

Energy Efficiency Optimization in a Two-Level Supply Chain Model: Incorporating Shortage Considerations

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Abstract:

As a result of the global energy crisis, energy prices have risen significantly. Governments are also implementing policies to reduce carbon emissions and promote sustainable development. Consequently, enterprises within the global supply chain are under pressure to optimize energy efficiency in their operations.

In response to this trend, many authors have incorporated sustainability and energy efficiency into inventory models (Becerra et al., 2021). These efforts aim to reduce energy consumption, CO₂ emissions, and overall costs for companies. Energy consumption during production, warehousing, and transportation is also identified as a major source of emissions. A two-machine inventory model has been proposed to analyze energy consumption during both production and non-production phases (Zanoni et al., 2014). The authors provide a method to determine the optimal production rate and machine status during the non-production phase, minimizing the total cost, including energy costs. Furthermore, the impact of shortages on carbon emissions reduction has been investigated (Taleizadeh et al., 2018). A Sustainable Economic Production Quantity (SEPQ) model is proposed, considering carbon tax and different shortage policies (full backorder, partial backorder, and full lost sale).


Building upon the existing literature, this study focuses on a two-level inventory system with a single product and a production line. Energy consumption is quantified for each cycle of the production line, considering both production and non-production periods. To conserve energy, the production line's state dur-


ing the non-production phase is taken into account, deciding whether to remain on standby or be turned off. Additionally, shortages are incorporated into the inventory model, fully compensating for them during the production phase at the end of each cycle. A resolution procedure is developed for the Mixed-integer nonlinear programming (MINLP) problem to determine optimal decisions regarding the production line's non-production state, production rate, maximum backordering quantity from the retailer, number of shipments per batch production run, and quantity transported per delivery. These decisions aim to minimize the overall system's average total cost, including energy consumption costs.


This study is also an extension of our previous work that was published in the IFAC World Congress 2023 (Nguyen et al., 2023).

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