Heating and cooling with renewable energy

The energy devoted to heating purposes makes up 57 % of Germany's overall final energy consumption.

Some 40 % of final energy consumption in Germany is used to heat buildings. In the mid- to long-term goal is to have solar heating (active and passive) cover nearly all heating demand (space heating and hot water) in new buildings and a large part of demand in existing buildings. Another field of application that is becoming more important is the provision of process heat at high temperatures.

Heat from solar thermal collectors

Heat generation from biomass

Cooling with solar heat

Heating and cooling with geothermal energy

Heat storage

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or www.Renewable-Energy-Research-Association.org

Heat from solar thermal collectors

Solar heat can be collected in various ways as a source of energy:

- Solar thermal collectors can heat up service water and drinking water, be used for space heating, and high-temperature process heat
- Passive solar energy can be used in architecture

Research and development requirements

- R&D into more efficient and more cost-effective large collector fields in the low temperature range, especially for the heating of buildings
- Development of improved long-term storage as an important component in a more intensive collector utilisation strategy
- Material research for alternative, ecologically friendly absorbers with good heat conductivity, anti-corrosive properties, and temperature resistance
- Development of new heat carrier media modified for absorbers
- Development of highly efficient collectors, including concentrating systems for industrial and commercial process heat (also in conjunction with combined heat and power) as well as desalination of sea water
- Development of model-based networked control systems and remote monitoring processes
- Development of switchable absorption surfaces on building envelopes
- Development and implementation of parameters for the logging of the solar energy yields of various systems

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Heat from biomass

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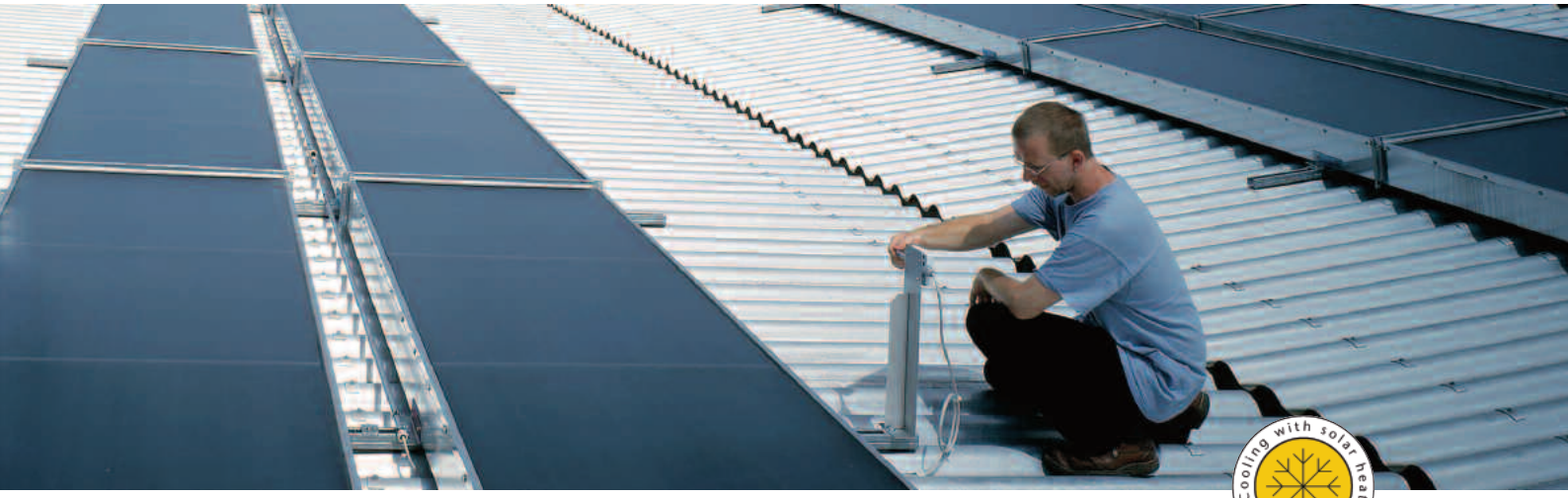
The sun's energy stored in the form of biomass can be converted directly into heat. The thermal conversion technology used for this is combustion. This technology has already reached an advanced level. Heat from biomass is also produced in combined heat and power plants.

