Exemplary in energy

Setting a good example

Technical implementation of measure no. 2:
Analyses of potential of waste heat and renewable energies

Utilization of own waste heat at the PSI

Part of the cooling circuit, which today also serves as a waste heat source

Today the Paul Scherrer Institute (PSI) can meet half of its heat requirement with waste heat from its own installations on the site. This share should rise to 75% by integrating further installations, which is made possible by making adjustments to the heating system.

An analysis of the heating and cooling situation at PSI was the factor that triggered a closer examination in 2010 of the potential for further utilization of its own waste heat. At that time PSI was still sourcing heat to a large extent via Refuna AG's district heating network from the Beznau nuclear power station. The temperature level was and still is 115° C in winter (see figure 1 on page 2).

In the secondary network, the inlet temperatures were between 60° and 90° C, depending on the year of construction of the building and installations and on the process-related consumers. On the other hand, the temperatures of the unused waste heat from PSI's own installations were to a large extent less than 60° C. Further utilization was therefore not possible directly. At that time, a maximum of 20% of the heat requirement could be met with the waste heat from several compression cooling machines, a pneumatic compressor and the cooling of the high-frequency electronics. The waste heat had to be utilized locally and could not be transported via the district heating network.

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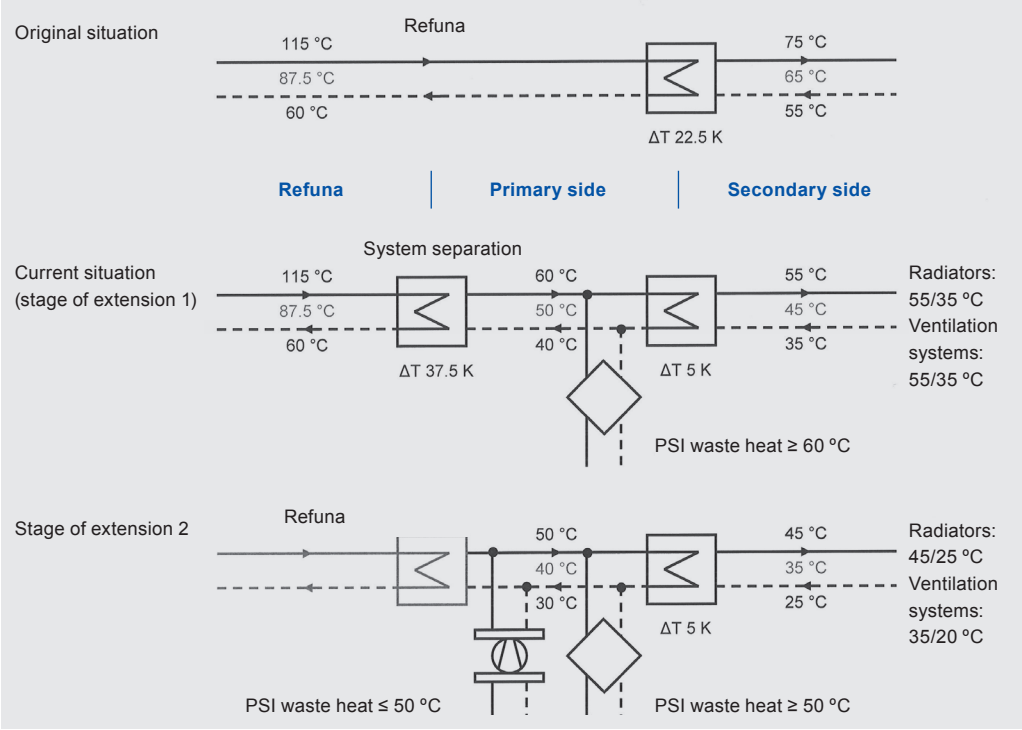

Figure 1: Original situation and the two stages of extension with the operating temperatures

An outline analysis of the situation

In order to examine further utilization of waste heat, the company Amstein + Walthert AG conducted a first study. In cooperation with PSI, the existing and possible future waste heat sources and the capacity of the existing heating systems or the adjustments that were required to them, as applicable, were analysed. In addition, the key data of the existing buildings were collated and the changes expected in the energy sourcing surface area in future were determined. From this data, the study's authors estimated the long-term heat requirements for heating and energy. An outline analysis based on these data yielded the theoretical, technical and economic potential of further utilization of the waste heat generated.

It was found that the conversion can be divided into two sub-stages. Stage one comprises the necessary conversion works that make the directly-usable waste heat exploitable. In stage two, waste heat from installations at lower temperatures would also be able to be used indirectly, in particular by utilizing heat pumps. In this way PSI would theoretically be supplied with heat completely autonomously.

In-depth analyses

The data were verified in an in-depth study. This made it possible to evaluate the actual potentials and to devise measures at the level of both the site and individual buildings. The cost estimates were refined and an economic efficiency calculation was done. One practical result was that the planning phase for the first extension stage was initiated. On the other hand, the second stage is not yet to be executed because the project is currently not yet economically viable.

Organization of project implementation

The contract for the technical conversion works was awarded to the company ENGIE Services AG (formerly Cofely AG), which provided a project manager and fitters. On the PSI side, in addition to a steering committee and the project manager, the staff from the operating and maintenance groups also supported the works. If necessary, supporting advice was in addition provided by Amstein + Walthert.

