A product carbon footprint model for embodiment design based on macro-micro design features

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Abstract

Greenhouse gas emissions have become one of the most attractive global concerns for sustainable development. To reduce product life cycle carbon footprint, planning should begin at embodiment design phase. Accurate assessment of carbon footprint is the foundation of carbon footprint reduction. However, existing carbon footprint models are not applicable to embodiment design phase due to incomplete and limited design information. With this in mind, this paper proposes a carbon footprint model for embodiment design based on macro-micro design features. First, a Function-Structure-Feature (FSF) model for embodiment design is established to convey the design information. The concept of design features is introduced (as both macro and micro level). The macro design feature denotes the different operational states of the product and the constraint relationships between parts. The micro design feature denotes specific properties of parts. Then, a model of product carbon footprint based on design features is presented through analyzing the relationships between macro-micro design features and product carbon footprint. The feasibility of the proposed method is demonstrated by a gear hobbing machine. The amount of carbon footprint from each type of design feature can be predicted. Through the optimization of design features, product life cycle carbon footprint has decreased significantly.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

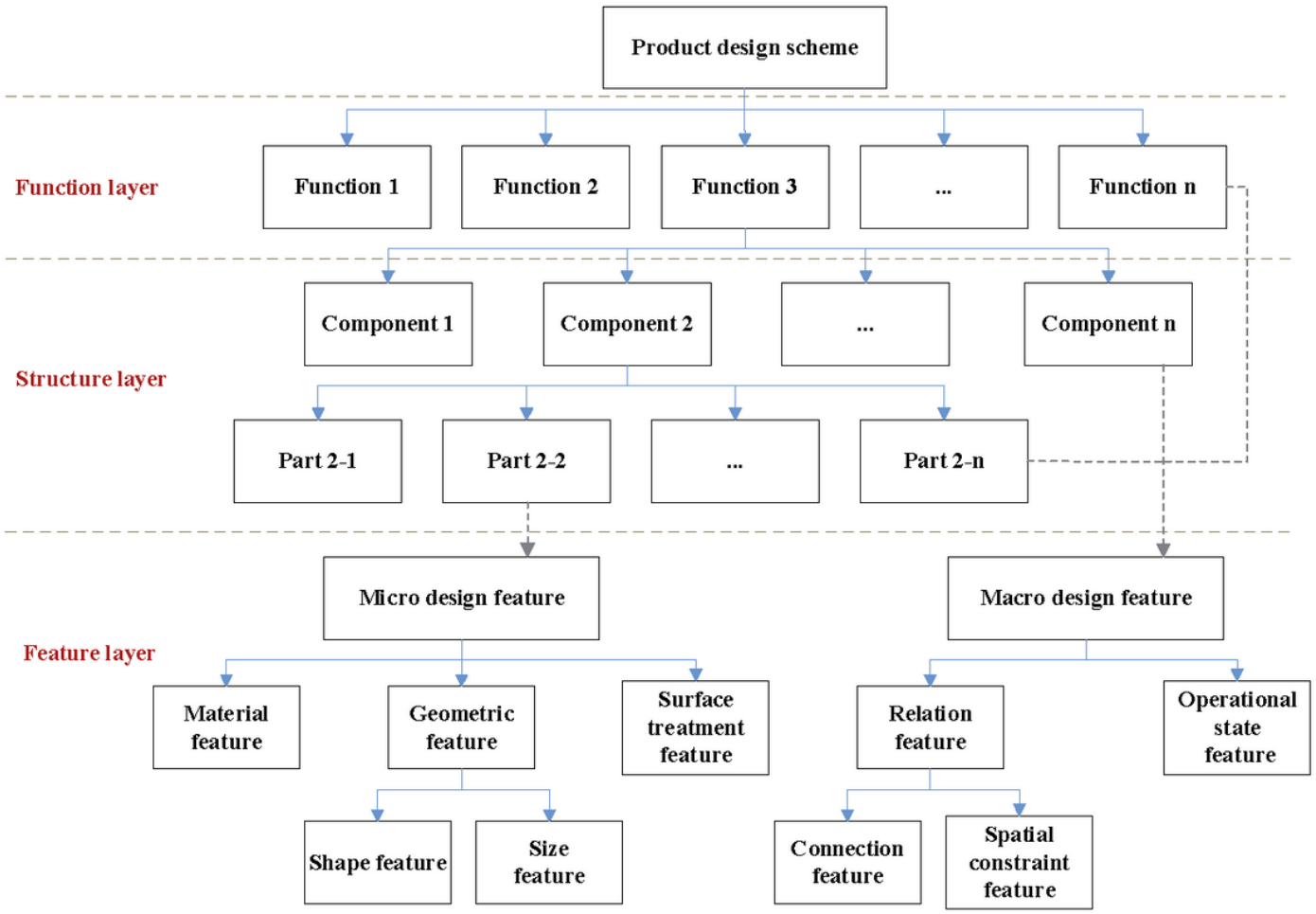

Figure 1

FSF model for embodiment design

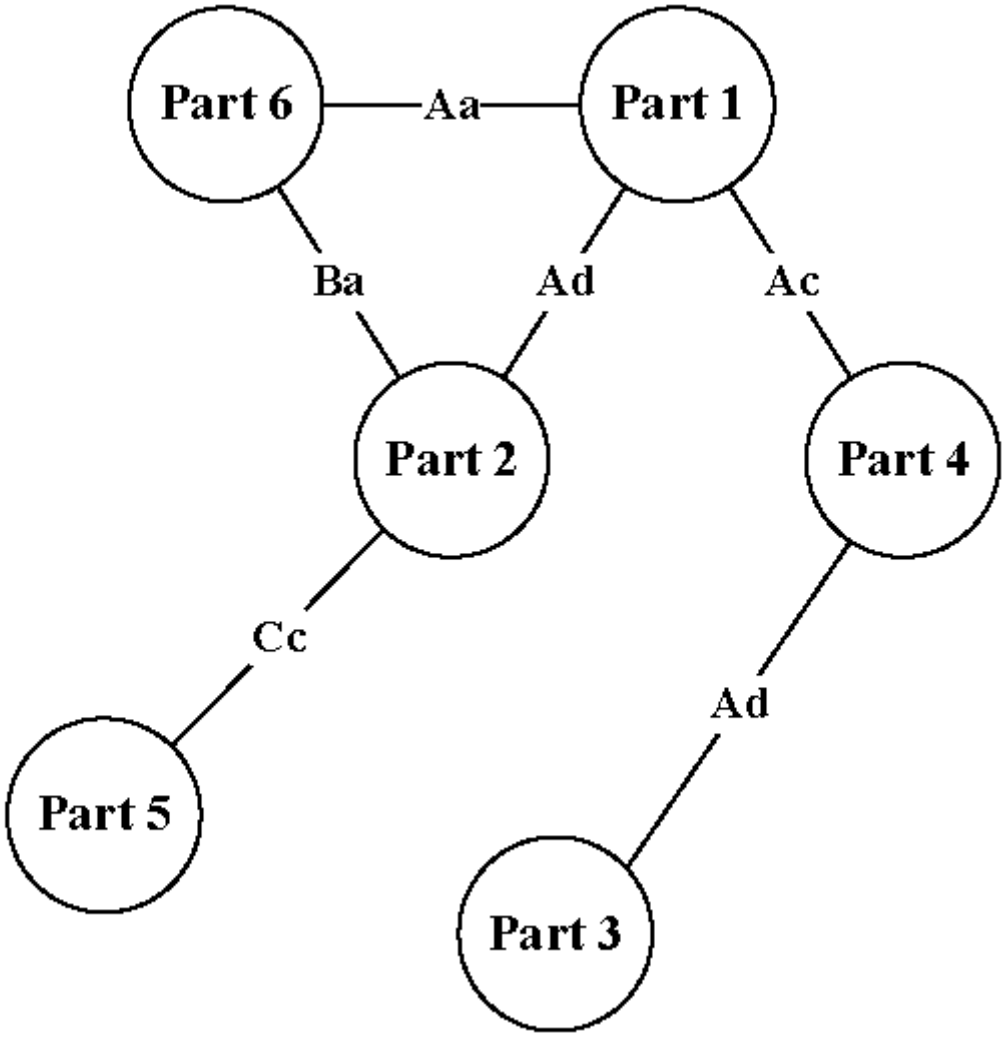

Figure 2