The potential of biomass energy for heat production in Germany is at least 10 % of current energy consumption. The German government's ambitious targets for the use of biomass as a source of energy require new concepts that will provide for competitive generation costs along with improved energy payback and ecological impacts.

Research and development requirements

More research needs to be directed towards affordable, low-emission and low-corrosion combustion technologies in the field of conventional (combustion) heat generators for the use of solid biomass. Furthermore, innovative energy conversion systems must be researched and developed so that residual heat can be better utilized in cogeneration units fired by biomass for heating and cooling.

Cooling with solar heat



Heat can be used in combination with sorption technologies to drive thermodynamic circulation processes that produce high-quality heating or cooling (thermochemical heat pump).

Here, a distinction is made between adsorptive systems that work with solids (such as silica gel and water) and systems that work with fluids (such as lithium bromide and water).

Typical temperatures for single-stage systems range from 60°C to 120°C. They are therefore ideal for operation with solar heat, district heat, waste heat from cogeneration units, or fuel cells. Because cooling is mainly needed in the summer when there is generally an excess of solar energy and waste heat available, these environmentally friendly sorption technologies (no CFCs) are ideal for air-conditioning and refrigeration.

Another advantage of these cooling systems is that in most cases they can be set to a second operational mode to function as heating systems as well. At the same time, sorption systems also offer capabilities for the efficient long-term storage of thermal energy – a major advantage of the widespread use of solar energy systems.

The technical feasibility of solar-operated systems has been demonstrated successfully in many projects in recent years. Today there are already market segments in which it makes economic sense to use these systems. Investigations reveal a large number of approaches to improvement, which if implemented would enable additional markets to be opened up to their use.

Research and development requirements

- Material research in the field of absorbance
- For the development of small thermal cooling systems (compact, efficient heat exchangers, internal heat recovery)
- Development of electric/thermal hybrid systems
- Research into system technology for system concepts, design, controls, maintenance, and equipment management

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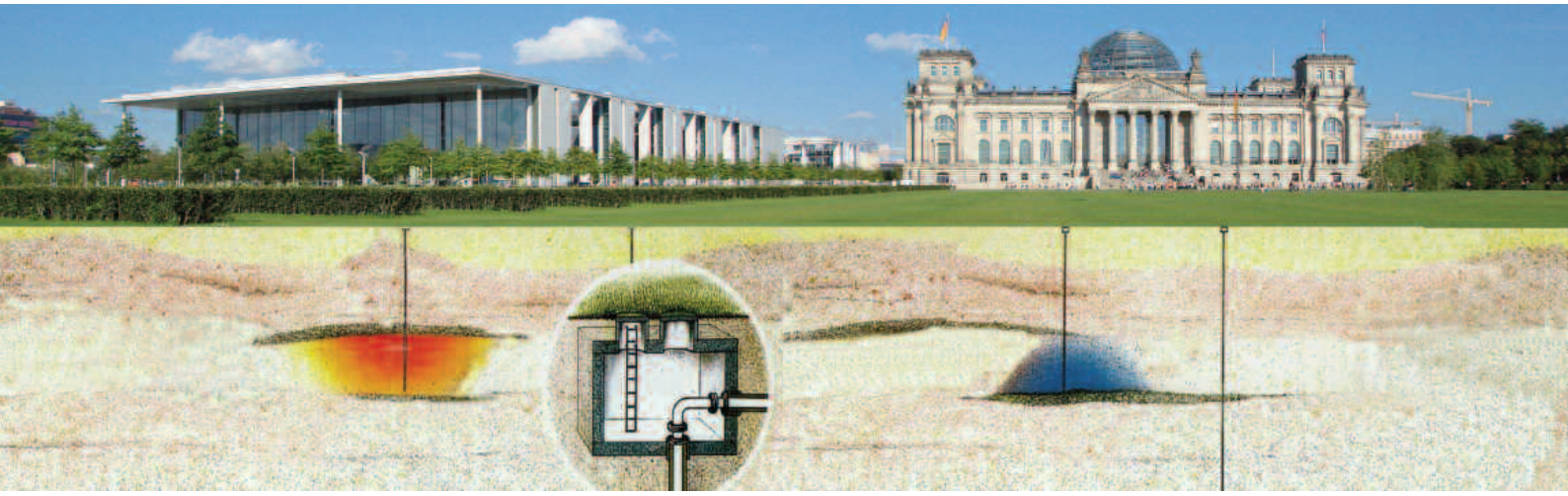
Heating and cooling with geothermal energy



