Alternative Heating Sources

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Introduction

The environmental and climate discussion is permanently present in media. In August 2008 new negotiations about the follow-up of the Kyoto Protocol started in Ghana. There is a growing ecological understanding amongst the population, fossil fuels are limited and therefore will become more and more expensive. The goal of the German government is to increase the share of renewable energy from today's 6% up to 20% in 2020. Therefore, in future there will be a higher demand for alternative (renewable) energy sources. The aim of this essay is to show some alternatives to current heating sources against the background of German conditions.

Conclusion

- Fossil resources are limited and will become more and more expensive, this will be an opportunity for renewable heating sources
- An integrated combination between heating, insulation and ventilation in buildings should be aspired to
- Possible alternatives are the replacement of old condensing boilers, heat pumps, biomass, cogeneration, solar heat
- There are some programs for grants and low interest loans provided by German institutions for investing in ecological heating sources.

Current situation

In Germany, the most common heating sources are oil and gas condensing boilers in residential trade and industry. The current low oil prices are just temporary. As the prices of fuel and gas will increase during both the medium and long term, it is important to be aware of alternatives when deciding to change an existing fossil heating source or when planning a new building.

Change in heating

It is helpful to understand heating as an interaction between heating source, façade, windows, and controlled room ventilation for example.
For heating sources such as heat pumps it is necessary that the houses are fitted with *large heating surfaces* such as floor heating. In most cases existing heating surfaces in old buildings must be replaced or enlarged when switching to heat pumps.
Another criterion is the *age of the house*; house owners have to be aware of possible differences in building structure. A common method of reducing the differences in building structures between new and old buildings, and therefore to reduce the heat demand, is to insulate the *façade* and change the *windows*. The first step should be to optimize the *thermal outer shell* of a building. In most cases it is useful to insulate an old façade and to change old windows first; otherwise house owners run the risk of over sizing the heating with corresponding higher initial and operating costs.

> Example: A multi-family dwelling built in the 30`s previously fitted with an apartment coal oven installation, and (currently using an operational cost intensive gas apartment heating). The house owner decides to change to central heating and thinks about the building structure. The façade of the house is permeably constructed (breathable) to let air circulate for the former coal oven and the gas-condensing boiler. Useful measures to supplement the central heating could be thermal insulation of the façade and controlled room ventilation to provide an integrated solution and not to oversize the new heating.

Controlled mechanical room ventilation can dramatically reduce the risk of mildew, and recover heat that normally would be wasted by uncontrolled ventilation via windows. When sealing the façade by insulation it would normally be necessary to install controlled room ventilation.
If the windows are changed and the façade is insulated to reduce heating costs, there is a risk that problems with mildew in old buildings could appear. In many cases this has nothing to do with no or false ventilation by occupants/tenants but rather possibly it is to do with faulty window installation by the craftsmen. A German court recently judged that house owners are primarily responsible for the ventilation, and not the residents/tenants. A reasonable action for house owners could be to install a controlled room ventilation system with vents in the façade, in order to minimize the risk of mildew and to save the building structure. By recovering heat, normal amortisation period for installation of controlled room ventilation is between 10 to 15 years.

One should strive to achieve an integrated combination of heating, insulation and ventilation.

Alternatives

Replacement of old condensing boiler

In Germany there are currently an approximate 17 million condensing boilers. Ninety percent of them are older than 10 years and have low efficiency of approx 65 to 85%. Merely 10% of the existing condensing boilers achieve an efficiency of more than 98%. This means that there is a high potential to save fuel. The conventional alternative to existing condensing boilers is, simply to replace them with a new one to obtain higher efficiency. Replacing an old gas or oil condensing boiler older than 10 years reflects amortization periods usually between 5 and 7 years.

