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Energy for heating and ventilation in pig production on farms

The demand of energy and its optimal use are getting increasing attention in pig production with respect to raising prices of energy. The main consumers of energy in conventional husbandry are heating and ventilation. During the last years the kind of building construction, the technique and the control system as well as the kind of production and the requirements of livestock farming have changed significantly which have an influence on the demand of energy. The data published in literature show wide variations. So updated data are needed.

Keywords
Pig production, livestock housing, energy demand, heating, ventilation

Abstract
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The Teaching and Experimental Institute Futterkamp of the Schleswig-Holstein Chamber of Agriculture examined the energy consumption in 29 North German pig housing systems, broken down by heating energy and electric power. This was done within the framework of the costing document work programme of the Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V. (KTBL). Demand figures for heating and ventilation were derived from the data collected.

Material and methods

Selection of the housing facilities. The housing facilities originate from selected farms being advised in North Germany. These operate with litter-free housing systems in line with the present state of the art. The requirements of the Animal Welfare Livestock Husbandry Regulation regarding dimensions of the animal places are observed. The piggeries have their own heating installation. Energy consumption can be clearly allocated to the housing facilities via the filling of storage containers or readings of gas and electricity meters. Consumption data from up to three production years are available in order to balance the influence of the weather in the respective years. Altogether 8 to 13 housing systems with different installations for heating and ventilation control were selected for each of the specific sections of business – sow keeping, weaner rearing and pig fattening, ensuring a scatter of the respective energy consumption levels. All the housing installations were checked for correct execution and operation of the structural and technical facilities, especially the heating and ventilation. Important measurements, technical characteristics and the type of occupation of the sections were surveyed.

Evaluation

The energy consumption for heating and electricity is determined on the basis of the amounts of energy supply media consumed according to the billing as total consumption in the respective year.

For heating it is not possible to allocate the figures to the individual heating technologies used or to specific sections. For electricity consumption, separation was achieved between consumption for ventilation and for the rest of the equipment by calculating consumption for the other equipment on the basis of the installed performance capacity of the equipment in the housing and the customary operating hours obtained from the farm manager. Consequently the consumption figures for lighting, cleaning, cleaning out and individual secondary loads in the respective housing unit can be estimated sufficiently precisely. It is not possible to record the operating times for feeding. The energy consumption is calculated via the feed consumption per production unit and a lump sum figure for electricity consumption per kg feed for the feed distribution [3]. The electricity consumption for ventilation results from deducting all other loads with their calculated consumption levels from the total consumption. The energy consumption of the housing installations determined in this way is shown per animal place for weaners and fattening pigs, and for the reference figure productive sow in the sow housing.

Results

The energy consumption of the housing facilities examined displays a broad scatter, as is evident from the example of sow housing (**table 1**). The median value was used for evaluation

Table 1

Consumption of energy in eight housings for sows

Energieverbrauch *Consumption of energy*	**Median** *Median*	**Min.** *min.*	**Max.** *max.*
	kWh/(prod. Sau · a) *kWh/(sow · year)*		
Heizenergie *Energy for heating*	341,29	152,22	555,38
Strom gesamt *Electricity total*	180,27	93,50	271,67
Lüftung *Ventilation*	127,96	61,62	208,00
Infrarotstrahler Ferkelnest *Infrared lamp for suckling piglets*	33,75	12,77	55,71
Beleuchtung *Lighting*	12,32	3,94	36,28
Fütterung *Feeding*	1,36	1,32	1,44
Nebenverbraucher[2] *Secondary consumer*	4,87	1,78	15,19

[1] Norddeutsche Stallanlagen mit Ø 420 produktiven Sauen.
Livestock installations in northern Germany with 420 sows in average.

[2] Reinigung, Entmistung und sonstige Verbraucher.
Cleaning, manure removal and other consumer.

Table 2

Consumption and demand of energy in pig husbandry for heating and ventilation

		Sauen *Sows*	**Ferkelaufzucht** *Weaned piglets*	**Mast** *Fattening pigs*
		kWh/Tierplatz[1] · a *kWh / (animal place · year)*		
Heizung *Heating*	Energieverbrauch *Consumption of energy*	341	61	45
	Bedarfswert [2] *Demand of energy*	330	170	70
Lüftung *Ventilation*	Energieverbrauch *Consumption of energy*	128	7	16
	Bedarfswert [2] [3] *Demand of energy*	50-55	–	10

[1] Bei Sauen je produktive Sau.
In the case of sows given per sow kept.

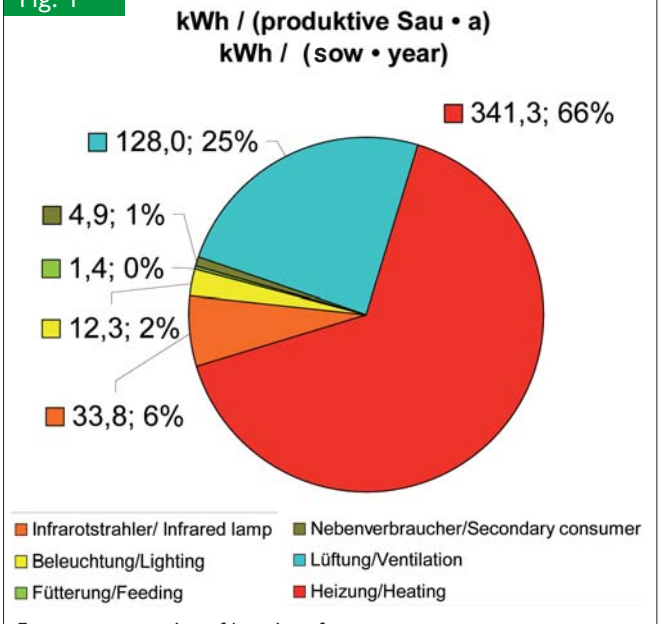
as it is more robust vis-à-vis outliers in the data series. The differences in energy consumption appear to depend above all on farm and management characteristics. With the small number of housing facilities considered, the influence of specific equipment in heating and ventilation is not detectable.

