Environmental performance of grate furnace and fluidised bed furnace systems to produce electricity from forest biomass residues

Paula Quinteiro, Tamíris Pacheco da Costa, Luís Tarelho, Luís Arroja, and Ana Cláudia Dias
Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, University of Aveiro, 3810-193 Aveiro, Portugal
E-mail contact: **tamiris@ua.pt**

LiSAT Life Cycle Based Sustainability Assessment Tools Team

Introduction and objective

Electricity production from forest biomass residues has the potential to significantly contribute to Portuguese power mix with lesser environmental impact than non-renewable resources. In Portugal, the annual production of forest biomass residues from logging activities is estimated at 0.8-1.2 million dry tonnes per year, and about 47-58% of these residues come from eucalypt [1].

In this country, fluidised bed furnaces is the technology most used for the combustion of forest biomass residues (11 plants in operation with an installed capacity of 298 MW), followed by grate furnace (9 plants in operation with an installed capacity of 155 MW) [2].

Therefore, the comparison of environmental performance of alternative combustion technologies become imperative to support decision making. This can be performed by using life cycle assessment (LCA) methodology.

The aim of this study is to assess the environmental impacts, by means of LCA, of electricity production from forest biomass residues, considering; a) three different types of supply chains at the collection, processing and transportation stage and b) two different combustion technologies (grate furnaces and fluidised bed furnaces) at the energy conversion stage.

Methodology

- **Functional unit:** 1 kWh of electricity delivered to the Portuguese grid.
- **System boundaries:** include six scenarios shown in Figure 1.

