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Energy-Led Sustainability Assessment Approach for Energy-Efficient Manufacturing

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Abstract : In recent years, manufacturing processes have interacted with sustainability issues realized in the cost-effective ways that minimalize energy, decrease negative impacts on the environment and are safe for society. However, the attention has been on separate sustainability assessment methods considering energy and material flow, energy consumption, and emission release or process control. In this paper, the energy-led sustainability assessment approach combining the methods: energy Life Cycle Assessment to assess environmental impact, Life Cycle Cost to analyze costs, and Social Life Cycle Assessment through 'energy LCA-based value stream map', is used to assess the energy sustainability of the hardwood lumber manufacturing process in terms of technologies. The approach integrating environmental, economic and social issues can be visualized in the considered energy-efficient technologies on the map of an energy LCA-related (input and output) inventory data. It will enable the identification of efficient technology of a given process to be reached, through the effective analysis of energy flow. It is also indicated that interventions in the considered technology should focus on environmental, economic improvements to achieve energy sustainability. The results have indicated that the most intense energy losses are caused by a cogeneration technology. The environmental impact analysis shows that a substantial reduction by 34% can be achieved with the improvement of it. From the LCC point of view, the result seems to be cost-effective, when done at that plant where the improvement is used. By demonstrating the social dimension, every component of the energy of plant labor use in the life-cycle process of the lumber production has positive energy benefits. The energy required to install the energy-efficient technology amounts to 30.32 kJ compared to others components of the energy of plant labor and it has the highest value in terms of energy-related social indicators. The paper depicts an example of hardwood lumber production in order to prove the applicability of a sustainability assessment method.

Keywords : energy efficiency, energy life cycle assessment, life cycle cost, social life cycle analysis, manufacturing process, sustainability assessment
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