Figures 1 to **3** show the consumption levels determined for sow keeping, weaner rearing and pig fattening. The energy consumption for heating is by far the highest in all cases. It accounts for 66 % in sow keeping, 87 % in weaner rearing and 70 % in pig fattening. For sow keeping and pig fattening, 25 % of the energy is required for ventilation. For weaner rearing this figure is 10 %. Among the other connected loads, the infrared lamp accounts for 6 % in sow keeping. The other loads lie in the range of 1 % and in isolated cases up to 3 %.

Conclusions

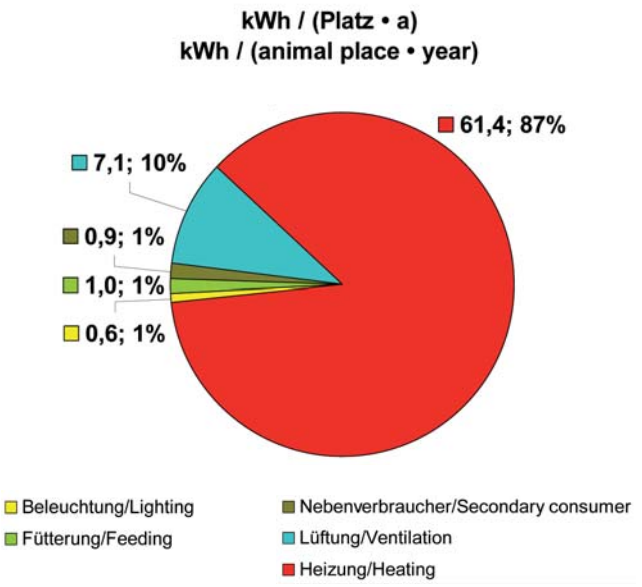
Evaluation of the total energy consumption based on consumption billing for the energy sources used in selected pig housing facilities makes it possible to derive methodologically plausible values on energy consumption for the two main consumer loads – heating and ventilation. If the consumption levels determined in the study are compared with the demand levels frequently used in extension work from Feller [2], that also refer to Schmitt-Pauksztat and Büscher [3], the following picture results (**table 2**): In energy consumption for heating, the figure for sow keeping matches data from extension work well. In weaner rearing and pig fattening, the levels in the current survey are distinctly lower. In the case of energy consumption for weaner rearing, it should be taken into account that the farms examined largely work with zone heating and partly also with covered resting areas. The figure of 61 kWh/AP • a thus represents a consumption-optimised level. For the fattening pigs, the level of 45 kWh/AP • a represents necessary demand. If care is taken to ensure when pigs are taken into the housing that not only the room temperature but also the temperature of the slatted floor meets the requirements of the animals, a higher demand may be necessary. For regions with cold winters and at high elevations, a higher demand can generally be expected.
In energy consumption for ventilation, the consumption levels determined differ distinctly from the demand levels known so far [2; 3]. However, the figures were determined very reliably for the working farms, so that demand is to be estimated as

Fig. 1



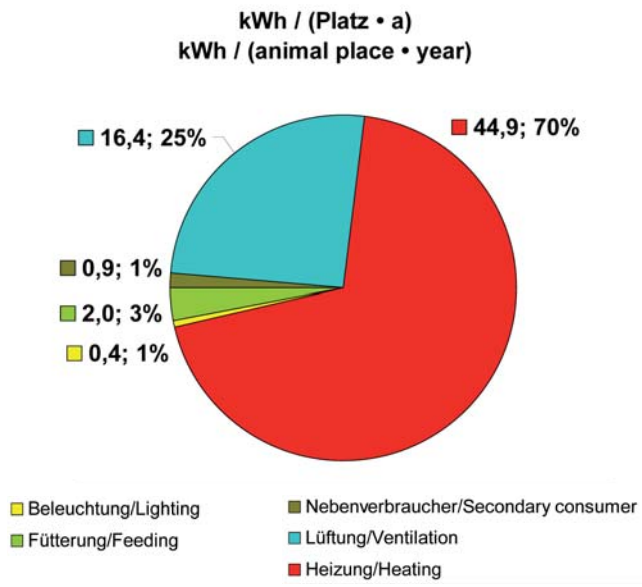
Energy consumption of housings for sows

Fig. 2



Energy consumption of housings for weaners

Fig. 3



Energy consumption of housings for fattening pigs

higher than assumed so far. The high consumption level for ventilation for breeding sows is attributable to the constant high animal weight, the low temperature requirements of the pregnant sows and the high level of heating energy in the farrowing sector. This means that comparatively high air flow rates are operated on an average over the year. In weaner rearing and pig fattening, the ventilation demand is only related to the average weight of the animals. The temperature requirements are substantially higher especially for weaner rearing, as a result of which the air volume flow rates are still relatively low even in summer. The energy consumption for ventilation ascertained here can be distinctly higher in regions with high peak temperatures in summer. The consumption figures determined for the other loads in the housing depend strongly on the farm-specific operating times of the technology and cannot be used as demand values.

The consumption figures ascertained for heating and ventilation in the study appear plausible. They can be used as demand values for current standard husbandry procedures in closed housing without litter and are taken over by KTBL as planning values. In future further similar studies will need to be conducted to place the figures on a broader basis and validate them. Differentiation between the heating and ventilation methods applied requires additional studies for direct comparison of the engineering under otherwise the same conditions.

Literature

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