Formulation and Testing of a Commercially viable Bio-coal recipe from Biomass as clean fuel for Heritage Rail Sector

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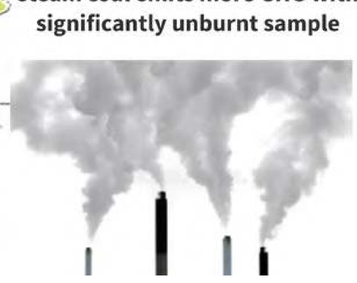
Abstract

An alternatiive fuel made from non-fossil coal that powers steam trains in the Heritage sector and other heavy duty industrial sector like steel is possible, to reduce pressure of GHG on earth.

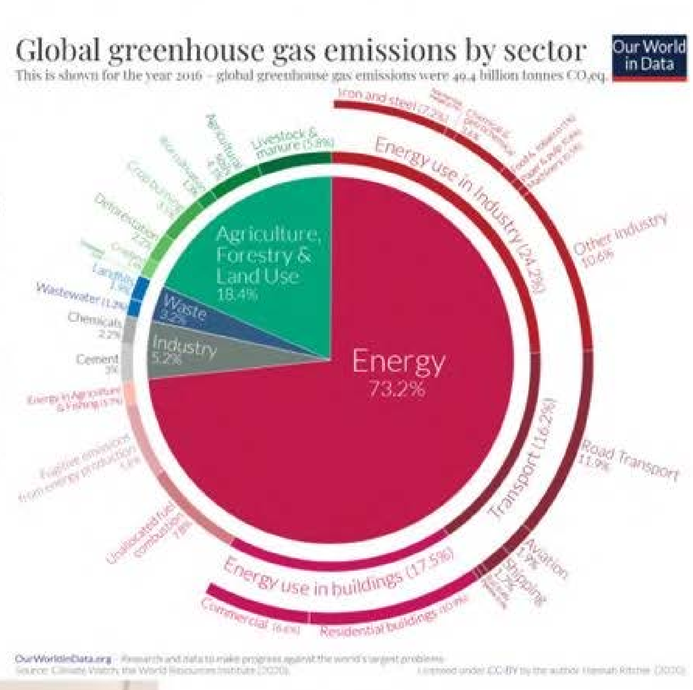
Statistical analysis of bio-coal data reveals less GHG emission, steam coal emits more GHG with significantly unburnt sample



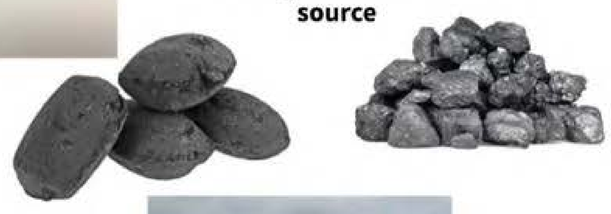
These research presents a viable alternative to the steam coal for the UK Heritage rail sector and aligns with the UK net zero target by 2050[1] nationally and globally.

Introduction

Energy use from the trio sectors of industry, transport and buildings contribute almost 75% of the global greenhouse emission... see the global greenhouse gas emission by sector pie chart[2].

