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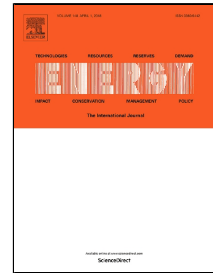
Effects of Firm Characteristics and Energy Management for Energy Efficiency in the Pulp and Paper Industry

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1 Effects of Firm Characteristics and Energy Management for Energy 2 Efficiency in the Pulp and Paper Industry

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6 ABSTRACT

7 The Swedish pulp and paper industry (PPI) must increase energy efficiency to remain competitive on
8 the global market, which has experienced entries from countries with cheaper energy and raw
9 material supplies. Interactions among variables for energy use, production, energy management,
10 electricity price and firm characteristics (FC), in different types of mills, i.e., pulp, paper and integrated
11 mills, in Sweden from 2006-2015 indicate that correlations among the studied variables were different
12 in different types of mills. This difference between types of mills seemed to originate partly from
13 varying accessibility to production residue that could be used for energy. For all types of mills, variation
14 of electricity prices did not correlate significantly with energy efficiency during the study period. The
15 studied FC were firm's age, number of employees, number of companies in company group, net sales
16 and profit for the year. Energy efficiency was more affected by the variables characterizing energy and
17 production compared to the variables representing FC. This study also suggested presence of possible
18 discrepancies between FC that were perceived as barriers to energy management towards energy
19 efficiency, according to previous studies, and what was shown by the data combining variables
20 representing energy use, production and FC.

21
22 *Keywords:* energy efficiency, specific energy, pulp and paper industry, firm characteristics, energy
23 management standard, energy management.

24 1. Introduction

25 Ongoing attempts to make the Swedish pulp and paper industry (PPI) more energy efficient called for
26 investigation into whether firm characteristics (FC) affect energy efficiency (EE), and if so, how.
27 Specifically, the ongoing attempts aim to minimize the difference between actual and possible EE,
28 called EE gap [1]. Hence, EE gap is extensively studied including studies in energy-intensive industries,
29 such as PPI, in Sweden (e.g. [2], [3]) and abroad (e.g. [4]). The potential for improving EE in energy-
30 intensive Swedish firms was evaluated to be 18%: 5% of the current energy use by energy-efficient
31 technologies and 13% by improved energy management [5]. Energy-intensive PPI in Sweden used ~73
32 TWh energy totally in 2015, which corresponds to ~52 % of the total industrial energy use in Sweden
33 [6]. Consequently, PPI is the major user of total energy in Swedish industry. Hence, a saving of 18%
34 would correspond to saving ~13 TWh or 9% of the total industrial energy use in Sweden.

35 Firms started working to decrease their negative effects on the environment in the 1970s, triggered
36 by the Declaration of The United Nations Conference on the Human Environment in Stockholm in 1972
37 and the 1970s oil crises [7]. The international standard for environmental management (ISO 14001,
38 formed in 1996), for example, was triggered by the United Nations Conference on Environment and
39 Development in Rio, 1992 [8], a follow-up to the previous conference.

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