# *MEASURING THE EFFICIENCY OF ENERGY-INTENSIVE INDUSTRIES ACROSS 23 EU COUNTRIES*

Georgia Makridou, Research Centre for Energy Management, ESCP Europe Business School, UK & Technical University of Crete, Greece, Tel: +44 207 443 8870, E-mail: gmakridou@rcem.eu
Kostas Andriosopoulos, Research Centre for Energy Management, ESCP Europe Business School, UK, Tel: +44 207 443 8809, E-mail: kandriosopoulos@escpeurope.eu
Michael Doumpos, Technical University of Crete, Dept. of Production Engineering and Management, Financial Engineering Laboratory, Greece, Tel.:+30 28210 37318, E-mail: mdoumpos@dpem.tuc.gr
Constantin Zopounidis, Technical University of Crete, Dept. of Production Engineering and Management, Financial Engineering Laboratory, Greece & Audencia Group, School of Management, Nantes, France, Tel.:+30 28210 37236, E-mail: kostas@dpem.tuc.gr

## Overview

Energy demand is growing significantly in most countries and is expected to continue to expand—perhaps by 45% between now and 2030, and by more than 300% by the end of the century (Brown and Sovacool, 2012). Industry is generally the largest consumer of energy, currently consuming about 37% of the world's total delivered energy, and the highest in energy-related CO2 emissions among the major sectors of energy use in an economy. Sadly enough, large amounts of energy consumed by industry are used inefficiently because of lack of awareness about proper energy management and weak energy policies and measures, among others. As a result, the industrial development across the world results in more energy use and leads to more concentration of greenhouse gases. Hence, finding ways to increase energy efficiency in the industrial sector is highly important because the global climate and the region's energy security depend on it. In this paper the efficiency trends of five energy-intensive industries namely construction, electricity, manufacturing, mining and quarrying, and transport in 23 EU countries over the period 2000–2009 is analysed. The performance of the sectors is evaluated in terms of an input/output production framework described by capital stock, employment, total energy consumption, value added, and GHG emissions using the Data Envelopment Analysis (DEA). The bootstrapping Malmquist Productivity Index (MPI) is also performed to explore the efficiency trends over time and to attribute sectors' productivity to either efficiency or technology change. Currently, the concern of policy makers is to promote energy efficiency for reducing energy consumption while maintaining or even boosting economic growth. Therefore, at the second stage analysis, further research is carried out by exploring the influencing factors of industrial energy efficiency scores using the two-level cross-classified model.

## Methods

On the methodological side, we use the DEA to measure the relative efficiency of each industrial sector. DEA is a popular nonparametric efficiency analysis technique with many applications energy efficiency assessment (Sarica and Ilhan (2007), Mukherjee (2008), Azadeh et al. (2007)). Given the panel nature of the considered data set, the MPI is used to assess the trends in energy efficiency over time and to distinguish between the effect of efficiency change and technical change. At the second stage of our analysis, we focus on the analysis of the relationship between the energy efficiency estimates and a set of explanatory factors related to the characteristics of examined sectors and countries considering a cross-classified model. We apply a two-level cross-classified model in which the level-1 represents the influence of time and level-2 the influence of sector- and country-level factors in energy efficiency.

## Results

For most sectors MPI has been higher than 1 in most years, thus indicating an improving trend. This trend appears to be stronger in electricity and mining. In fact, both have improved steadily since 2003-04. On the other hand, transport and mainly construction exhibit fluctuations with the MPI being lower that 1 in most years.The observed efficiency changes reflected in the MPI could be the result of changes in technical efficiency (efficiency change) and/or in the underlying production technology (technology change). It is evident that most sectors have been driven by technology change. Overall it is apparent that improvements due to efficiency change have been modest at best (e.g., no more than 5-10%), whereas improvements due to changes in the best practices (technology factor) have been significant in most of the sectors. The cross-classified model proved that that the most important variables

affecting the state of energy efficiency are the contribution of the industry to overall GDP and the electricity prices. The coefficients of productivity and number of employees to capital are statistically insignificant whereas almost all other country- and sector-characteristics (energy mix, share of fossil fuels, gross value added to capital, market share of the largest generator in the electricity market, and energy taxes) indicate a negative impact on energy efficiency.

## Conclusions

Improving energy efficiency is universally recognised as an important means of reducing greenhouse gas emissions, improving competitiveness, and reducing dependence on depleting fossil fuel resources. Hence, finding ways to increase energy efficiency in the industrial sector is highly important because the global climate and the region's energy security depend on it. This study's results not only provide a general evaluation of the investigated industries, but also facilitate various interesting efficiency comparisons, with respect to factors that have the highest explanatory power. Taking into account the results of this study, policy makers could identify the main steps that should be followed to improve each industry's energy efficiency. Furthermore, the significance of each step can be measured, leading to more informed decisions in terms of priorities given.

## References


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