Prime Mover Sizing for Base-Loaded Combined Heating and Power Systems

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Abstract : This article considers the problem of sizing prime movers for combined heating and power (CHP) systems operating at full load to satisfy a fraction of a facility's electric load, i.e. a base load. Prime mover sizing is examined using three criteria: operational cost, carbon dioxide emissions (CDE), and primary energy consumption (PEC). The sizing process leads to consider ratios of conversion factors applied to imported electricity to conversion factors applied to fuel consumed. These ratios are labelled RCost, R CDE, R PEC depending on whether the conversion factors are associated with operational cost, CDE, or PEC, respectively. Analytical results show that in order to achieve savings in operational cost, CDE, or PEC, the ratios must be larger than a unique constant R Min that only depends on the CHP components efficiencies. Savings in operational cost, CDE, or PEC due to CHP operation are explicitly formulated using simple equations. This facilitates the process of comparing the tradeoffs of optimizing the savings of one criterion over the other two – a task that has traditionally been accomplished through computer simulations. A hospital building, located in Chlef, Algeria, was used as an example to apply the methodology presented in this article.

Keywords : sizing, heating and power, ratios, energy consumption, carbon dioxide emissions
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