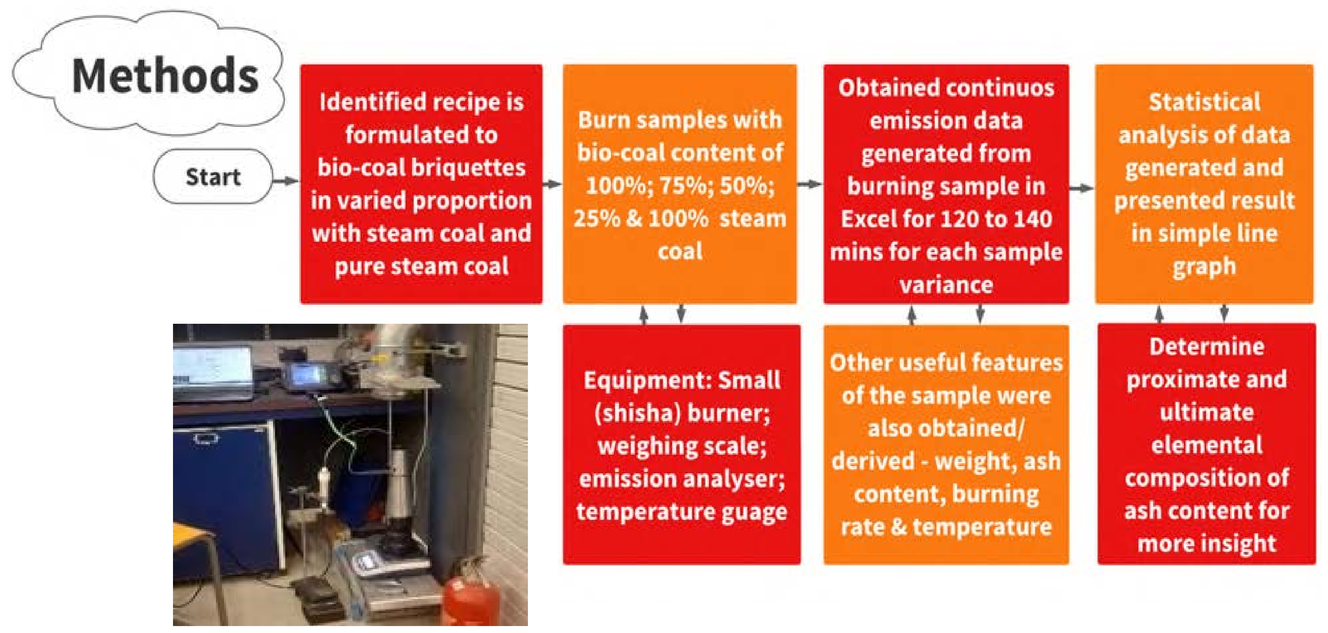


To maintain the long-standing legacy of the Heritage rail for the UK people and the world, it needs to identify and start using alternative source

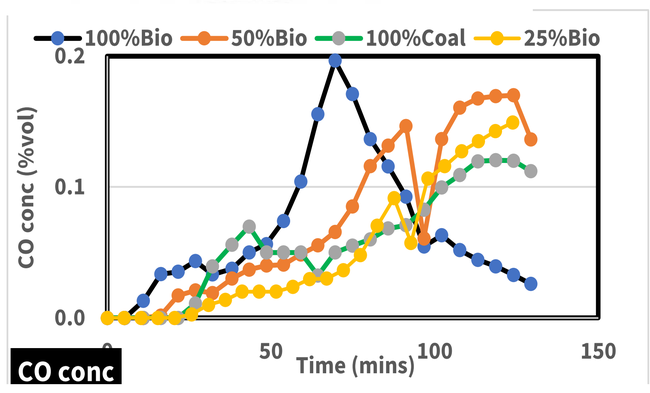


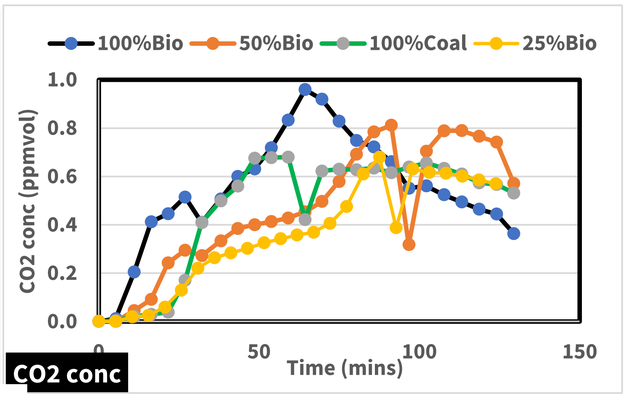
Similar studies were done by Otieno et al[3], Ajimotokan et al[4] and Tumutegyereize et al[5] on different bio-coal recipes while Hussain et al[6] presented feedstock as a solution to greenhouse emission.