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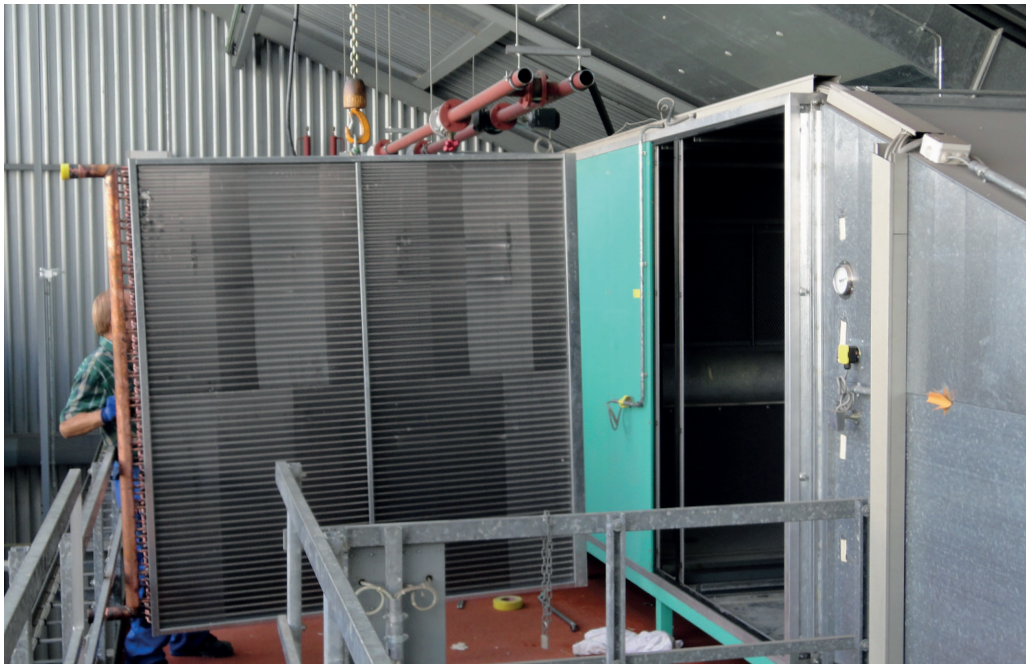
Technical adjustments

In order to make possible further utilization of PSI's own heat, it was necessary to lower the inlet temperatures on the primary side. The system separation of the Refuna network with the use of central heat exchangers was an important prerequisite. To this end, a separate circulation and extension system was installed for the heat network on the PSI site. This step was particularly well prepared; a bypass was planned for safety reasons, so as to ensure the availability of local heat at any time. Adjustments were also necessary at the transition points between the local heating network and the building heating systems. At the substations, the existing tube heat exchangers in particular were replaced by plate heat exchangers, which provide a larger exchange surface area for a given available space. In addition, further, directly utilizable waste heat sources were integrated hydraulically into the heat network.

A large proportion of the work and costs was borne by the heat consumers. The actual heat requirement had to be determined for each building. By doing so, it was possible to establish whether a reduction of temperatures would be possible under the existing conditions. If not, only those ventilation systems, radiators and air circulation heaters were replaced which required a higher temperature than that which had been defined. In the course of this work it could be seen particularly clearly how important it is to provide direct access to the knowledge the staff in charge have of the installations, buildings and infrastructure. The fact that valuable information is not 100% available on paper is probably true not only of PSI.

Successful implementation

Thanks to the detailed preparation phase, there were no major surprises during implementation and the planned costs were not overrun. After conversion work lasting three years, already 51% (6600 MWh) of the heat requirement could be covered by PSI's own waste heat in 2015. The next move is to increase the proportion of own waste heat to 75% by 2020. This will be achieved by integrating the SwissFEL Free Electron X-ray laser, which is currently under construction and will also provide a lot of waste heat in winter.



Replacing the air heating register

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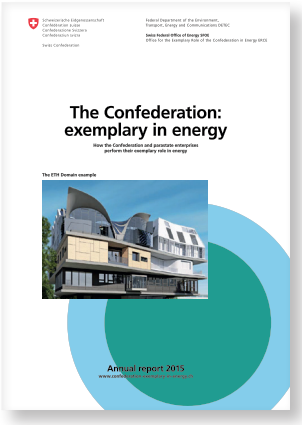
A reliable supply for the future
With the measures taken and its far-sighted strategy, PSI is ensuring that it will have a flexible heat supply in future. It is generally advisable to take a long-term view, even if a project for using waste heat should not be directly implementable. For example, the prerequisites can already be met at an early stage by having a long-term strategic plan and by deriving guidelines from it. Space can already be provided for the necessary conduits and the heating be designed to work at a low temperature, among other measures.

Implement the measures yourself

- Where waste heat is also generated in winter and in the immediate vicinity of buildings, it can be worthwhile to utilize it.
- An existing, usable local heat network is an ideal prerequisite, as it can be costly to install such a network at a later stage.
- The knowledge that one's own employees have in the infrastructure area can be valuable for project implementation.

Further information
- PSI website with an energy model
- SwissFEL website

Contact person
Paul Scherrer Institute
David Reinhard
david.reinhard@psi.ch



Exemplary in energy

The annual reports form the core of the reporting by the Exemplary in energy initiative. They present the 39 joint measures and summarize the actors' actions plans, which also contain their specific measures. Furthermore they enable all the measures to be monitored. You will find the reports on www.exemplary-in-energy.ch.

Contact
Federal Office of Energy FOE, 3003 Bern
Phone + 41 58 462 56 99
www.bfe.admin.ch