Energy-saving modernization of a heating system on a large company site

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Figure 1 *Company site*

The modernization of the heating and ventilation with ejector technology and the conversion to district heating at Dehner made use of an enormous savings potential for heat energy and electricity. The thermal pumps enabled a 95% saving in electricity and a 52% saving in heat energy.

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The family company Dehner was founded in Rain am Lech in 1947 and the site is still the company headquarters today. Dehner has meanwhile become the largest garden center chain in Germany with pet and agricultural shops (“Agriculture”). With 110 branches in Germany and several in Austria, the company has grown to employ over 5000 staff. About 1100 of these are employed in the main office in Rain. The number and extent of the buildings on the company grounds which extend over 70,000 m^2 in Rain am Lech are very large.

Reasons favoring modernization

The natural needs of plants, such as light, air and heat, which can also be fulfilled by greenhouses, mean that garden centers have to occupy a large space. Correspondingly long routes for heating and ventilation as well as solar thermal loads and hall doors being opened and closed frequently need to be taken into account. The heating technology must respond rapidly. The old heating system had become unable to live up to modern expectations regarding inexpensive and optimal energy usage. A large number of boilers were spread over the various buildings and numerous circulating pumps as well as many auxiliary solutions maintained the supply on the extensive grounds. However, the reliability of the system was not always ensured.

For the entire premises of the head office in Rain, consumptions of approx. 18,462 MWh/a for gas, approx. 1,490 MWh/a for oil and approx. 6,207 MWh/a for electricity were measured in 2010. For both heat energy and electricity, the values were very high in statistical comparison to other installations, which indicated a high savings potential.

This argued in favor of a complete modernization of heating and ventilation with optimization of the building automation and control. An important prerequisite for successful renewal of both was the condition that business operation in the company was not to be interrupted – firstly owing to the sensitivity of plants and seeds and secondly because no alternative location was available as a temporary solution.

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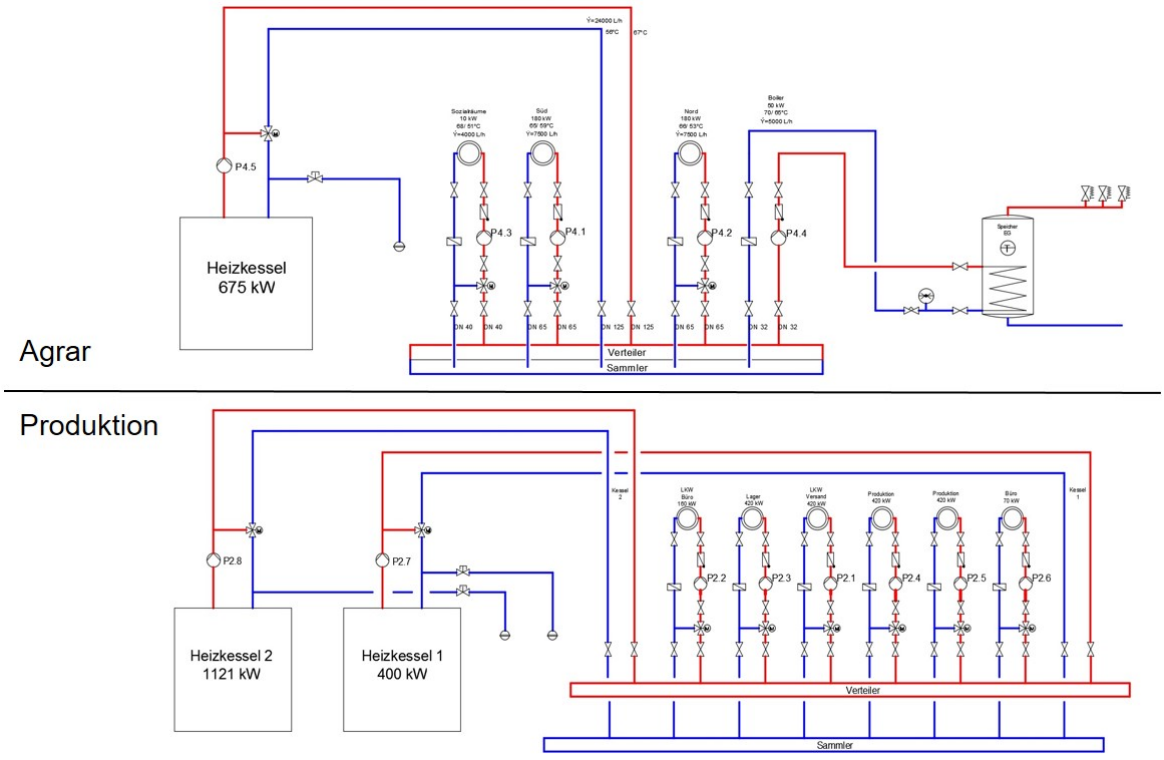

