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Energy use for climate control of animal houses: the state of the art in Europe

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Abstract

Animal rearing is done into houses where heating, cooling, ventilation and lighting are adopted to control the indoor climate, however there are not reference values for the energy performance of such enclosures. In this paper, a first analysis on the energy use for climate control of animal houses that can be found in the technical and scientific literature is done for broilers, hens and pig houses, deriving reference energy use values that may be used for the benchmarking of the performance of these buildings.

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1. Introduction

Since 2002 the EU legislation has set out stringent requirements in order to certify and promote the improvement of the energy performance of buildings through the building energy certification. However, in case of livestock housing, most of the requirements of EU legislation are dealing with the animal welfare related to the type of housing [1, 2], without considering aspects directly related to the energy performance of the enclosure. Even though some certification programs have been developed for specific products that are used in livestock houses (e.g. fans for

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climate control are now certified following the ErP – Energy related Products – Directive 2009/125/CE), there is not an energy performance scheme for assessing the energy performance for the climate control of livestock housing. This is particularly important in case of houses for swine and broilers, where there is a significant energy use for ventilation, heating and cooling of the indoor environment with variable schedules. In fact, breeders have the need to know the energy consumption of their houses and foreseen with a reasonable accuracy the energy consumption of livestock housing as regards the ventilation, heating and cooling, that for some intensive rearing systems represent the major energy uses.

The energy audit of livestock houses and the possible energy retrofitting are subject to a preliminary benchmarking activity with the aim of comparing the measured performance with reference data. In this paper, a review of values of energy use for the climate control (ventilation, heating, lighting and cooling) of livestock houses that can be taken as a reference are presented for some European countries. This work will be useful to develop reference values in order to compare measurements and numerical simulations and to identify different livestock housing systems as a function of the energy use and environmental performance of the houses.

Animal production has strongly incremented its production since the '60s, and this trend is going to be the same in the further coming future at least until the half of this century, when, for example, an increment of about 70% in meat consumption is estimated [3]. Simultaneously, the importance of the energy use in this sector is increasing too, due to the application of new technologies and the continuous rise of energy sources prices [4].

The target of this paper is to retrieve and compare some energy use values found in literature of different European countries related to some of the most common animal productions. For the analysis, only heating, cooling, ventilation and lighting energy uses were considered, as energy uses related to the control of the indoor environment of the enclosure.

2. Literature sources and methods

2.1. Literature sources

The entire work is based on a bibliographical review. The documents were consulted with the aim to find energy values useful for proposing energy use values.

The investigation started from the reference document at European level in this field (Best Available Techniques-BAT)" [5], where the best solution concerning poultry and swine breeding are reported. Its goal is to disseminate and promote the best techniques and technologies available as regard for example odors' emissions, treatment of waste, noise problems and consumption of water and energy. In this document, many data are present, but very few were useful for the energy use analysis, because most of them regard other production issues too.

The most interesting document for obtaining energy use values was "Progetto Re Sole" [6]. It focuses on broilers (chickens reared for meat production), laying hens (egg production), swine and dairy cows, referring to Emilia-Romagna, an Italian region with a high concentrations of livestock houses. This project was carried out by a research institute and started in 2009, ending in 2013, with the final aim to promote the use of energy saving systems, especially solar thermal and photovoltaic collectors. In order to do that, the different uses of energy in various types of animal farms were investigated through a sample and an analytical analysis. The first one consisted in sending questionnaires to farms that filled out them with their data, while the latter one consisted in direct measurements carried out by the researchers. Data are divided by final use (e.g. ventilation, feeding) and type of energy (thermal or electrical) and reported to livestock unit (LSU), a unit of measurement that facilitates the comparison of environmental impact or feeding requirements between different species of livestock. The final results are average values. A similar report was done also by the Swedish University of Agricultural Sciences [7]. In that case the production data are also presented.

Reports from other countries are also used, for example, those coming from France, written by institutions as ITAVI (a French research institute) and ADEME (French agency for energy and environment) and they refer to specific regions of that country, as Loire or Brittany [8, 9, 10]. These reports only regard poultry, focusing on many different species as broilers, laying hens or minor productions, as ducks. In the last section of some of these reports, there are charts for allowing the farmers to calculate their own energy consumptions in order to compare them with some provided benchmarks of electricity and gas consumption.

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