Optimal management of a hybrid heat pump for heating through the assessment of building thermal load and dynamic performance

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Hybrid heat pump (i.e. electrical-driven heat pump working alternatively with a gas-fired boiler) represent an attractive solution for the refurbishment of buildings, in particular the ones where efficiency actions on envelope are not possible or convenient. To obtain the maximum economical convenience for the final user, it is important to correctly choose the generator to be used to meet the load. In particular, for each operative hour, the dynamic operative costs obtained by the using of either the heat pump or the boiler are compared. Thus, the accurate assessment of the heat pump COP, depending on external temperature, supply temperature, and load factor, is crucial. Each heat pump has its operative performance affected by these factors differently, so a tailored analysis of the performance should be carried out to evaluate the effective economical convenience in real use.

In this context, a novel procedure is proposed to guarantee the optimal control of the hybrid heat pump, by the evaluation of heat pump performances in dynamic working conditions. The proposed procedure is divided into three parts:

- dynamic simulation of heating needs for reference buildings, differing for size, external climate, terminal users, identifying the most frequent operative conditions (in terms of temperatures and loads);
- monitoring campaigns of the heat pump working in the most frequent operative conditions;
- definition of a fitting equation for the evaluation of COP depending on the source temperatures and loads.

This equation for the COP estimation is part of the hybrid heat pump control algorithm, which can also estimate the thermal load required by the building through a data-driven methodology. This machine-learning approach is based on indoor temperature, supply temperature and effective required thermal load monitored during a training period.

The results of the application of this methodology to a set of case studies highlight the savings obtainable compared to classical hybrid heat pump control (weather-based control and generators' switch depending on external temperature). Savings up to 20% are obtainable on older and more inefficient buildings using radiators.