Figure 2 *Old system layout before modernization for Agriculture and Production*

Technical changes geared towards saving energy

Renewal of the heating system began with the Agriculture and Production department in 2012. Prior to the modernization, the Agriculture installation was supplied by a gas boiler, while the Production installation was supplied separately by two other boilers. In addition, each consumer needed a circulating pump (figure 2). Consultation and planning by the Engineering Office Weinmann, Munich, initially led to an essentially simpler system setup with ejectors and also to a heating system consolidation of Agriculture and Production with conversion to district heating (figure 3). This not only did away with the boilers but also all boiler and boiler charging pumps. Only a central feeder pump (high-efficiency pump) was required. Circulating pumps and differential pressure regulators could also be dispensed with.

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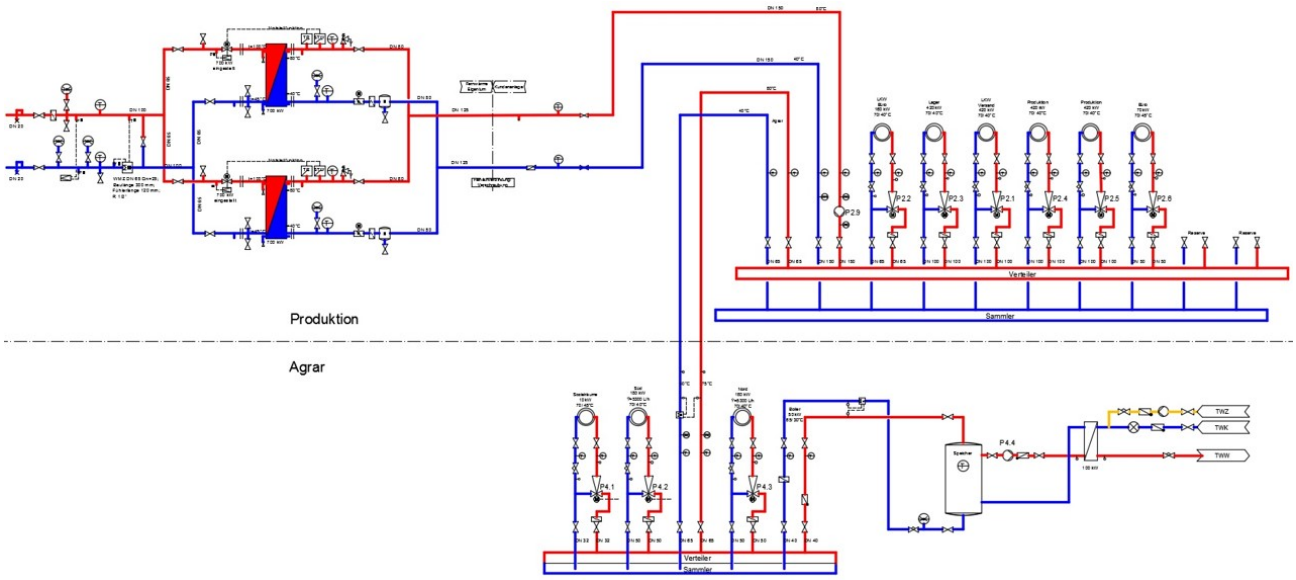

Figure 3 *New system layout after modernization for Agriculture and Production*

Results of the heating modernization

The electricity consumption of the installation was reduced considerably by installing the ejectors, which only require a minimum amount of electricity. In this part of the project alone, 13 circulating pumps were dispensed with, leaving just one high-efficiency pump now generating the required differential pressure. At an electricity price of 16.5 cents/kWh, this resulted in an annual electricity price saving of 3,527 € for the agricultural and production systems. Table 1 shows the annual electricity consumption of the circulating pumps before modernization in comparison to the newly installed pumps.