Heat pump

Most heat pump technology moves heat from a low temperature heat source to a higher temperature level. The two main types of heat pumps are compression heat pumps and absorption heat pumps. Compression heat pumps always operate on mechanical energy via electricity, while absorption heat pumps may also run on heat as an energy source via electricity or fossil fuels.
For efficient operation of heat pumps it is necessary that houses are fitted with almost 50 percent surface heating in relation to heating cores, because surface heating need a lower flow temperature to retain the same heating effect as heating cores.
The heat pump is the most commonly used alternative to conventional heating sources in Germany, having a market share of 10% in new buildings. A number of sources have been used for heating private and communal buildings; in the following passages the three most important sources of heat pumps are described:

Air-source heat pumps

Air source heat pumps are relatively easily constructed, and hence inexpensive to install. Therefore, they have historically been the most widely used type of heat pump because they use the warmth of the surrounding air. They have limitations due to their dependence on the outside air as the heat source during changeable conditions, and so therefore there can be a need for an additional condensing boiler. The higher temperature differential during periods of extreme cold or heat leads to a lower efficiency. On cold winter days it is normally more economical to switch off the air heat pump and to operate an additional condensing boiler.
In Sweden 95 percent of all new buildings are fitted with air heat pumps as standard.

Geothermal heat pump (bed rock heater)
Geothermal heat pumps typically have higher efficiencies than air-source heat pumps. The reason is because they draw heat from the earth which is at a relatively constant temperature all year round at below a depth of approx 50 to 90 meters. Geothermal probes in the earth absorb the heat with a constant temperature, which means that the temperature differential is lower than from the air. Hence there is no dependency regarding outside conditions that leads to higher efficiency. Another advantage is that normally no additional condensing boiler is needed.
Generally, a geothermal heat pump is the most expensive but also the most efficient kind of heat pump.

Ground water heat pump
Special geothermal heat pumps are the groundwater heat pump types that use solar power saved in the ground water. In Germany one needs to dig on average about 15 meters deep to reach the ground water table. There is typically, little seasonal variation and lower differences in temperature (on average a constant temperature of 10 degree Celsius) as compared with air-source heat pumps. The trade-off for the improved performance is that a ground-source heat pump is more expensive to install than an air-source heat pump, this is due to the need for digging wells or trenches in which to place the pipes that carry a heat exchange fluid. In comparison, groundwater heat pumps are generally more economical than heat pumps using heat from the soil.

Biomass

The most important biomass resource in Germany is wood, because of the short transportation distances between the source of the wood and end user. In city houses there normally is not enough space to store firewood, but a reservoir of *wood pellets* or *chips* is possible, this provides the same comfort as gas or oil because of using an automatic filling process of the energy source in the condensing boiler. One disadvantage is that more space is needed to house a reservoir that is big enough to meet the demand of 4 to 6 weeks at the least. To minimize the risk of price fluctuations, a long-term supplier contract can be made. The main advantages are that wood is much cheaper than fossil heating sources and is a renewable resource. Currently the kilowatt-hour energy from wood chips or pellets costs approximately 0.04 €/kwh, whereas the kilowatt hour energy from gas costs 0.08 €/kwh. The pellet prices over recent years have been stable and will continue to be stable despite an increasing higher demand.
In Munich or Regensburg, - cities with very strong particulate matter restrictions- the initial operation of pellet heating is communally promoted in the city centres. One reason for this is

that pellets do not produce more respirable dust than comparable heating. An advantage that should not be underestimated is that biomass heating has a positive impact on a buildings energy passport, every house owner has to show this to potential tenants in Germany as from 2009. Furthermore, with increasing oil and corresponding gas prices, it will become more and more attractive to change to biomass as an ecological and economical resource.

