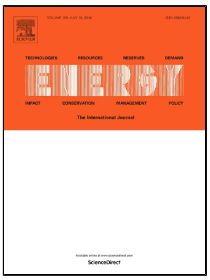
Accepted Manuscript



Environmental assessment of the wind turbine systems based on thermo-ecological cost

Wojciech Stanek, Barbara Mendecka, Lidia Lombardi, Tomasz Simla

PII:	S0360-5442(18)31327-6
DOI:	10.1016/j.energy.2018.07.032
Reference:	EGY 13297
To appear in:	*Energy*
Received Date:	25 October 2017
Accepted Date:	08 July 2018

Please cite this article as: Wojciech Stanek, Barbara Mendecka, Lidia Lombardi, Tomasz Simla, Environmental assessment of the wind turbine systems based on thermo-ecological cost, *Energy* (2018), doi: 10.1016/j.energy.2018.07.032

Environmental assessment of the wind turbine systems based on thermo-ecological cost

Wojciech Stanek[a], Barbara Mendecka[b**], Lidia Lombardi[c], Tomasz Simla[a]

[a] *Silesian University of Technology, Konarskiego 22, 44100 Gliwice, Poland, wojciech.stanek@polsl.pl*
[b] *University of Florence, via S. Marta 3, 50139 Florence, Italy,*
[c] *Niccolò Cusano University, via don Carlo Gnocchi 3, 00166 Rome, Italy, lidia.lombardi@uncusano.it*
***corresponding author: barbara.mendecka@unifi.it*

Abstract

An increased wind capacity penetration reduces loading on conventional thermal units causing higher fuel requirements due to the off-design operation. Regarding the environmental analysis, such an adverse effect should be allocated to the operational phase of wind turbines. In the present work, we apply Thermo-ecological Cost (TEC) to evaluate the environmental performance of wind power systems operating in Poland and Italy. The analysis focuses on the quantitative assessment of the effect of additional chemical energy consumption due to part-load operation of the conventional power units in both analyzed electricity systems. We present the results for two different dispatch strategies. The results confirm high environmental effectiveness of wind power systems. However, the TEC resulting from the compensation for wind generation variations has a significant contribution to the overall LC-TEC index. In particular, without considering the effect of compensation, the TEC for wind turbines are from 47 to 65 times lower than for coal-fired power plants and 35 to 48 times lower than for NGCC plants. Concerning the real load conditions, and considering the effects resulting from the compensation for wind generation variations, the TEC index for this phase contributes between 36% and 75% to the total TEC value.

Keywords: life cycle assessment, thermo-ecological cost, wind energy, electricity production