LOCATION PLANNING TOOL FOR BIOMASS BOILERS

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Degree of Master of Engineering

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DECLARATION

This report contains no material which has been accepted for the award of any other degree or diploma in any University or equivalent institution in Sri Lanka or abroad, and that to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference is made in the text of this report.

I carried out the work described in this report under the supervision of Dr. Himan Punchihewa.

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Name of Supervisor : Dr. H.K.G. Punchihewa.

Abstract

Steam boilers constitute an important part of a production facility. Though traditionally, fossil fuel has been used predominantly in steam boilers, the environmental impacts of using fossil fuel and the higher economics have fuelled exploration on alternative fuels such as biomass and in 2016 demand for biomass energy in Sri Lanka has been 194.3 PJ out of which 75.8 PJ has been industry demand which is an increase of 300 TJ compared to previous year.

In light of above, this study has been carried out with the aim of mitigating the environmental impacts of using biomass as a fuel for boilers in Sri Lanka and to improve related economics by developing a location planning tool for biomass boilers & with the objectives of assessing factors that would govern the environmental and financial costs associated with the operation of a steam boiler with respect to heavy oil and biomass variants leading to proposing of a framework to rank the fuel variants based on environmental performance and finances.

Methodology followed in this study was carrying out a life cycle assessment (LCA) to assess the environmental loads of each biomass variant in context via data collected in surveys and analysing reports of 60 steam boilers followed by comprehensive financial analysis and sensitivity analysis enabling comparison of relative contribution of each step in the process.

It was identified due to extremely adverse impact of using fossil fuel, using biomass where sustainable has become the best alternative regardless the location of the boiler and subsequent distance from biomass source to the application, in Sri Lankan Context, consequently the threshold points for switching to biomass lie in the economic factors as cost of transportation dominates whether the process is feasible. Sawdust was identified as the most environmentally friendly fuel followed by wood chips, wood logs and husk respectively. Distances from wood log, husk, wood chip, and sawdust biomass sources to the point of application to equal the financial cost of heavy oil-based boiler operation were identified as 530 km, 554 km, 595.5 km and 604 km respectively. It was identified, ranking order of financial performance of fuels, toggle along with distance from respective biomass source to point of application, such that a fuel more feasible compared to another at similar relatively lower distance from fuel source to point of application would not necessarily be so at higher similar distances. Though husk usage is costlier than sawdust at relatively smaller distances, at similar distances over 140 km from respective fuel source to point of application, sawdust becomes the more viable fuel. Similarly, chips usage though expensive at relatively lower similar distances equivalent to other biomass variants, becomes more viable compared to husk and wood logs at similar distances over 460 km and 355 km respectively.

Precise data on biomass sources in Sri Lanka are lacking and taking measures to develop a biomass resources map would contribute to location planning process of biomass boilers favourably and streamline supply chain process.

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List of Abbreviations

CEB	Ceylon Electricity Board
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
GHG	Greenhouse gas
ISO	International Organization for Standardization
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
N_2O	Nitrous oxide
NMVOC	Non-methane volatile organic compounds
UK	United Kingdom
USA	United Stated of America
kWh	kilowatt hour
GWh	Gigawatt hour
kt	kilo tonne
MT	Metric tonne
kCal	kilo Calorie
ha	Hectare
LKR	Sri Lanka rupee
Ltr	Litre
MJ	Megajoule
TJ	Terajoule
PJ	Petajoule
PM	Particulate matter