CIEEMAT`22

CIEEMAT 2022
VII Ibero-American Congress on Entrepreneurship, Energy, Environment and Technology

Book of Abstracts

6-8 July 2022
Bragança, Portugal

ipb INSTITUTO POLITÉCNICO DE BRAGANÇA

CEFET/RJ

CeDRI

CIMO Centro de Investigação de Montanha

SUSTEC Associate Laboratory for Sustainability and Technology in Inland Regions

CIEEMAT 2022 - VII Ibero-American Congress on Entrepreneurship, Energy, Environment and Technology
Book of Abstracts

6-8 July 2022

Editors

Ângela Ferreira, Instituto Politécnico de Bragança
Carla Sofia Fernandes, Instituto Politécnico de Bragança
Florbela Fernandes, Instituto Politécnico de Bragança
Luís Pais, Instituto Politécnico de Bragança

Instituto Politécnico de Bragança – 2022
Campus de Santa Apolónia
5300-253 Bragança, Portugal

ISBN: 978-972-745-305-4

Book Cover: Soraia Maduro, Instituto Politécnico de Bragança

ABOUT THE EVENT

The VII Ibero-American Congress on Entrepreneurship, Energy, Environment and Technology (VII CIEEMAT), coordinated by the Federal Centre of Technological Education from Rio de Janeiro (CEFET/RJ), was held for the third time in Portugal, and for the second time in the city of Bragança, under the organization of the Polytechnic Institute of Bragança (IPB), the Research Centre in Digitalization and Intelligent Robotics (CeDRI), the Mountain Research Centre (CIMO) and the Associated Laboratory for Sustainability and Technology in Inland Regions (SusTEC). The event aims to consolidate the Luso-Brazilian and Ibero-American cooperation in those areas, gathering the multinational contribution and enhancing collaboration in academic and scientific fields.

The VII CIEEMAT took place on July 6-8, 2022 and had the Energy Transition as its specific theme.
The current energy context and the transition of energy generation and consumption typologies are unavoidable in defining the profiles of national and international societies and energy policies. The dynamism to which the energy sector is currently subjected is imposed by environmental and safety concerns, the fluctuation of the fossil fuels price and shifting technologies, which translates into challenges and opportunities across various sectors as research and innovation, education, policy and environmental governance. The opportunities and challenges of the energy transition are outlined, for instance, in the exploitation of natural assets, the decarbonisation of the economy and the transport sector and the flexibility of energy infrastructure through smart grids.

The VII CIEEMAT followed a program addressing various perspectives of action of higher education institutions and R&D units and their cooperation with society: i) the academic perspective (why, what and how to teach the challenges of energy transition); ii) the perspective of international cooperation, defining new cooperation programs between Portugal and Brazil in the energy field, with emphasis on the Brazilian EnergIF program and its potential for international cooperation with Portugal; iii) and the research and innovation perspective, with the contribution of academic experts and the business sector regarding the challenges that the necessary and emerging energy transition poses.

At the same time, the VII CIEEMAT provided also a forum to disseminate and share ongoing research in various academic and scientific institutions, through oral communications in the areas of sustainable urban mobility, energy generation and self-consumption, environmental challenges, decarbonisation and climate change.

COMMITTEES

Organizing Committee
Luís Pais, IPB
Marco Juliatto, SETEC-MEC
Ronney Boloy, CEFET/RJ
Ângela Ferreira, IPB
Artur Gonçalves, IPB
Carla Sofia Fernandes, IPB
Florbela Fernandes, IPB
João Azevedo, IPB
José Luís Lima, IPB
Ana Carolina Lima, IPB

Scientific Committee
Ana Queiroz da Silva, IPB, Portugal
Ângela Ferreira, IPB, Portugal
António Castro Ribeiro, IPB, Portugal
António Valente, UTAD, Portugal
Arlindo Ferreira de Almeida, IPB, Portugal
Artur Gonçalves, IPB, Portugal
Carla Fernandes, IPB, Portugal
Daniel de Cerqueira Santos, IFPE, Brasil
Florbela Fernandes, IPB, Portugal
Gabriel Pinto, UMinho, Portugal
Gardênia Mendes de Assunção, CEFET/RJ, Brasil
Ian Mateo Sosa, ITSON, México
João Azevedo, IPB, Portugal
João Miranda de Castro, IPB, Portugal
José Luís Lima, IPB, Portugal
Laene Oliveira Soares, CEFET/RJ, Brasil
Laíce de Souza Scotelano, CEFET/RJ, Brasil
Luis Hernandez Callejo, UVa, Espanha
Manuel Sabença Feliciano, IPB, Portugal
Marcos Vallim, UTFPR, Portugal
Margarida Arrobas Rodrigues, IPB, Portugal
Orlando Soares, IPB, Portugal
Paulo Brito, IPB, Portugal
Paulo Cicero Fritzen, UTFPR, Brasil
Ronney Boloy, CEFET/RJ, Brasil
Sara Paiva, IPVC, Portugal
Thiago Machado Bazzo, UTFPR, Brasil
Vanessa de Almeida Guimarães, CEFET/RJ, Brasil

CONTENTS

Wind Turbine Blade Waste: A Quantifying Model

Lucas Lisboa[1] [0000-0002-0255-4862], Luís Frölén Ribeiro[1,2] [0000-0003-4336-6216]
[1] Instituto Politécnico de Bragança, Portugal
[2] INEGI-LAETA, 4200-465 Porto, Portugal
a46705@alunos.ipb.pt; frolen@ipb.pt

Abstract

The growing trend of renewable energy, while helping decentralise and diversify the current energetic matrix, may also bring opportunities for improvement. Until today, a vital part of the wind turbine does not have a solidified disposal method in its afterlife. To better assess this issue, one needs to quantify it. A model based on actual wind turbine data enabled high accuracy estimation of the existing waste and predicted what will be generated in the industry's future.

Between 2000 and 2014, the wind was the type of energy that registered the most considerable growth – not just among the renewable, but overall (15% more than second-placed gas) [1]. In the current European Union's plan to achieve net-zero emissions in its energy system by 2050, wind energy will play a relevant role: it expects a continuously grow in installed capacity of 17% until 2025, followed by a 12% one by 2030 [2]. However, what environmental impact can this measure and similar ones induce?

Most wind turbine composition is from recyclable materials (94%); the issue lies in the remainder: the blades, mostly made of composites and resins – challenging to recycle materials [3].

One must take a step back and analyse some data to understand better how much of a concern it can become in the following years. In this paper, one analysed 357 distinct accurate wind turbine blade models from different manufacturers with rated power from 65 kW to 14 MW to attain enough data to create a model to predict the future waste generated by decommissioned wind turbine blades. The primary source of technical information was obtained through a wind turbine model database [4].

As a result, one developed a model to predict with a high resolution – compared to similar works from several authors – what the future holds regarding wind turbine blade waste.

Instead of plotting all the data points in a scatter graph and using the resulting trendline to calculate an equation based on linear regression, the rated power range was divided into 10 intervals to offer a better resolution, Figure 1.

One used a data set published by Wind Europe [5] as an exercise in the practical use of this model. In it, we have the total output of offshore wind turbines installed in Europe between 1995 and 2022. By applying the median (to filter outliers in the data) results seen on each rated power interval in Figure 2 to the number of installed turbines in the respective bin. One estimates the result of 27 years of wind turbine operations: 333.936,15 tons of waste with no current solution besides landfilling or incineration.