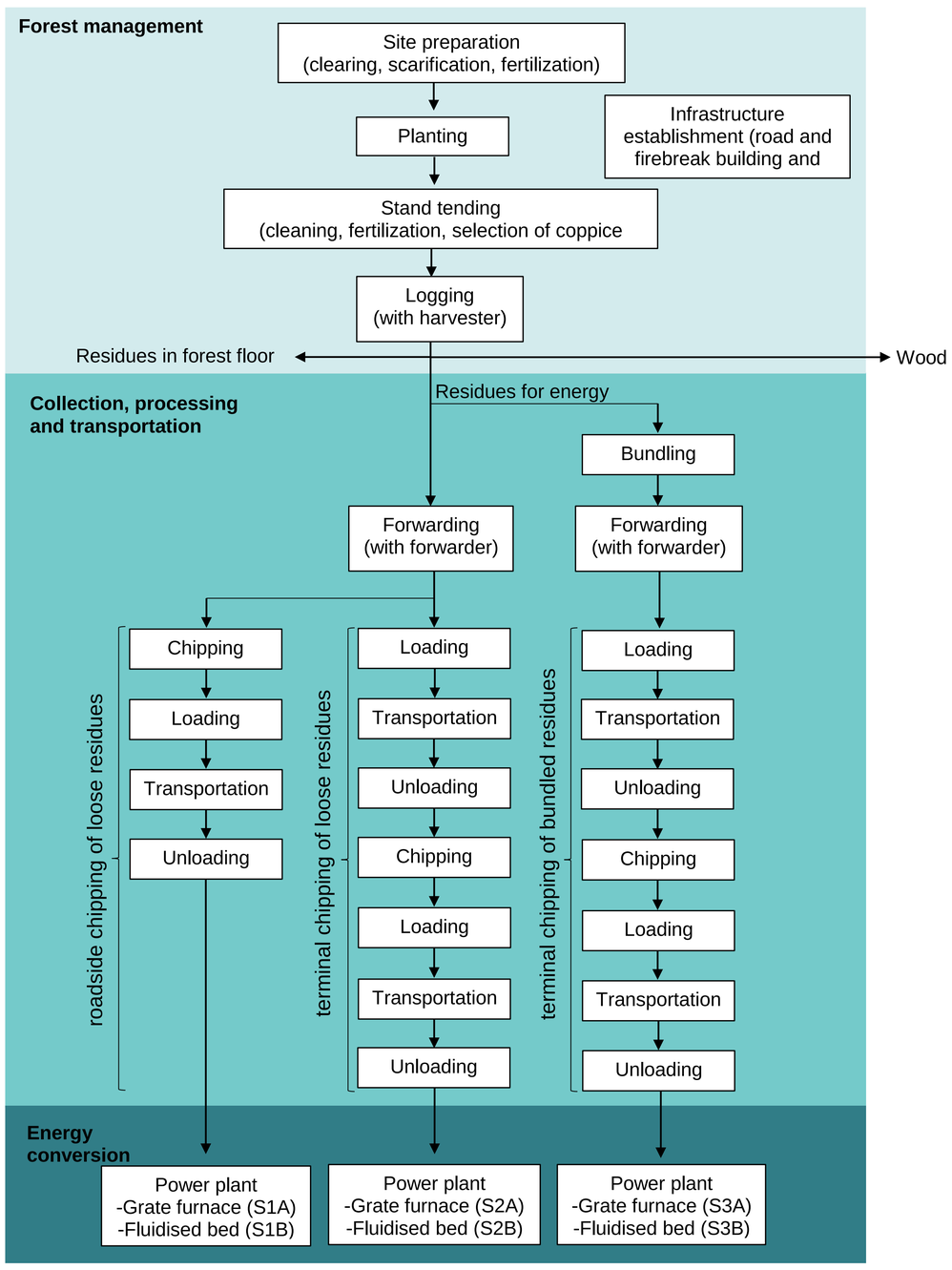

Figure 1. System boundaries.

- **Impact assessment method**: International Reference Life Cycle Data System (ILCD) [3].
- **Allocation:** in the forest management stage based on the mass of co-products.

Results

Figure 2. Environmental impact assessment results associated with each stage of the production of 1 kWh of electricity from the combustion of forest biomass residues.

Conclusions

For all impact categories analysed (Figure 2), the forest biomass supply chain to produce electricity with smaller impacts is the one in which the logging residues are collected and chipped at the roadside (S1A and S1B scenarios), due to a lower diesel requirement in transport and loading/unloading operations.

Regarding the combustion technologies, the fluidised bed furnace has a better environmental performance than grate furnace (S1B, S2B and S3B) in all impact categories, indicating that this technology can be a good alternative, from an environmental perspective, for implementing new power plants in Portugal.

References

[1] Viana, H., Cohen, W.B., Lopes, D., Aranha, J., 2010. Assessment of forest biomass for use as energy. GIS-based analysis of geographical availability and locations of wood-fired power plants in Portugal. Appl. Energy 87, 2551-2560
[2] E2p, 2017. Energias endógenas em Portugal. URL http://e2p.inegi.up.pt/?Lang=PT#Tec2 (accessed 20.01.2020).
[3] EC/JRC/IES, 2010. International Reference Life Cycle Data System (ILCD) Handbook – General guide for Life Cycle Assessment - Detailed guidance. European Commission, Joint Research Centre and Institute for Environment and Sustainability. Luxembourg.

Acknowledgements

This study was supported by the projects SABIOS (PTDC/AAGMAA/6234/2014) and SustainFor (PTDC/AGR-FOR/1510/2014), both funded under the project 3599-PPCDT by FEDER through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI) and by national funds (OE) through FCT/MCTES. Thanks are due to FCT/MCTES for the financial support to CESAM (UIDP/50017/2020+UIDB/50017/2020) through national funds. Thanks are also due to FCT/MCTES for contracts granted to Paula Quinteiro (CEECIND/00143/2017) and Ana Cláudia Dias (CEECIND/02174/2017).

cesam universidade de aveiro centro de estudos do ambiente e do mar
FCT Fundação para a Ciência e a Tecnologia MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR
COMPETE 2020
PORTUGAL 2020
UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional