
Tracks Course: Fuel cell system (TRA105)

# Development of a life cycle inventory model of a 150kW fuel cell for use in Life Cycle Assessment

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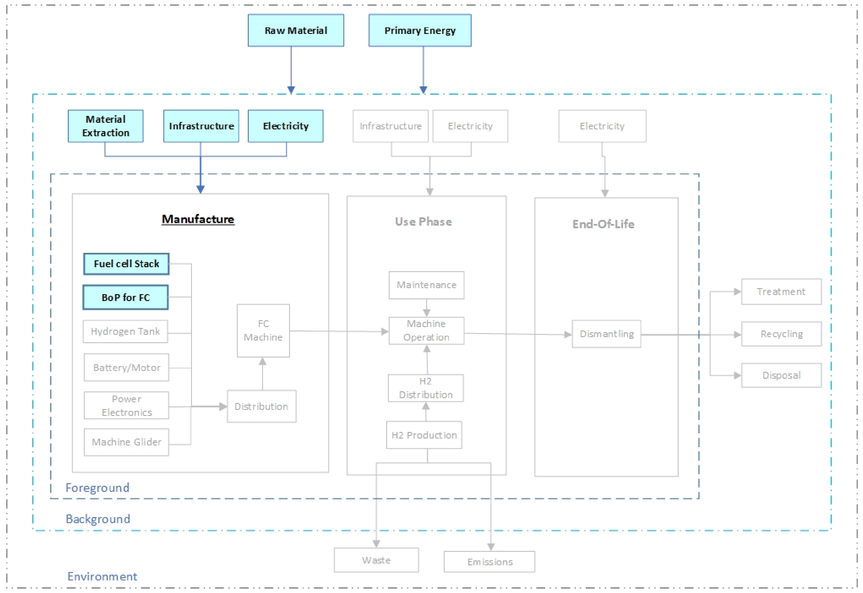
## Background

Eventhough Fuel cells offer emission free power, it is important to understand the total cradle-to-grave impacts of it to focus the research on development of materials and components used in the fuel cell which has low cost, low energy and low emissions throughout its lifetime.

## Introduction

This project focuses on the Cradle to gate analysis of a 150kW fuel cell unit to estimate the environmental impacts of the FC system, i.e. Only manufacturing of the Fuel cell and its balance of plant has been the focus of this study. System boundary diagram shown below illustrates the scope of the project

The primary impact assesment parameter analyzed in the study is Global Warming Potential (GWP) but other other parameters like Acidification Potential (AP), Fresh water Eutrophication (FWE), etc. were also considered.



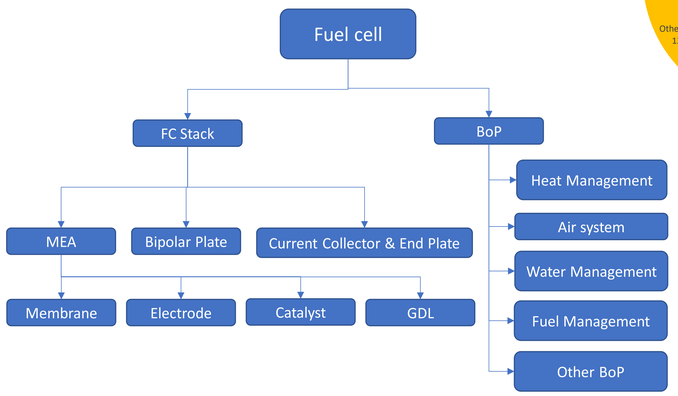

System Boundary of a fuel cell machine

## Method

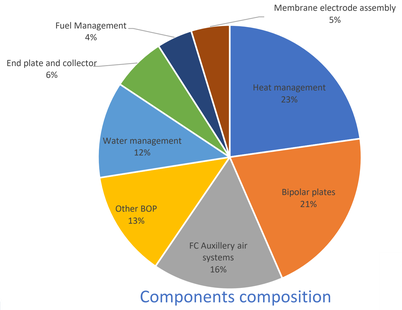
The project have used life cycle assessment method inorder to assess the environmental impact as per four stages stipulated in ISO 14040: goal and scope definition, inventory analysis, impact assessment and interpretation.

The life cycle inventory was adopted from Usai et al. (2020) and Garbe (2020). The assessment was performed using OpenLCA software using EF dataset, literatures and own assessment.

Main components and sub-components included in the table Below were used for the Life Cycle Inventory (LCI) compiled for this study.