Methods



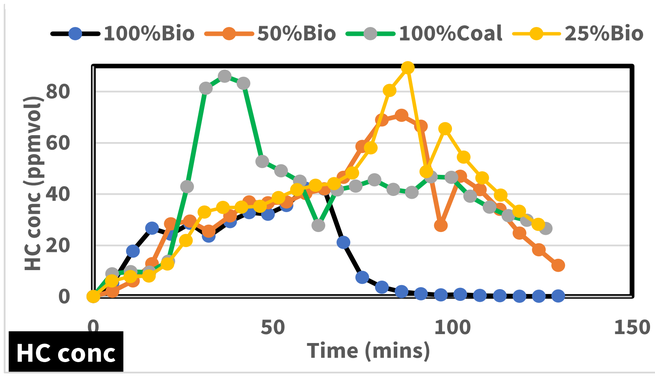
Preliminary Results and Discussions

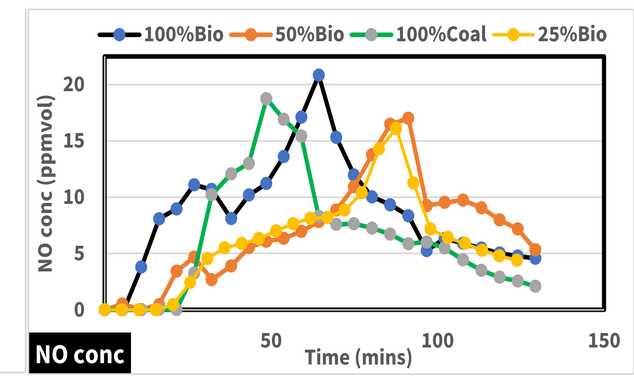




1. The CO emission in 100% bio-coal showed an early peaking in the first hour before declining while the other variant continues to rise within the 120 mins test period

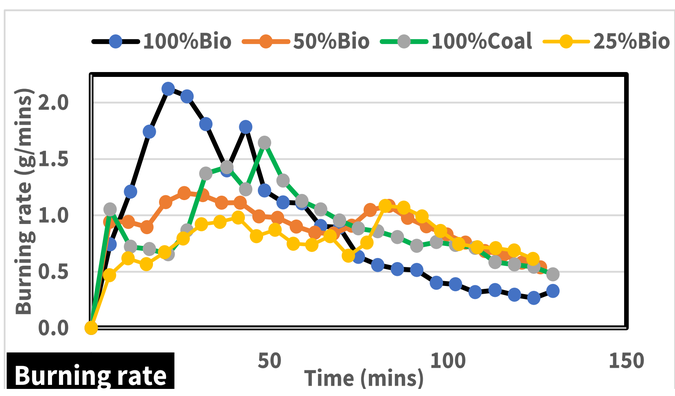
2. The CO2 showed a similar trend, indicating the high volatility of the 100% bio-coal when compared to the other variants

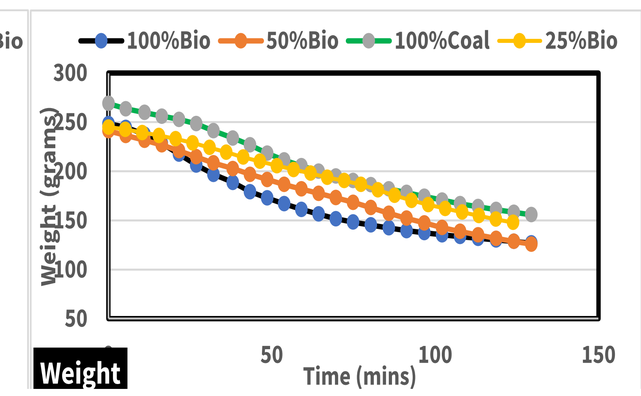




3. The 100% bio-coal produces a significantly less hydrocarbon which is expected of a non-fossil fuel

4. The NO for the 100 bio-coal appears to be relatively high, however this can be controlled when used





5. As projected, the burning rate of the 100% bio-coal is higher in the early stage and tends to burn quickly with higher percentage of ash contents up to 30% of the initial weight unlike other variant with ash contents less than 10%

6. Weight loss in 100% bio-coal sample is reflective of the burning rate and amount of ash content produced within the same test duration for other variant also indicating its high volatility.

The novelty of this research is the solution it provides for the Heritage rail sector which currently does not have an alternative to the traditional coal. It closes the gap of previous research on bio-coal as alternative energy for cooking and other domestics purposes. The statistical analysis shows interesting and promising outlook for implementation in the Heritage rail sector, gradually eliminating the use of coal, most of which it currently imports, thereby increasing the carbon footprint [7]. With the UK policy on coal sites, in support of its net zero agenda, bio-coal becomes a viable options for all other industrial sector in the near future.

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References:

1. Net zero strategy: Build back greener. (2021, October 19). Gov.uk.
2. (N.d.). Climatewatchdata.org.
3. Otieno, A. O.,Home, P. G., Raude, J. M., Murunga, S. I., & Gachanja, A. (2022).
4. Ajimotokan,H.A.,Ehindero,A.O.,Ajao,K.S.,Adeleke,A.A.,Ikubanni,P.P.,&Shuaib-Babata,Y.L. (2019)
5. Tumutegyereize, P., Mugenyi, R., Ketlogetswe, C., & Gandure, J. (2016).
6. Hussain, T., You, Z., Shah, K. J., & Tripathi, S. (2022).
7. Hewitt, S. (2020, April 3).

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