Relation feature of a product

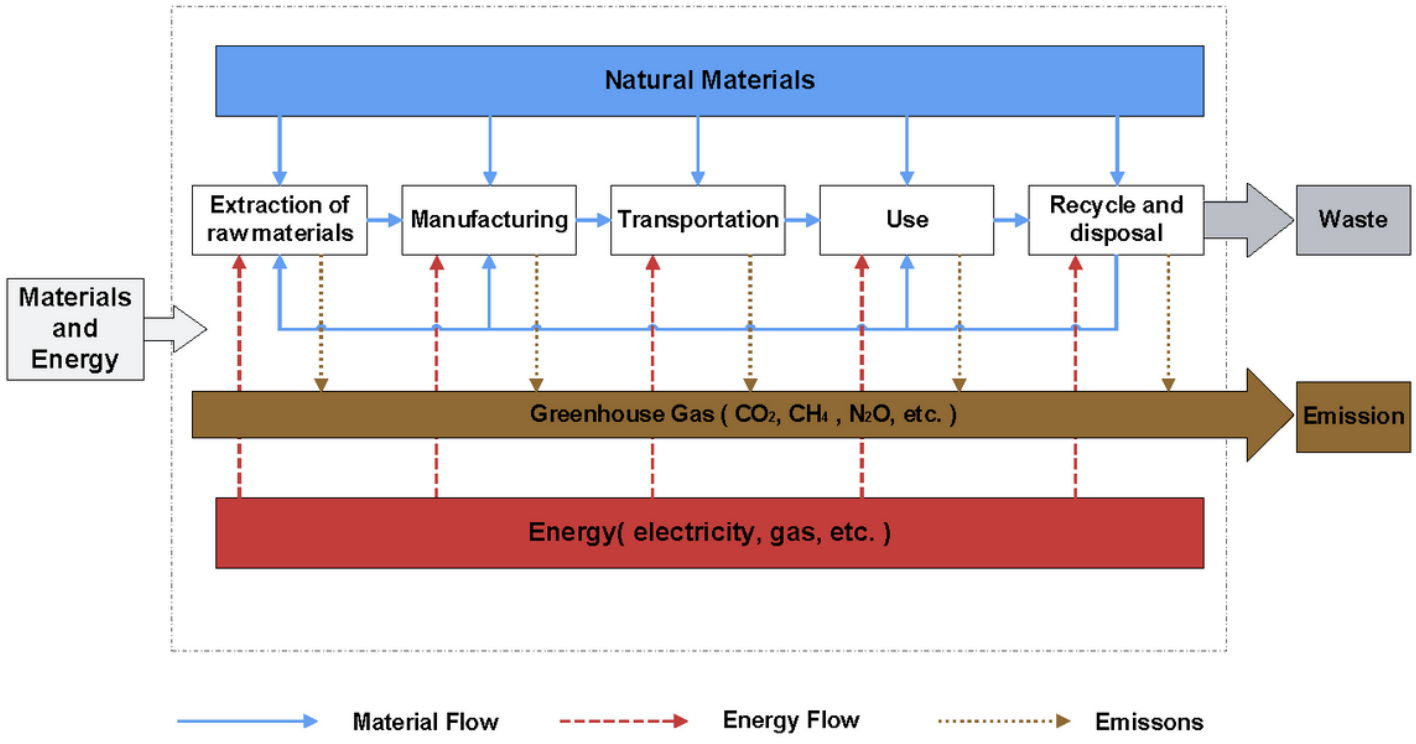

Figure 3

System boundary of product carbon footprint

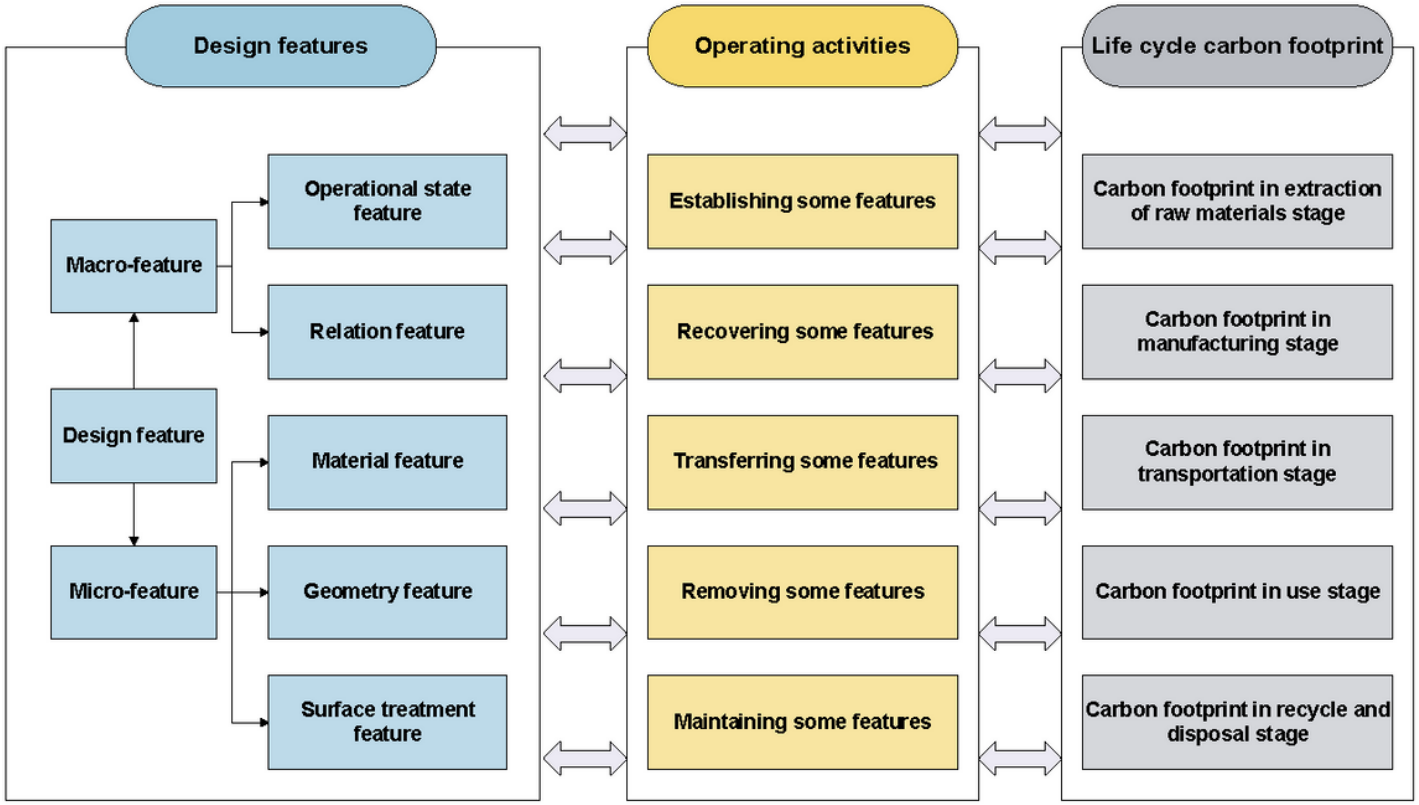

Figure 4

The mapping relation between product carbon footprint and design feature

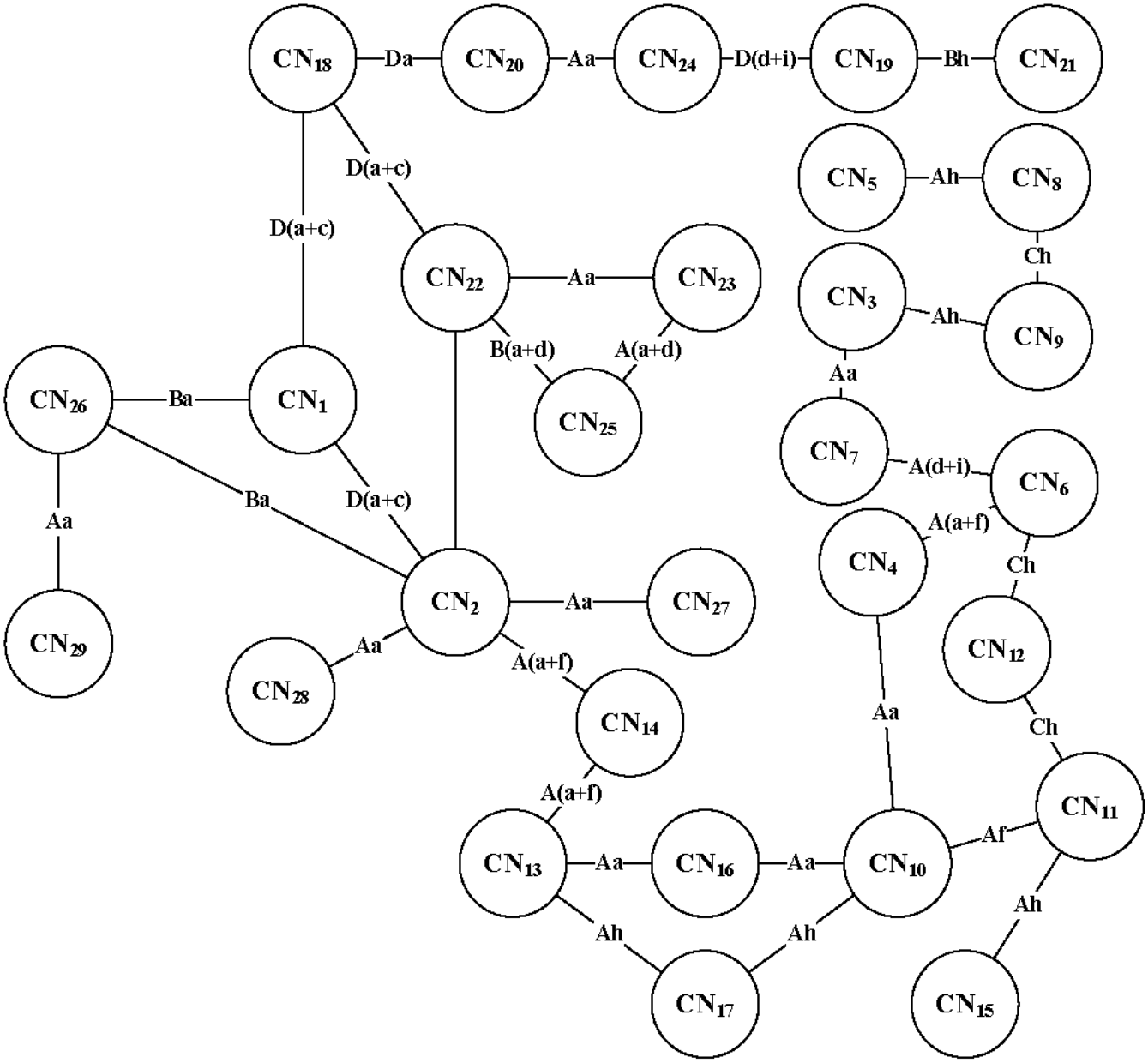

Figure 5

The relation feature of Scheme 1