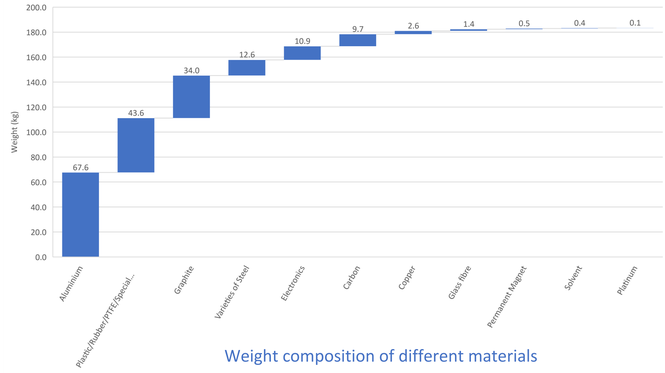

Components of the fuel cell modelled in the analysis



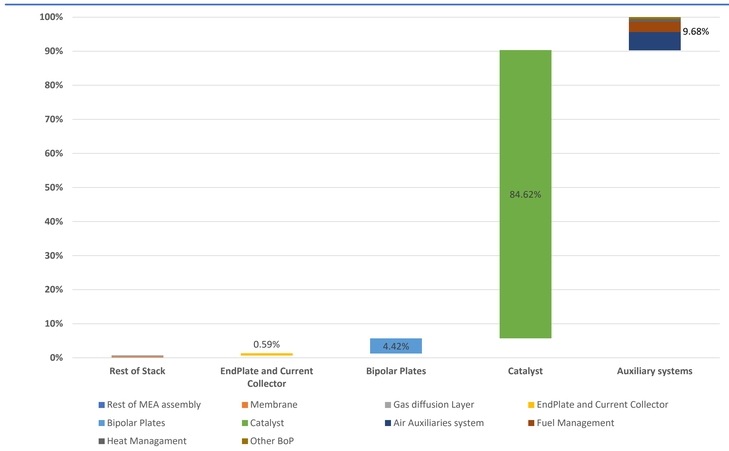

Components composition

Some components and materials were sized based on reference flows adapted to cell active area and net power output from peer reviews. While the rest were sized based on measurement of actual components and assumptions.

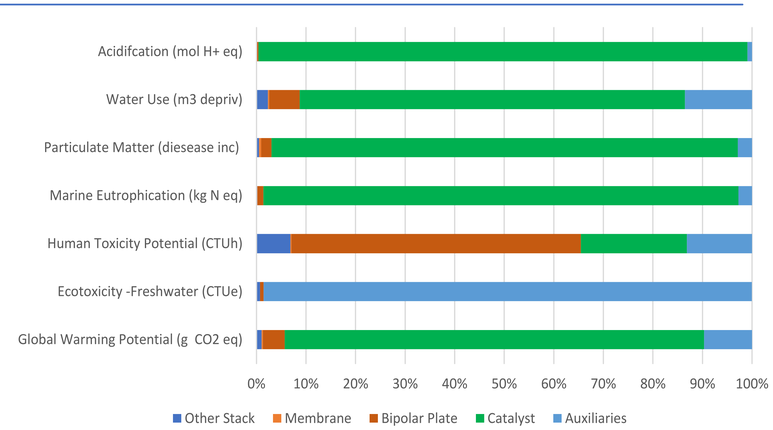
The total weight of the modeled system was 183.3kg (Excluding DCDC & Coolant). Aluminium (67.6kg)was the most used material as the housing of most components were made using it. Followed by Graphite which is used in Bipolar plates (34kg). Platinum was the least used with a total of 46g used in the catalyst.




Weight composition of different materials




Cumulative contribution to the GWP impact category of the 150kW$_{net}$ FC system.




Contribution Analysis for the impact category of the 150kW$_{net}$ FC system.

## Discussion

A total of 3760kgCO2eq was generated by the production of fuel cell and its auxiliaries. Production of platinum used in the catalyst contributed to 84.6% of the total emissions followed by the auxiliary components (9.68%) and Bipolar plates (4.42%) primarily by its main ingredient Graphite. The GWP impact was on par or lower than preceding studies.

Apart from Human Toxicity Potenial and Freshwater Ecotoxicity, production of catalyst (Platinum) contributed the most in majority of the impact categories.

## Conclusion

Platinum was one of the least used material but contributed the most in majority of the impact assessments followed by Bipolar plates and auxiliary / balance of plant.

Steps need to be taken to minimize the use of Platinum in catalyst or use recycled Platinum which require lower energy requirements.

More detailed and accurate information on the components and its manufacturing procedure is needed to accurately predict the impacts for each components.