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ENERGY LABEL IMPROVEMENT THROUGH RCOP-BASED HEATING OPTIMIZATION IN HEAT PUMP BUILDINGS

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Abstract – The growing usage of renewable energy sources in building energy systems has consequently increased the need for advanced control strategies that simultaneously enhance system efficiency and improve performance within regulatory assessment frameworks. In particular, heat pump–based heating systems must be evaluated not only by their operational efficiency but also by their contribution to renewable energy utilization as reflected in European Union (EU) building energy label calculations. This study examines the effect of RCOP (renewable coefficient of performance)-based heating optimization on the EU energy performance classification of a renewable energy-assisted heat pump building. The proposed optimization approach prioritizes heat pump operation during periods of high on-site renewable energy availability, with the objective of minimizing grid electricity consumption whilst maintaining indoor thermal comfort. A detailed simulation-based analysis is conducted using a representative building model equipped with a heat pump and a renewable energy generating source (e.g. PV panels). The performance of the RCOP-based control strategy is compared against a conventional reference control strategy, following standardized EU energy label calculation methodology. The results demonstrate that RCOP-based optimization leads to notable reduction in grid electricity demand as well as an increase in renewable energy self-consumption. These operational improvements translate into a more favorable outcome in EU energy label calculation, resulting in an improved energy performance classification for the building. The findings indicate that conventional control strategies may underestimate the renewable contribution of heat pump systems, whereas RCOP-based control more accurately aligns system operation with regulatory performance metrics. The study concludes that integrating RCOP-based heating optimization into heat pump control design can significantly enhance both energy system sustainability and compliance with EU energy efficiency frameworks. It is recommended that future building energy assessments and control strategies incorporate RCOP-oriented indicators to better reflect renewable energy utilization and support policy-driven decarbonization goals in the building sector.

Keywords – Energy self-consumption; grid electricity reduction; heat pump operation; sustainable control strategies