Efficiently utilizing energy carriers

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60 percent of the energy used in large-scale power plants is lost as waste heat through the cooling tower. Credit: Fraunhofer UMSICHT

Supplying energy is in the process of metamorphosis because people want to know what is the most intelligent and efficient way to utilize all types of energy carriers. German researchers at Fraunhofer put the most common ideas for heating under the microscope and come up with major potential.

Carsten Beier from the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen, Germany does not believe that “anyone would burn a 50-dollar bill just to keep warm. It’s obvious that it simply is too valuable for that.” But, in contrast to dollar bills, most energy carriers are all too frequently burned for less than they are worth. Take wood, for example. Beier and his colleagues have analyzed the efficiency of heat supply systems and he explains that

“wood is a high-quality fuel that can be compared to natural gas. With adequate technologies we could utilize it for power generation. As a fuel, there‘s a lot more in wood that we are taking advantage of at the moment.”

Beyond this, the researchers at the Fraunhofer Institute for Environmental, Safety and Energy Technology have come up with a model for comparing various systems and technologies in heat supply ranging from heating boilers for single-family dwellings right down to district heating networks for whole cities. They apply exergy as a criterion of analysis which is a thermodynamic parameter defined by the quantity and quality of an energy. In contrast to the CO_2 balance sheet and primary energy consumption, the exergy analysis indicates whether we are sufficiently taking advantage of the potential lying dormant in the energies we use. Carsten Beier has come to the conclusion that “if we used fuels such as natural gas or wood for power generation and only use the waste heat for heating, we would be able to save large quantities of primary energy and avoid generating CO_2 emissions.”

Cogeneration plants are taking advantage of these potentials. While large-scale power plants lose an average of 60 percent of the energy as waste heat through the cooling tower, cogeneration plants use this flow of heat for heating purposes, which means that they achieve overall efficiency of more than 80 percent. The researchers distinguished four categories of heat generation in their analyses: burning, cogeneration and using heat pumps or waste heat from industrial processes. Comparing these categories, using waste heat was particularly good in connection with heat networks. That said, it also became apparent that the way drinking water was heated was a key factor in exergy efficiency. Beier reveals that ”even heating a room with waste heat has a poor overall exergy balance sheet if the service water for the household is electrically heated.”

Researchers derived one basic recommendation from their comparison of systems and technologies. Beier demands ”we should take advantage of all sources of heat whose temperature level corresponds to our heating requirements.” And we could take advantage of the fact that there are a whole series of applications where heat is needed at different temperature levels. Beier explains how. ”Any type of cascade is very efficient. For instance, if you use fuel for power generation first, then the waste heat for water heating and finally the remaining heat for space heating.” He confesses that there might be discussions on the economic efficiency of these scenarios, especially because the initial investments are rather high. “But, on the other hand, it is essential to restructure our energy system quickly and an exergy analysis is an excellent tool for identifying how power supply should be designed in future.“

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