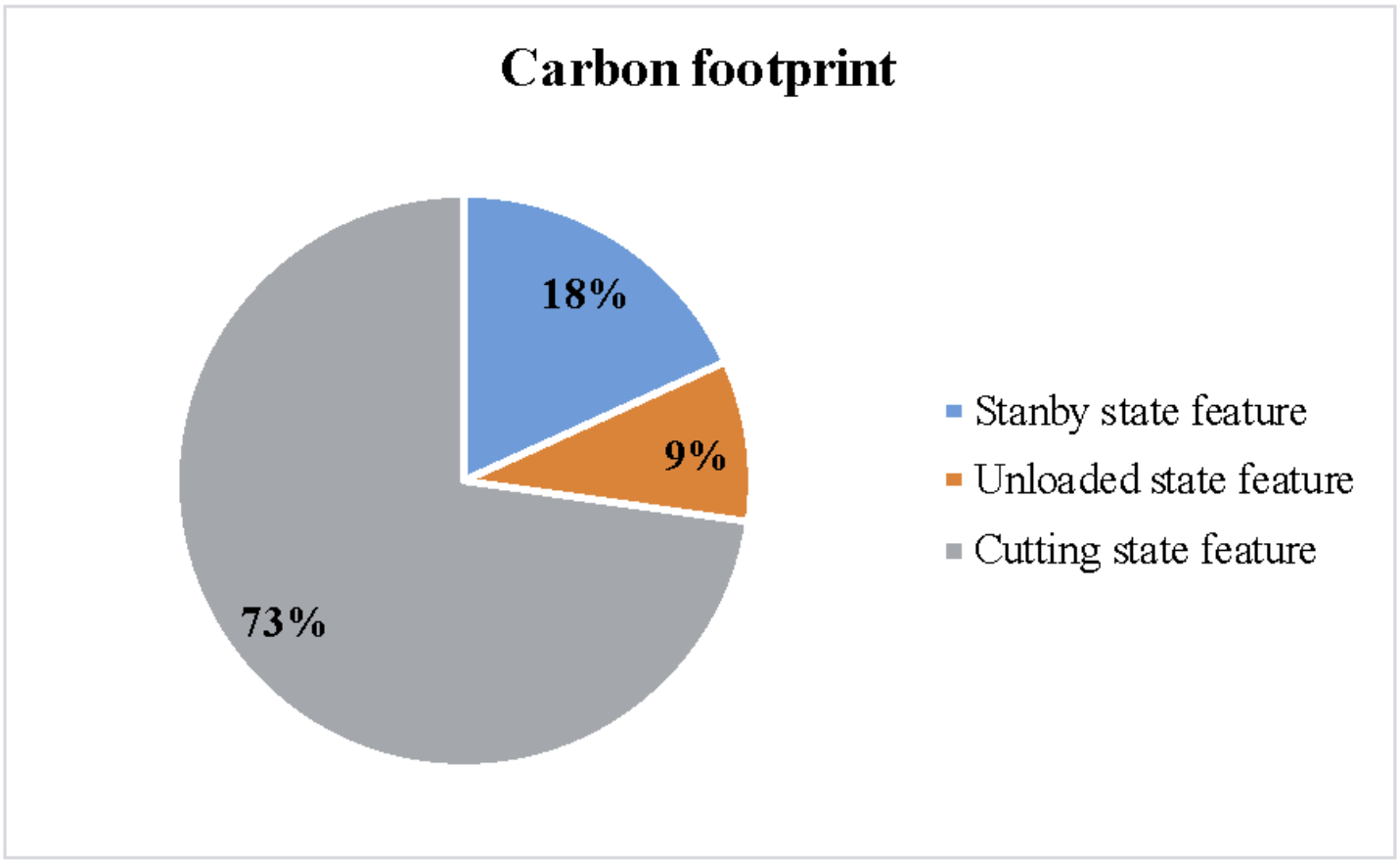

Figure 6

Carbon footprint distribution of operational feature

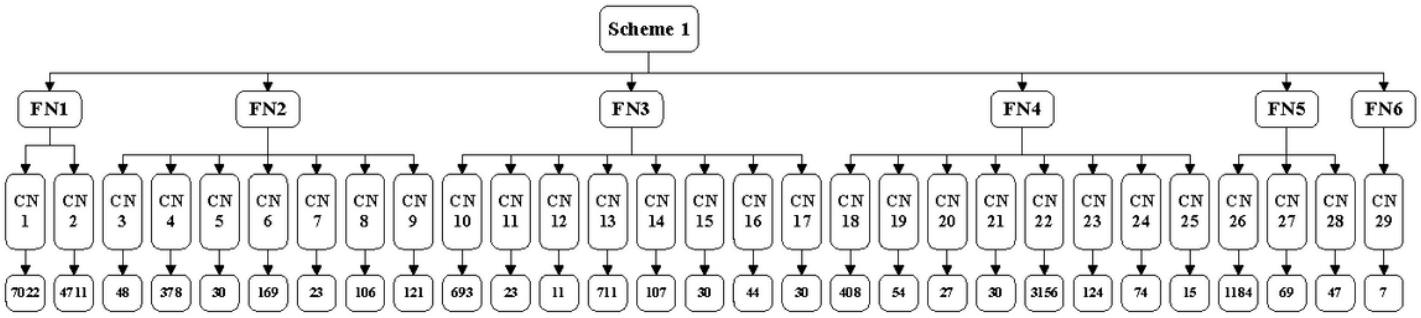

Figure 7

Carbon footprint of material feature

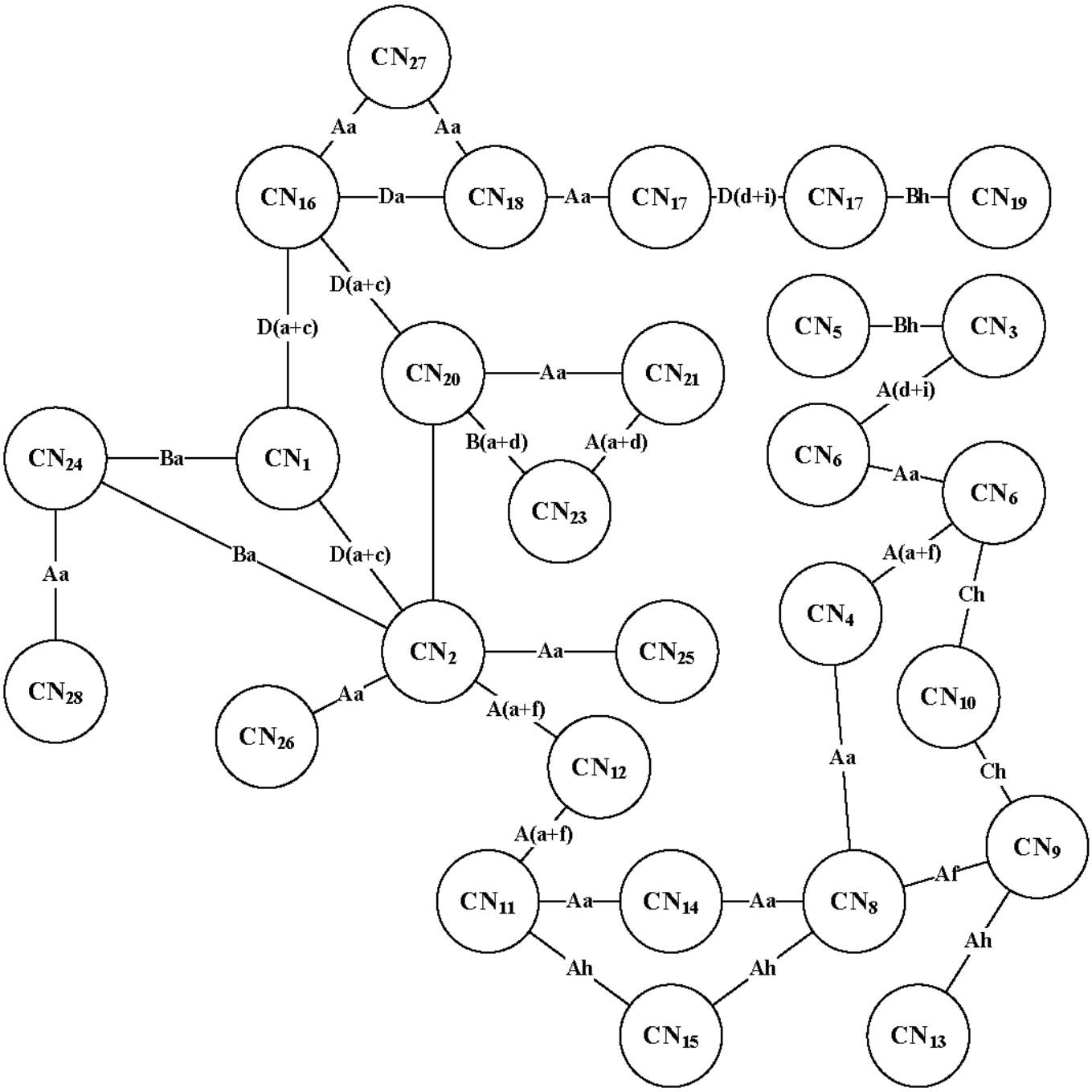

Figure 8

The relation feature of Scheme 2

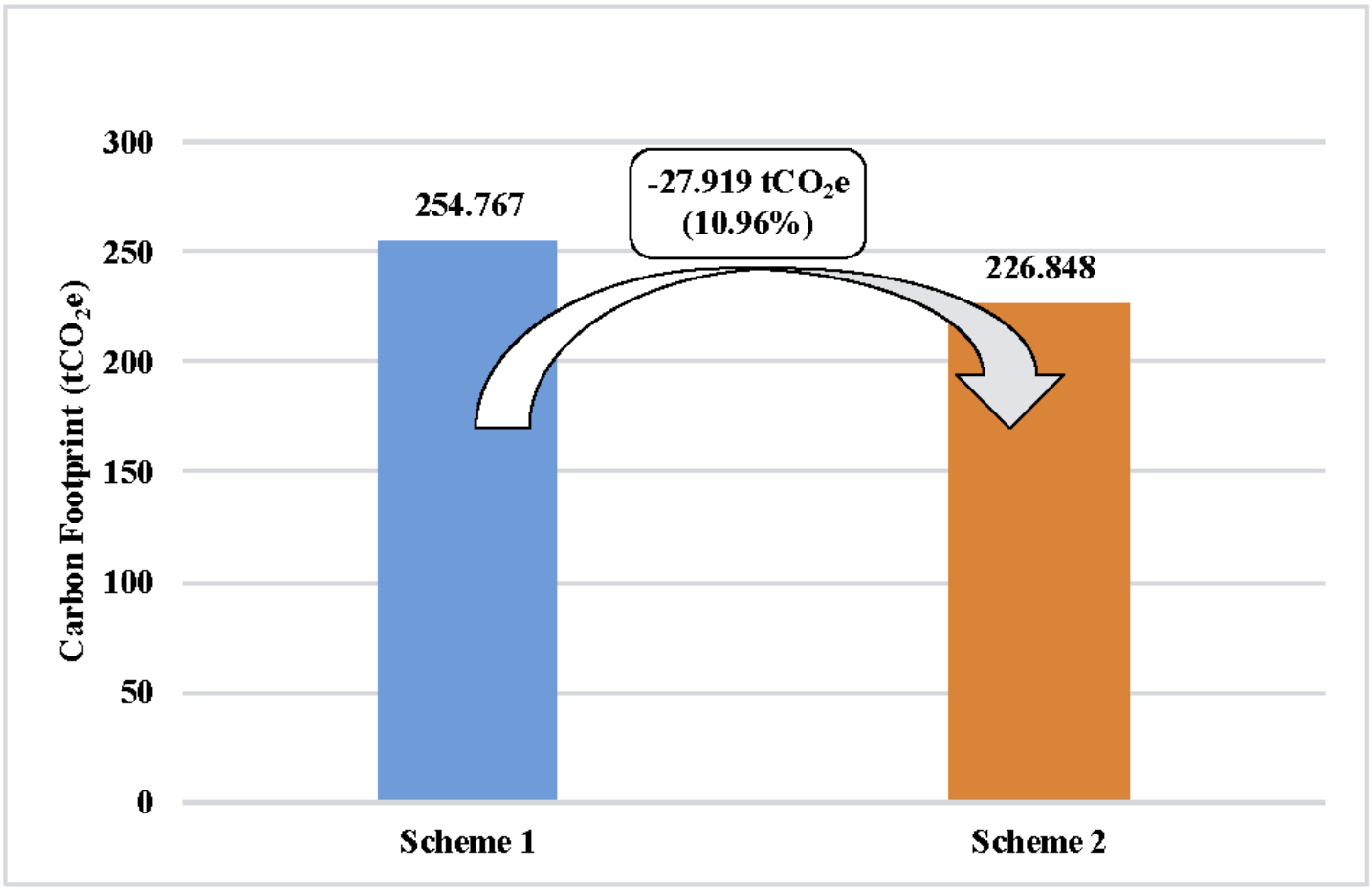

Figure 9

Total carbon footprint of two schemes

