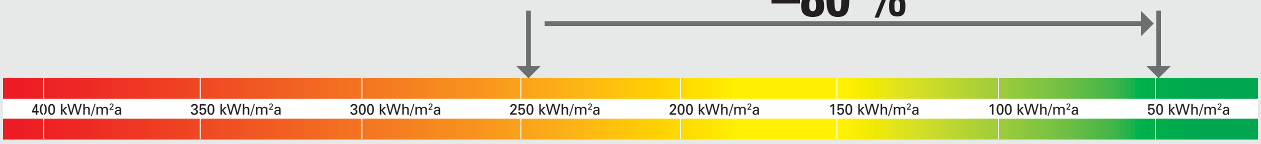
- partially refurbished building, constructed in 1970
- floor area 8 x 82 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:

- new wood pellet boiler
- new indirectly heated domestic hot water tank
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing
- refurbishment of flue system

Annual primary energy requirement:

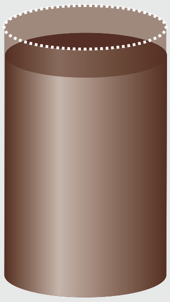
–80 %



246 kWh/m²a
before refurbishment

49 kWh/m²a
after refurbishment

Annual energy requirement:



160,439 kWh/a
primary energy
before refurbishment

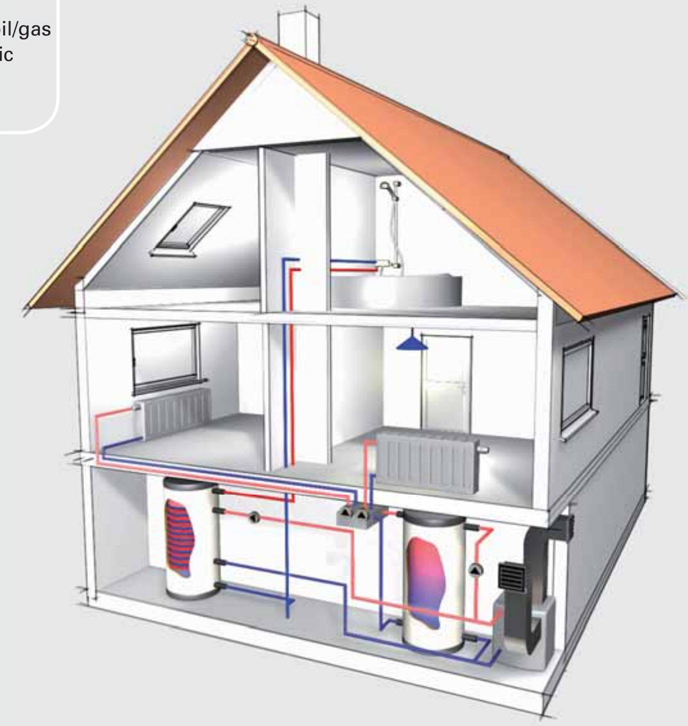
14,270 Litre/a (m³/a)
Oil (gas) before refurbishment

27,5 t/a
Pellets after refurbishment

32,111 kWh/a
Primary energy after refurbishment

Detached family house

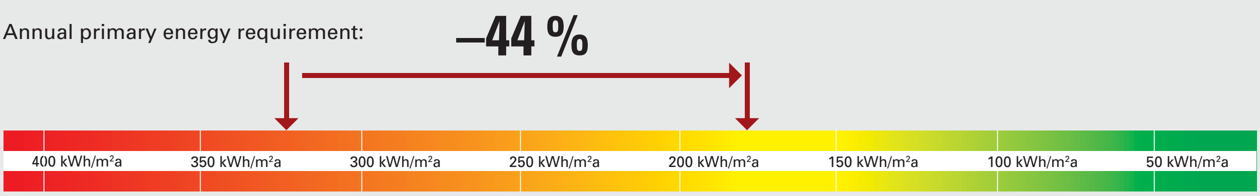
- partially refurbished building, constructed in 1970
- floor area 150 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump



Refurbishment work undertaken:

- new air/water heat pump
- new indirectly heated domestic hot water tank
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing

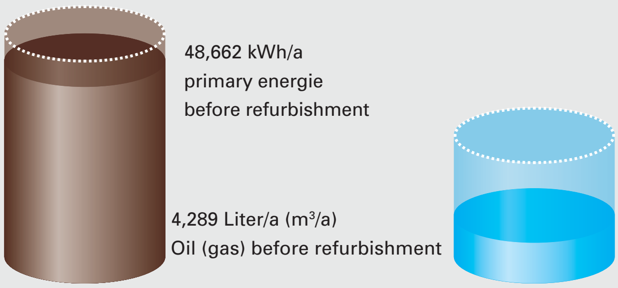
Annual primary energy requirement:



325 kWh/m²a
before refurbishment

181 kWh/m²a
after refurbishment

Annual energy requirement:



48,662 kWh/a
primary energie
before refurbishment

4,289 Liter/a (m³/a)
Oil (gas) before refurbishment

27,037 kWh/a
primary energy
after refurbishment

9,739 kWh/a
Power after refurbishment

Further informations
Page 22–23

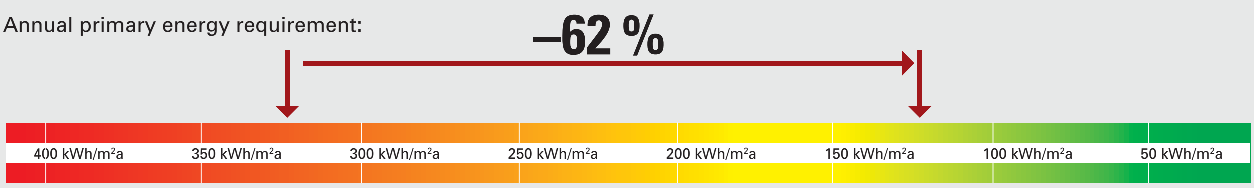
Detached family house

- partially refurbished building, constructed in 1970
- floor area 150 m²
- type of construction solid walls/render
- standard heating boiler oil/gas
- indirectly heated domestic hot water tank
- unregulated pump

Refurbishment work undertaken:

- new brine/water heat pump
- solar-heated domestic hot water
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing

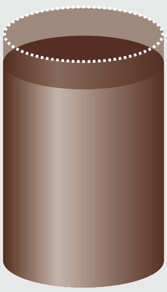
Annual primary energy requirement:



325 kWh/m²a
before refurbishment

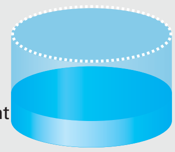
125 kWh/m²a
after refurbishment

Annual energy requirement:



48,662 kWh/a
primary energie
before refurbishment

4,289 Liter/a (m³/a)
Oil (gas) before refurbishment



18,667 kWh/a
primary energy
after refurbishment

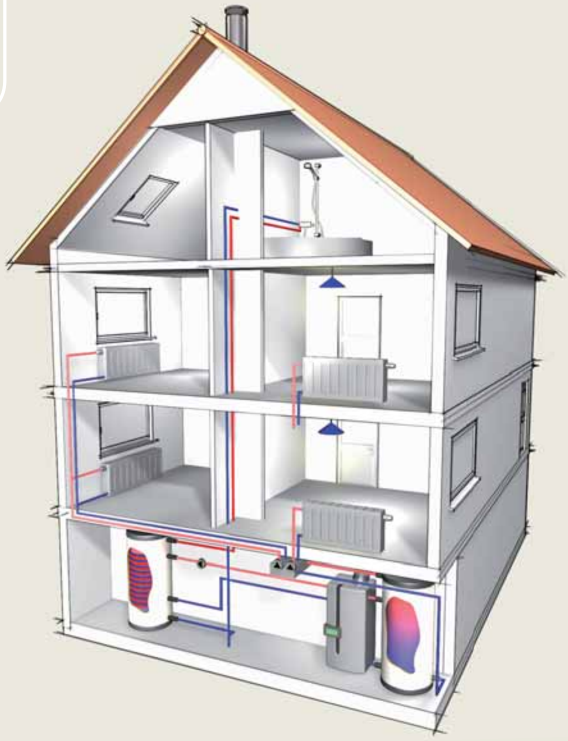
6,377 kWh/a
Power after refurbishment

Detached apartment block (4 flats)

- partially refurbished building, constructed in 1970
- floor area 4 x 80 m^2
- type of construction solid walls/render
- standard heating boiler gas/oil
- indirectly heated domestic hot water tank
- unregulated pump

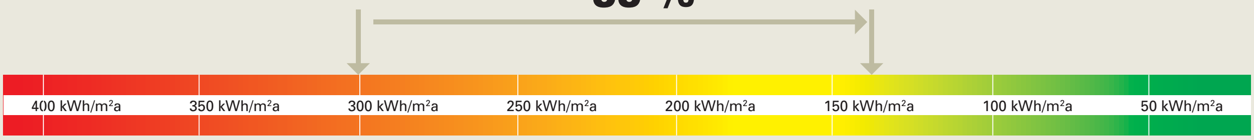
Refurbishment work undertaken:

- new mini-CHP plant (cogeneration plant)
- new indirectly heated domestic hot water tank
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing
- refurbishment of flue system



Annual primary energy requirement:

–55 %



300 kWh/m^2a
before refurbishment

136 kWh/m^2a
after refurbishment

Annual energy requirement:

8,506 m^3/a (Liter/a)
Gas (oil) before refurbishment

8,903 m^3/a (Liter/a)
Gas (oil) after refurbishment

Annual power generated:

1)

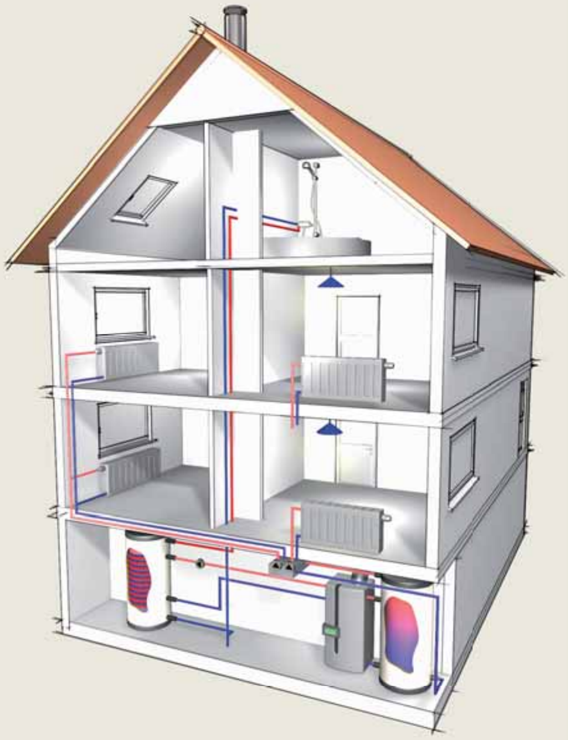
20,600 kWh
Power generated

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

Further informations
Page 26–27

Detached apartment block (8 flats)

- partially refurbished building, constructed in 1970
- floor area 8 x 82 m²
- type of construction solid walls/render
- standard heating boiler gas/oil
- indirectly heated domestic hot water tank
- unregulated pump