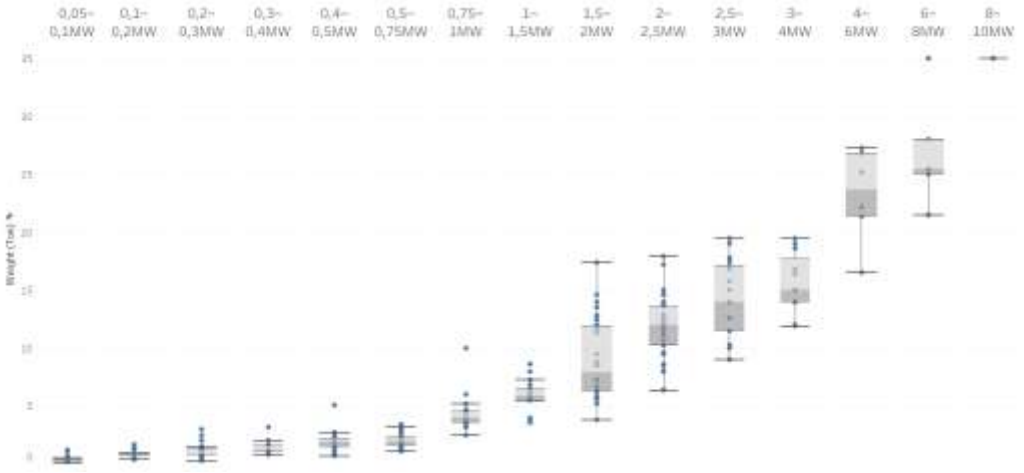

Figure 1 - Weight distribution by rated power

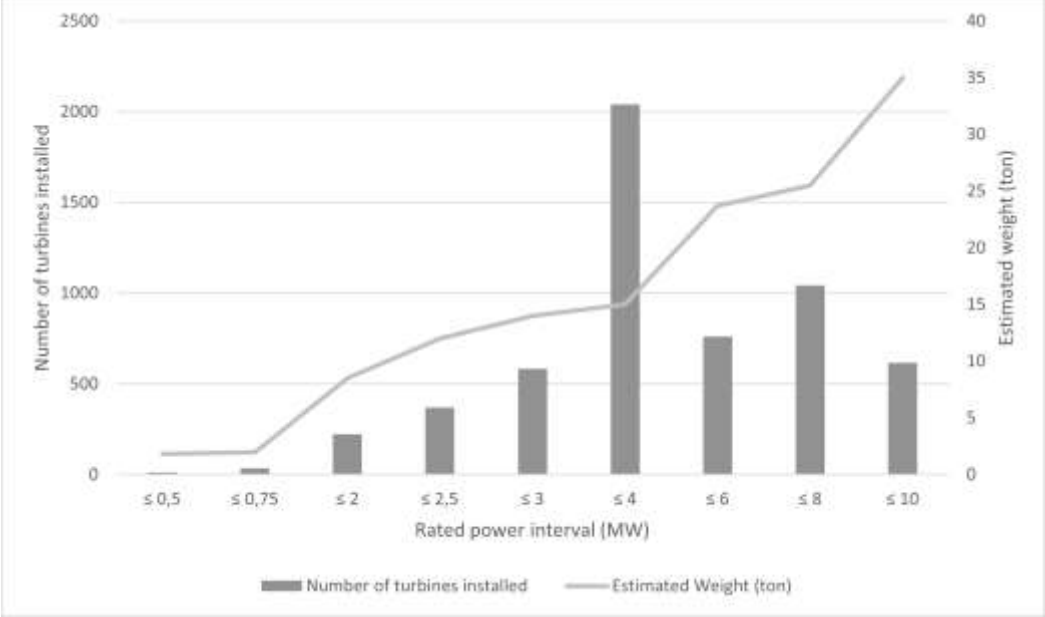

Figure 2 - Estimated weight of offshore turbines in Europe

Keywords: Wind turbine blade, waste, model.

References

[1] GWEC – Global Wind Energy Council. Global wind report – annual market update 2014. (2014). pp. 45.

[2] European Commission. Towards net-zero emissions in the EU energy system by 2050. (2020).

[3] Beauson, J., Bech, J. I., Brøndsted, P. (2014). Composite recycling: Characterising end of life wind turbine blade material. In Proceedings of 19th International Conference on Composite Materials.

[4] Bauer, L. and Matysik S. (2022). Wind-Turbine-Models. Available at <https://en.wind-turbine-models.com/>. Accessed on 22 June 2022.

[5] Wind Europe. European Offshore Wind Farms Map Public. Available at < https://windeurope.org/intelligence-platform/product/european-offshore-wind-farms-map-public/>, Accessed on 25 June 2022.