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The use of geothermal energy for heating purposes and the use of water saturated rock formations below ground for cold water storage in connection with seasonal air-conditioning and cooling is already established on a commercial basis. Particularly, heating by means of geothermal energy is presently experiencing a period of considerable growth in Germany. Shallow geothermics is used for heating and/or cooling in connection with vertical heat exchangers and heat pumps. But the enormous technical potential of geothermal energy sources is still far from being fully exploited in Germany.

Research and development requirements

The main R&D task consists of providing this technology dependably and predictably. For geothermal energy to become economically competitive, the efficiency of geothermal systems has to be be increased which is indicated by seasonal performance factor (SPF) that describes the ratio of useful energy output (heat generated) to the energy input (electricity), averaged over an entire heating season.

Depending on the heat source SPF of 3 to more than 4 are attained for ambient air and water (in vertical heat exchangers), respectively. Larger supply systems should be improved by a cost effective seasonal storage of heat or cold below ground. Additionally, deep heat sources have to be exploited more economically. Research can be divided into two main categories:

1. **Shallow geothermics**
- An optimization of systems above ground will profit from an improved knowledge of the geological and geothermal situation below ground.
- Higher energy efficiency additionally requires a program for SPF increase to > 5. The competitiveness of absorption heat pumps needs to be improved.
- The integration of underground heat and cold reservoirs in local energy supply systems must be developed.

2. **Deep geothermics**
- Exploration technologies have to be developed to increase the accuracy of expensive drillings and to enable forecasts on the behaviour of the subsurface during long-term operation.
- Geothermal technology development requires the systematic continuation of research aiming at the exploration and exploitation of productive sources at low costs and lower risk so that various locations with different geological settings can be used as energy sources.

Heat storage

Efficient energy storage facilitates the integration of renewable energy sources into energy systems. Because of temporal variability in the availability of solar and industrial process heat, thermal storage systems are key components for the effective utilisation of this heat in solar thermal power stations, heat recovery processes, solar local heat projects, air-conditioning systems in buildings, and service water systems.

With large seasonal heat storage facilities, around half of the total heat requirements of large building complexes in Germany can be covered by solar energy.

Research and development requirements

New storage technologies require a comprehensive research and development. The development of new storage materials based on phase-change and sorption materials basically opens up entirely new approaches to heat storage with little loss, higher energy density, and the use of decentralized heat supply systems.

Such new approaches are especially promising in modern buildings with lower energy consumption. Furthermore, new storage materials open up new applications for high-temperature solar thermal stations and improve the use of industrial process heat.

Storage systems for small combined systems (power, heat and cooling) are interesting because electricity generation determines overall output, and the heat generated could be stored for several days.

The installation of heat storage units could increase the capacity utilize a nation of solar thermal stations as well as lower the cost of electricity generation. Considerable research is still required for the development of such storage systems so that the properties of active storage materials can be optimized, new materials found, and costs reduced. In addition, high performance for the entire service life and a minimum service level at a desired temperature need to be improved.

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