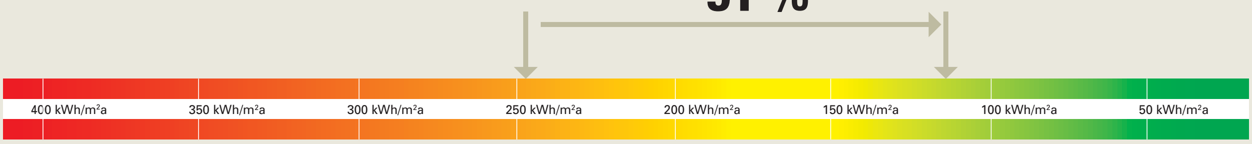


Refurbishment work undertaken:

- new mini-CHP plant (cogeneration plant)
- new indirectly heated domestic hot water tank
- regulated pumps
- new radiators and thermostatic valves
- insulation for central heating pipes
- hydraulic balancing
- refurbishment of flue system

Annual primary energy requirement:

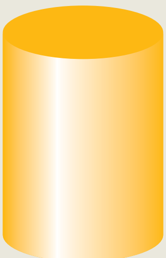
–51 %



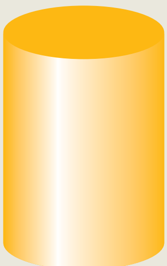
246 kWh/m²a
before refurbishment

120 kWh/m²a
after refurbishment

Annual energy requirement:



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



14,826 m³/a (Liter/a)
Gas (oil) after
refurbishment

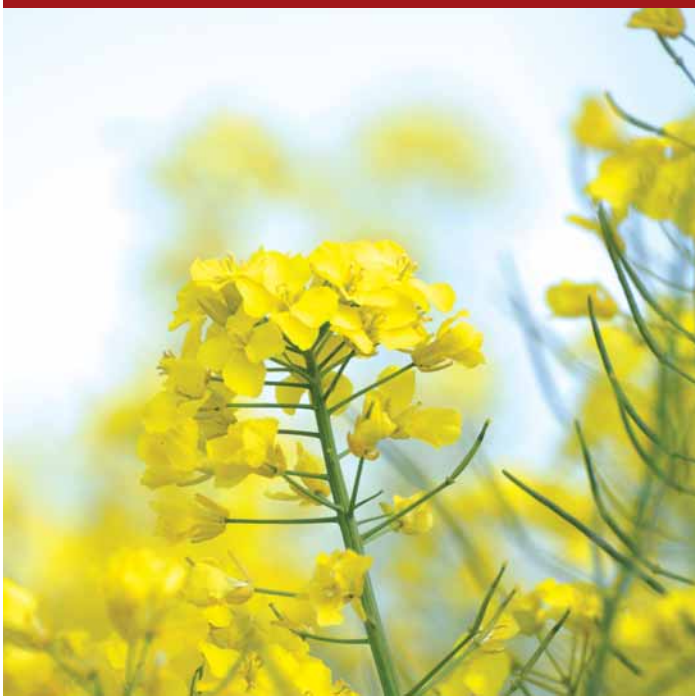
Annual power generated:

1)

32,100 kWh
Power generated

- ACV
- ARBONIA KERMI
- ARISTON THERMO GROUP
- ATLANTIC
- BALTUR
- BDR THERMEA
- BOSCH THERMOTECHNIK
- CARADON
- DE LONGHI
- ENERTECH
- FAGOR
- FERROLI
- GIANNONI
- GRUNDFOS
- HONEYWELL
- HOVAL
- IMMERGAS
- KORADO
- QUINN
- RETTIG
- RIELLO GROUP
- SAACKE
- SIEMENS BUILDING TECHNOLOGIES
- SIT GROUP
- THE HEATING COMPANY
- VAILLANT GROUP
- VIESSMANN
- WEISHAUPT
- WILO
- WOLF
- ZEHNDER

- APTT (CZ)
- ASSOTERMICA (I)
- ATTB (B)
- BDH (D)
- DEB (DK)
- FEGECA (E)
- ICOM (UK)
- BuildingClimate Switzerland (CH)
- SBBA (S)
- VFK (NL)
- VÖK (A)
- Uniclima (F)



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