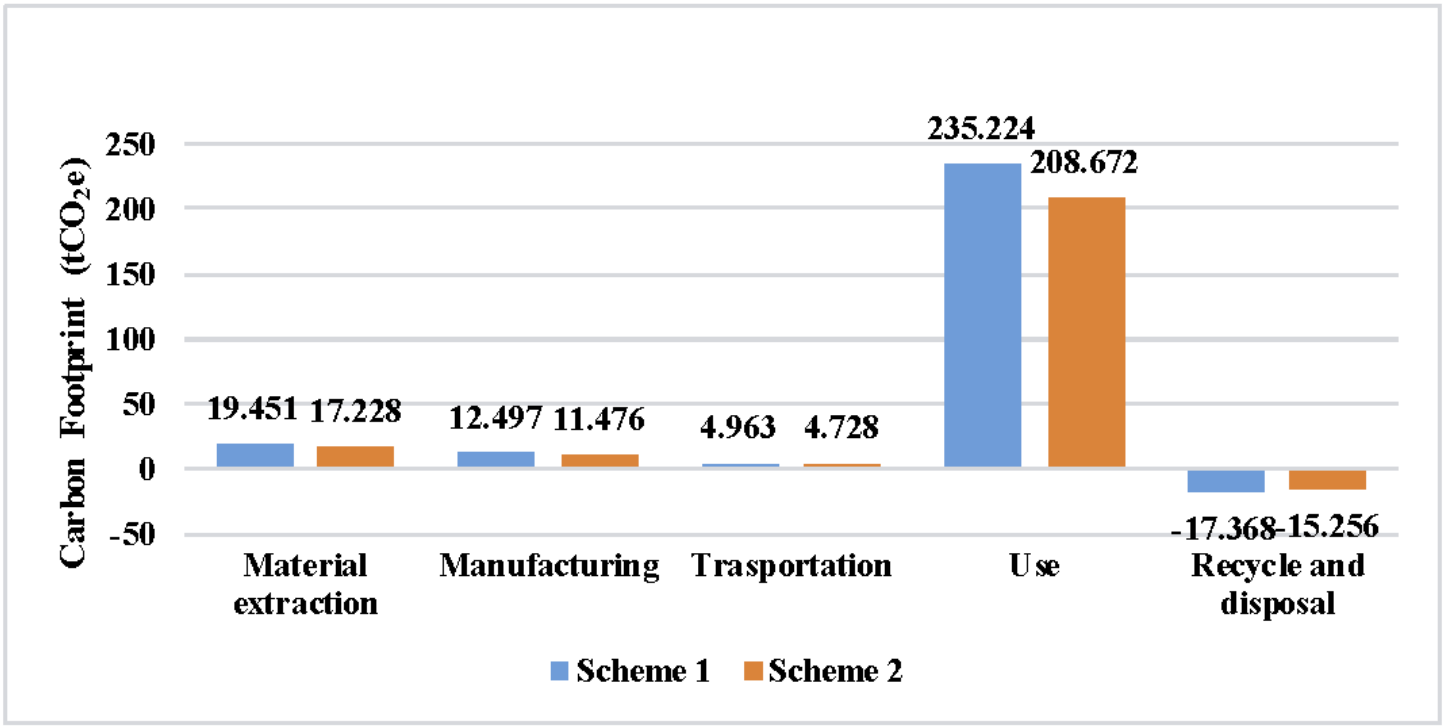

Figure 10

Carbon footprint of two schemes in different lifecycle stage

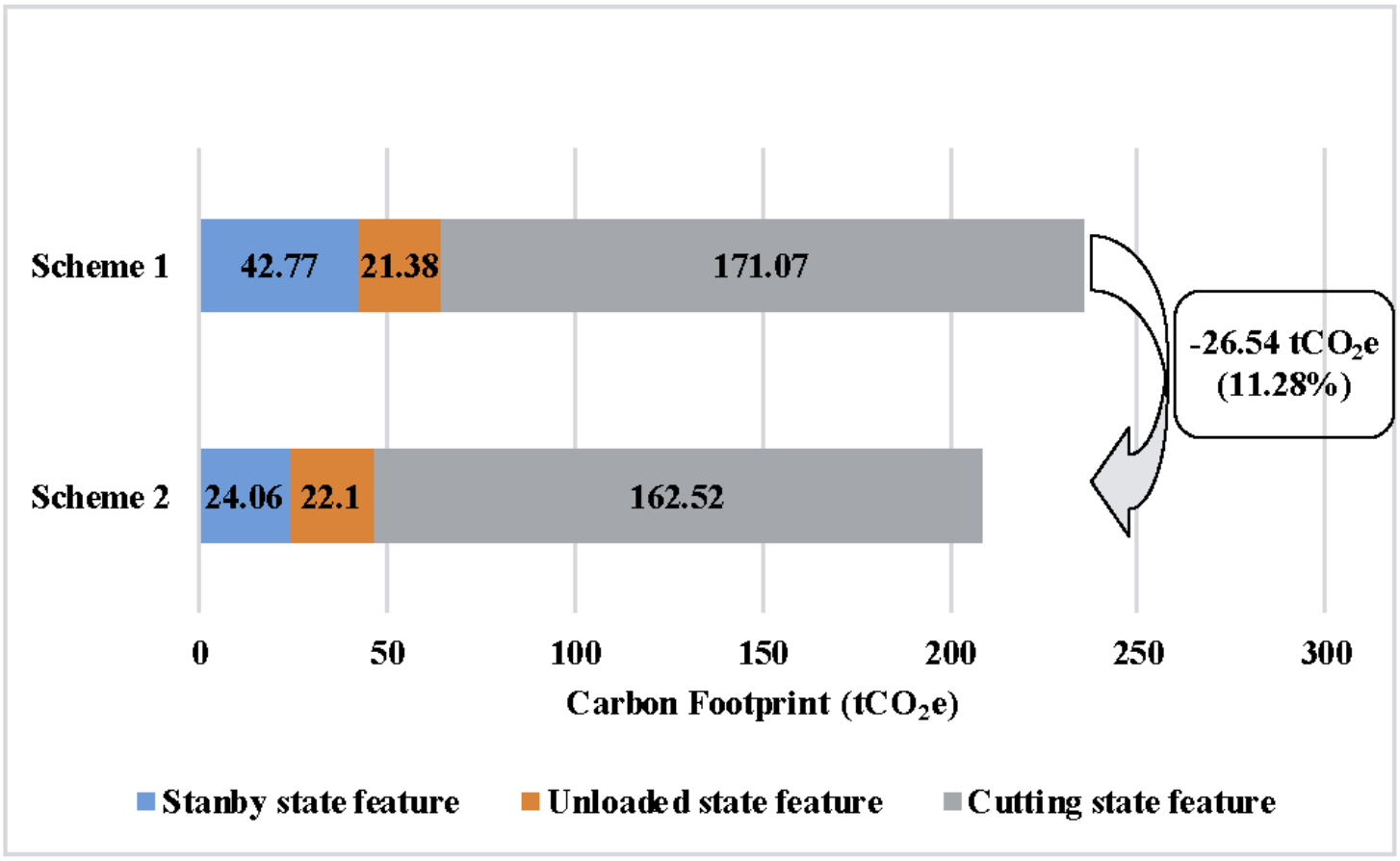

Figure 11

Carbon footprint of two schemes in use stage

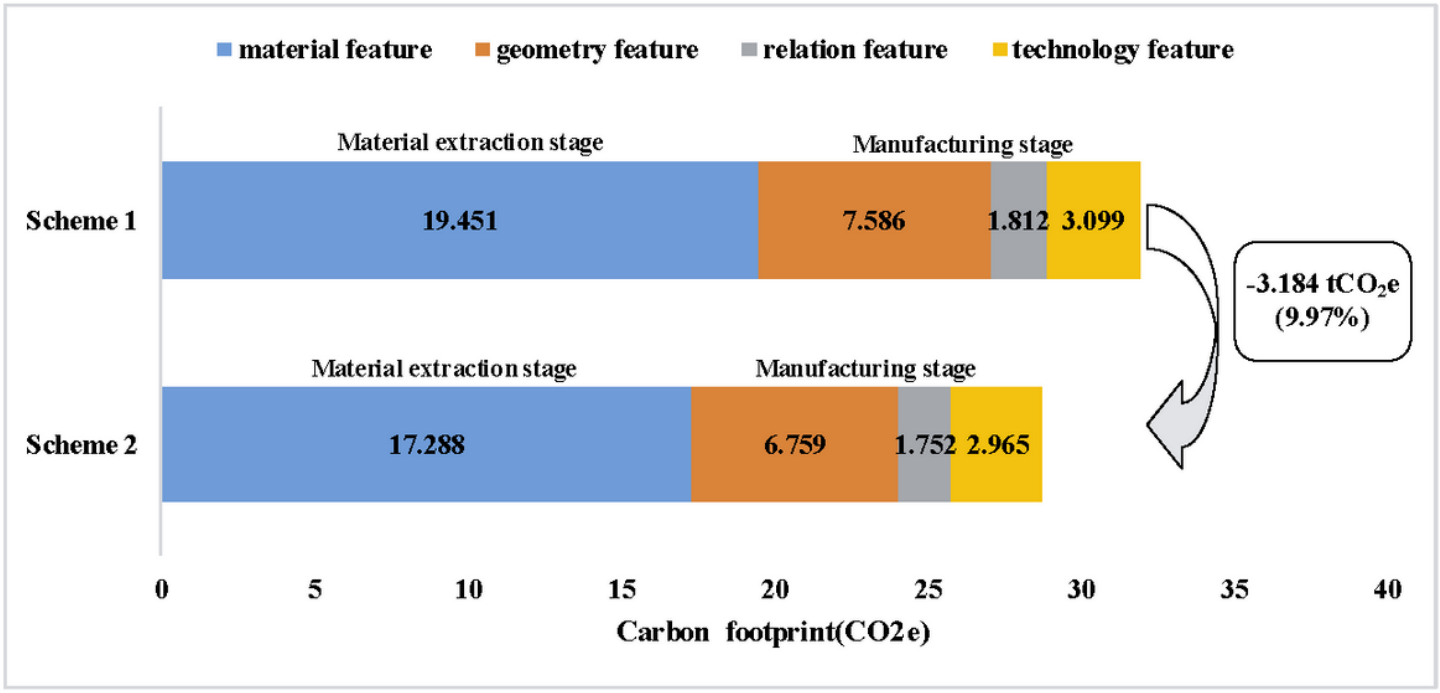

Figure 12

Carbon footprint of two schemes in material extraction and manufacturing stage