# Comparative Carbon Footprint Assessment of Door made from Recycled Wood Waste versus Virgin Hardwood: Case Study of a Singapore Wood Waste Recycling Plant

Ruisheng Ng[1], Chee Wai Patrick Shi[1], Jonathan Sze Choong Low[1], Hui Mien Lee[1], Bin Song[1]
[1] Singapore Institute of Manufacturing Technology

**Abstract**
Recycling of wood waste has the benefits of reducing waste stream and avoiding the need (avoided impact) of harvesting virgin wood. To justify these benefits, a carbon footprint assessment methodology is proposed to compare the carbon emissions of a door made from recycled wood waste (technical wood) versus virgin hardwood. Results show that technical wood door has lower carbon emissions of 12.8 kg-$CO_2$eq compared to virgin hardwood door (16.2 kg-$CO_2$eq). When avoided impact is taken into account, technical wood door carbon emissions may even be lower (-2.9 kg-$CO_2$eq). This assessment also identifies the 'hotspots' for future carbon emissions improvement.

**Keywords:**
Carbon Footprint Assessment; Recycled Wood Waste; Avoided Impact

## 1 INTRODUCTION

According to Singapore Key Environmental Statistics in 2009, the generation of wood and timber waste is approximately 0.27 million tonnes per annum. There are several wood waste treatment options. Landfilling of wood waste is not the best option for a land-scarce country like Singapore. Incineration is one of the most effective ways of treating wood waste but combustion of wood waste releases about 1.28 tonnes of carbon dioxide per tonne of wood waste [1]. A better option may be to recycle wood waste, especially for a resource-poor country like Singapore. This will allow Singapore to be less reliant on foreign import of wood resource. Another benefit of recycling wood waste is that it avoids the need (avoided impact) of harvesting trees for virgin wood. If trees are not felled, they can continue to sequester and store carbon dioxide from the atmosphere through photosynthesis. Furthermore, recycling wood waste delays the release of carbon dioxide stored within the wood.

To justify the benefits of recycling wood waste, a case study is carried out on a Singapore wood waste recycling plant (LHT Holdings Limited) to compare the carbon footprint of a door made from two different materials: recycled wood waste (technical wood) and virgin hardwood. Technical wood refers to the end-product from the recycling of wood waste and virgin hardwood refers to Kapur or Nyatoh, tree types commonly found in Southeast Asia. To carry out the comparative assessment, carbon footprint is chosen as the metric for comparison due to its relevance in quantifying the carbon storage and also its importance in global warming impact. Here, carbon footprint refers to the six greenhouse gas (GHG) emissions consisting of $CO_2$, $CH_4$, $N_2O$, $SF_6$, HFC and PFC and is expressed in weight of carbon dioxide equivalents ($CO_2$eq), e.g. kg-$CO_2$eq. Carbon footprint has also been commonly referred to as carbon emissions. In this paper, carbon footprint assessment refers to the quantification of carbon emissions. The results from the assessment are expressed in term of carbon emissions (kg-$CO_2$eq).

## 2 METHODOLOGY FOR COMPARATIVE CARBON FOOTPRINT ASSESSMENT

The carbon footprint assessment methodology follows closely the principles and framework set out by two standards: ISO14040/44 [2] and PAS 2050 [3]. The ISO 14040/44 is a de facto standard for carrying out Life Cycle Assessment (LCA) that quantifies the environmental impacts. On the other hand, PAS 2050 focuses on carbon emissions quantification. Both standards share great similarities but distinct differences still exist. To best fit the case study, specific elements from both standards and also literatures [4, 5, 6] such as carbon storage quantification and avoided emissions are modified and adapted.

### 2.1 Goal Definition and Scope

*Purpose*

To assess, quantify and compare the carbon emissions of recycled wood waste (technical wood) with virgin hardwood in the application of wooden door using comparative carbon footprint assessment methodology.

*Functional Unit*

The functional unit for the comparative study of the door is: One unit of standard size (2200 mm by 830 mm) door that has a product lifespan of 10 years

*System Boundaries for Comparative Study of the Door*

System boundary covers the activities included in the assessment. For a comparative carbon footprint assessment, both system boundaries cover the same life cycle stages that span from cradle to end-of-use. The life cycle stages include raw material acquisition and processing (cradle), door production and usage. The difference within the two system boundaries lies in the specific process activities shown in the boxes. Door knob, hinges, laminate and paint on door are excluded from the study. Figures 1 and 2 show the system boundaries for a virgin hardwood door and technical wood door respectively.

J. Hesselbach and C. Herrmann (eds.), *Glocalized Solutions for Sustainability in Manufacturing: Proceedings of the 18th CIRP International Conference on Life Cycle Engineering, Technische Universität Braunschweig, Braunschweig, Germany, May 2nd - 4th, 2011*,
DOI 10.1007/978-3-642-19692-8_109, 