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Circulating pumps for		Pump output [W]	Operating hours [h]	Energy consumption [kWh]
Agriculture _ Old	Social rooms	140	5,000	700
	South	480	5,000	2,400
	North	480	5,000	2,400
	Boiler charging pump	65	6,000	390
	Boiler pump	250	5,000	1,250
Production _ Old	Truck dispatch	880	5,000	4,400
	Truck office	Automatic	5,000	264
	Warehouse	880	5,000	4,400
	Production	880	5,000	4,400
	Production	880	5,000	4,400
	Office	245	5,000	1,225
	Boiler pump 1	Automatic	5,000	399
	Boiler pump 2	Automatic	5,000	700
			Total	**27,328 kWh**
Agriculture/Production _ New	Feeder pump	Automatic	5,000	5,954
			Total	**5,954 kWh**

Table 1 *Energy consumption of the pumps before and after modernization in Agriculture and Production*

The annual heat energy consumption measured with a heat meter for heating and ventilation in the installations before and after the modernization is shown with the corresponding costs in table 2. 2009, 2010 and 2011 were the years in which the old system with gas was still in operation. 2015 is the year in which the new system with district heating commenced operations. Bearing in mind that the winter of 2015 was warm, the comparison with 2011 – also a warm winter – reveals a saving of 23,798 €. Annual savings on heating energy and electricity amount to 27,325 €.

	Consumption [kWh]	Costs [€/a]
2009	1,961,587	97,302
2010	2,353,222	120,055
2011	1,835,002	95,738
2015*	1,308,000	71,940

*District heating price 2015: 5.5 cent/kWh

Table 2 *Heat energy consumption before and after modernization of the installations*

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Good saving results led to further modernization in the company

The very good results from the modernization in Agriculture and Production led to the work being extended to the other buildings on the premises. A total of 8 heating systems were installed during ongoing operation. This resulted in the elimination of approximately 105 circulating pumps, with 8 central feeder pumps having been installed. In the summer of 2013, after completing the main work, determination of the usage and consumption values before and after modernization revealed an impressive picture in terms of savings.

For the boiler system, the original energy utilization rate stood at an average value of approx. 75%, while an annual utilization rate of approximately 99% resulted after the optimization of the complete installation through hydraulic balancing, reduction of return temperatures etc. and the conversion to district heating (figure 4). The energy saving potential from this was approx. 32% (table 3).

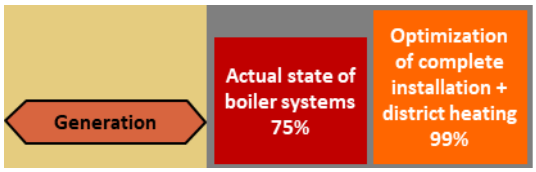

Figure 4 *Utilization rate of the energy generated*

In terms of energy distribution, the modified system technology with ejectors yielded over 90% energy saving through a reduction in the volume flow to less than 50%, and 75% through a high-efficiency pump. Further measures such as the insulation of pipelines and a lower temperature level for preventing heat losses resulted in a further saving of approximately 5%, resulting in a total energy saving for electricity of 95% and a further 5% for district heating being attained.

	Generation	Distribution	Usage transfer	Total
Heat energy	32 %	5 %	25 %	62 %
		95 %		95 %

Table 3 *Energy savings after optimization of the building automation and control*

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Use of the heat

Optimization of the hydraulic control system, a basis for heat supply in line with requirements, led to further savings. Rapidly responding heating technology is essential to saving energy in greenhouses and is ensured by modern building automation and control. When it came to water heating, the installation of decentralized units at more distant locations with low requirements led to lower heat losses. A district heating saving of approximately 25% resulted here.

In total, the saving after optimizing the building automation and control at the headquarters of Dehner in Rain am Lech was 95% alone for electricity in relation to the thermal pumps and 62% for the heat energy (table 3). This results in 2,280 tonnes less CO_2 emissions a year for electricity and 3,600 tonnes a year for heating in this company alone.

The total costs for the modernization of the heating system including long-term measures for further optimization and monitoring are approximately 850,000 €. The thermal saving per year is approximately 130,000 € and the electricity saving a further 20,000 €, bring the total savings to approximately 150,000 €. This means that the amortization period of the investment costs is about five and a half years.

Conclusion

The example of Dehner shows the enormous savings potential available in many small and large companies for heating, ventilation and warm water. Even larger conversions amortize their investment in a short time – in approximately five and a half years in this case. The savings potential realized in the use of ejector technology is also clearly apparent. Their durability and low level of maintenance also contribute to a reliable availability of the systems.

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