Energy
National Research Programmes 70 and 71

Project

Wood combustion for energy in buildings

How can energy from wood be made clean?

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In Switzerland, the share of energy accounted for by wood as a source could be expanded, benefitting both the climate and the forestry sector. Depending on the means of application, however, air pollution would result. But with the right combustion system and correct operations, wood energy can be expanded and the air made cleaner at the same time.

While a fire provides heat and comfort, it also pollutes their air. Automatically operated combustion systems are cleaner.
Source: Shutterstock

At a glance

- Wood is a CO_2-neutral and locally renewable raw material that can be used for heating as well as for process heat and electricity generation.
- Depending on the combustion system and operating method, however, the climate-friendly heating method pollutes the air: manually operated systems cause greater pollutant emissions than automatic combustion systems.
- The measurement of carbon monoxide provides a means of simple monitoring: this gas indicates other harmful substances.

A great deal of wood grows in Switzerland's forests – more than is currently used: the forests are underutilised. Part of this wood could be used for the expansion of wood energy, for example for the heating of residential buildings. This would allow for the country's dependency on fossil energy sources such as crude oil to be reduced. And because wood is CO_2-neutral, this would also have a positive impact on the climate. Depending on the type of combustion applied, however, pollutants that are detrimental to health escape into the air. If wood heating systems are to be incorporated in settlements more often, it is important that suitable combustion types are selected and that these are operated in an optimal manner. Researchers from the Lucerne University of Applied Sciences and Arts and the Paul Scherrer Institute systematically tested various combustion systems as part of two sub-projects and analysed the resulting waste gases. A unique feature of the investigation was the fact that pollutants that only emerge following conversion upon meeting sunlight in the surrounding area were taken into account. These include secondary organic aerosols and reactive oxygen compounds that are harmful to health.

Manual furnaces are inferior

The scientists tested nine different combustion systems – including both automatically operated and manual variants. They also varied the operating conditions: for example, altering the air supply (ideal, too little, too much) or the water content of the fuel and switching between a cold and warm start. The measurements of the waste gases revealed that automatic combustion systems with a continuous fuel supply are superior to manually operated systems. The former emit up to 2,400 times less pollutants – if the operating conditions are ideal, i.e. with high combustion temperatures and an optimal air-to-fuel ratio. Good planning with respect to heating requirements helps as the emissions can be reduced if the combustion systems are able to run as continuously as possible. Many pollutants are released during the start phase, in particular.

The operating conditions are even more important in the case of manual furnaces. The pieces of wood must not be damp and be of the right size. Even then though the manual furnaces remain worse in terms of pollutant emissions. If suitable automatic combustion systems are installed, however, an expansion of wood energy in Switzerland is possible. Where modern wood heating systems replace old plants, they contribute to improving the air quality.

Secondary pollutants

Pollutants do not only emerge during the combustion processes. Instead, certain gases are first converted into so-called secondary pollutants at a later time in the atmosphere under the influence of sunlight. Secondary organic aerosols, in particular, are formed in this way. As the investigations show, these contain a much higher quantity of reactive oxygen compounds that are detrimental to health relative to direct emissions.

The measurements of the scientists revealed that the secondary aerosols account for a considerable share of the overall pollution from combustion processes. For the monitoring of air quality as well as the further development of combustion plants, it is not only the primary pollutants such as nitrogen oxides, particulate matter and volatile organic compounds that need to be taken into account, but also the secondary pollutants.

Simple monitoring measurements

In order to check the effectiveness of clean-air measures, air quality is regularly monitored. However, measurements of the harmfulness of waste gases and secondary pollutants are time-intensive and costly. The analyses of the Lucerne University of Applied Sciences and Arts (HSLU) and Paul Scherrer Institute (PSI) now show that the measuring of carbon monoxide is not only a good indicator for the combustion processes, but can also point to harmful pollutants in the waste gas.

The research results of the two sub-projects allow for the optimised operation of wood heating systems and support their technical further development. The results also provide a basis for monitoring air quality and the measures aimed at improving it.

Produkte aus diesem Projekt

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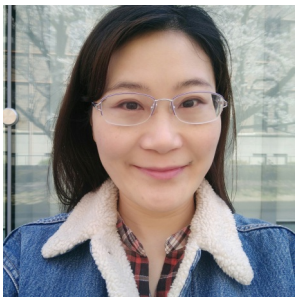

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Connected projects

Minimising pollutants in wood combustion

The clean burning of wood

Toxicity of pollutants in wood combustion

Harmful particles in the air originating from wood stoves

All information provided on these pages corresponds to the status of knowledge as of 10.05.2019.