Eco-design of Low Energy Mechanical Milling Through Implementation of Quality Function Deployment and Design for Sustainability

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Abstract. Malaysia as a developing country favor energy demand by years which created mainly from fossil fuel. Unfortunately, the action leads to significant increment in carbon dioxide (CO^2) emission that causing the global warming. The most promising mitigation strategy is by deploying Carbon Capture and Storage (CCS) technology where mineral carbonation was identified as the safest method for permanent storage and does not require continuous monitoring. Accordingly, National Green Technology was launched in 2009 to support the growth of green technology development in Malaysia as a carbon mitigation strategy. Thus, this paper aims to propose the development of a conceptual eco-design for Low Energy Mechanical Milling (LEMM). The concept was proposed by using the Quality Function Deployment (QFD) tool with combination of sustainability determinants (DFS) namely economic, environmental and social which evaluated using Solidworks 2015 sustainability assessment. The results show the new product targets for LEMM in prior on energy consumption (MJ), selling price (MYR), material cost (MYR), carbon footprint (kg CO^2) with weightage of 5.2, 4.2, 3.6 and 3.6 respectively. The implementation of DFS criteria into the QFD promote to reduce material used by 16%, 35% reduction of carbon footprint, 28% less energy consumption, 28% lower air acidification, 77% of water eutrophication declined and increased recyclability by 15%.

INTRODUCTION

Malaysia as a developing country, keeps favoring increments in energy demand year by year which generated mainly from fossil fuel [1]. Unfortunately, this power sector contributes about 30 to 40% of CO^2 emission in Malaysia with 7,650 MW capacity of coal generation reported as the major contributor to the power sector emissions [2]. Previous studies have reported there are three ways to reduce the CO^2 emission namely by increasing power plant efficiency, renewable energy substitution and carbon capture and storage (CCS). However, the usage of renewable energy is limited by dependencies on local resources availability and cost [3]. Other issues are intermittent power sources and associated technologies are not mature yet leading to high cost. CCS is one of

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