Cogeneration of heat and power

Cogeneration (heat and power plant) is the use of a heat engine or a power station to simultaneously generate electricity and useful heat. Cogeneration is the thermodynamically efficient use of fuel or other energy sources. In the separate production of electricity some energy is lost in the form of wasted heat. heat and power plants also use the thermal energy effectively as local heat. Compared with single gas heating or central power plant, a higher efficiency (up to 90 percent higher) is obtained by using the generated energy and heat directly, without suffering remarkable losses. A cogeneration plant must be operated for a certain number of hours per year to run economically. Therefore in general, a minimum of 20 residential units is needed to have regular amortization periods of 7 to 12 years. One disadvantage is that it has to be combined with a condensing boiler when a peak capacity is needed. There are different types of energy sources for cogeneration. Conventional sources are *gas and oil* and in the near future, *fuel cell cogeneration* with *hydrogen* will be possible. Currently, the infrastructure is not yet ready in most regions of Germany for the marketable use of hydrogen. One example plant is located in the Ruhr in Duisburg; it has a rated power of 200 kilowatts.

Solar heat

In Germany, 95% of all solar heating panels are installed on the rooftops of one and two family houses. Hence there is a high potential for using solar energy heating on multi-family dwellings because they meet 50% of the total heat demand in residential buildings.
In 2007 there was a dramatic decrease in new solar heat installations by 37%. Some possible reasons were the increase in the value added tax and the interim decrease of fuel prices. Nevertheless, solar heating is the most accepted *renewable energy* form in Germany.
The roofs need to fulfil different criteria for installing solar heating panels. Therefore, solar heat is only property related realizable, unlike geothermal energy, and there is a need for space to house buffer *storage*. It is not economical if long distances to the end user with high energy losses have to be covered.

The current standard solar panels can cover just 10 to 20 % of the heating requirement per year of a house; therefore an additional heating source such as pellet heating could be a good combination.
At the moment it is not economical to install solar heating because of the long amortization periods of between 15 to 20 years. Despite this, in the coming years there will be growing demand for solar heating as an alternative heating source, especially when the price of heating oil will be over 1 Euro per litre long-term (currently 0.50 Euro per litre).

Finance

There are several possibilities of getting financial assistance for new heating. A lot of programs are provided by the Federal Republic of Germany, the German States or the municipalities. It is important to know that in most cases there is no restriction to taking advantage of more than one source of aid for the same measure/action. In the following paragraphs, the most popular and most commonly used financial aids offered by German institutions are briefly described:

Grants

The Federal Office of Economics and Export Control (bafa) provides grants for example to: biomass condensing boilers, heat pumps, if they meet different requirements. The current requirements can be read under *www.bafa.de*.

Low interest loans

The German bank "*KfW Förderbank*" provides low interest loans for ecological and environmentally friendly heating technology, under the condition that certain requirements are met. Detailed information and current interest rates in combination with the different promotional loan programs can be read under *www.kfw.foerderbank.de*.
It is assumed that in October 2009 in Germany, the new energy saving regulation (EnEV 2009) will come into effect with corresponding harder criteria for getting low interest loans. Therefore, it is advisable to apply for aid as soon as possible in the coming year when planning measures that reduce energy consumption.

Contracting

If a house owner is not in the financial position to finance the investment in new heating by themselves, they have the possibility to make a contract with an investor that will finance the measures, but under the premise that the house owner pays for example a higher than market energy price over a period of

approx 15 years (with margin) to the investor, and after the period the investment will go over to the owner.

References

Interview with Dipl. Ing (FH) Wolfgang Hartmann

Dipl. Ing. (FH) of supply engineering, construction biologist (IBR), lecturer and energy consultant
December 12th, 2008

BAFA: Bundesamt für Ausfuhr und Wirtschaftskontrolle

http://www.bafa.de
December 10th, 2008

KfW: Kreditanstalt für Wiederaufbau

http://www.kfw-foerderbank.de/EN_Home/index.jsp
December 10th, 2008

Wikipedia

http://en.wikipedia.org/wiki/HVAC
December 10th, 2008

Tecson

www.tecson.de
December 10th, 2008

Pelletmagazin

www.pelletmagazin.de
December 10th, 2008

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