

## **European Industrial Energy Intensity:**

### **The Role of Innovation 1995-2009**

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Questions over the interaction of energy prices, climate change policies, trade openness and innovation lie at the heart of debates within Europe over the future of the manufacturing sector and the role that energy efficiency improvements can play in the shift towards a low-carbon economy. The limited potential for increasing renewable energy share in the energy mix for emission abatement in heavy industry necessitates a more intensive focus on other strategies such as process improvements through technological innovation.

By contrast, numerous past studies of energy intensity have examined how structural and technological efficiency effects separately influence aggregate energy intensity change, the existing literature reveals a clear neglect of the direct role of technological innovation on energy intensity. Others consider the shift over the past few decades from heavy energy-intensive industry to light less energy-intensive industry as playing an important role in the decline in energy intensity required to meet decarbonization objectives of the manufacturing sector overall. By contrast, we rely on industry-specific factors to examine the determinants of EU industry-level energy intensity by emphasizing the direct role played by technological innovation and price-induced innovation arising from the interactions of innovation and energy prices in achieving manufacturing sector energy efficiency improvement.

Therefore, we set out some testable hypotheses with regard to patents, energy prices, trade openness and capital intensity to investigate the determinants of energy intensity across EU manufacturing industries. To test our hypotheses, we use variables that capture these

influencing factors, for example, we use a unique industry-level patent dataset as a proxy for technological innovation. We investigate the effect of these variables on energy intensity using fixed effects estimators, with a dataset covering the period 1995-2009 in twelve industries across seventeen EU countries. We consider the asymmetric price response of industrial energy intensity by decomposing energy price into three components, which provides an insight into the interplay of energy prices and technological innovation on energy intensity. A look at different industry sectors reveals how different industries react to technological innovations. We explore differences across industry categories, with special focus on energy-intensive industries and less energy-intensive industries, and we further investigate differences across the main energy-intensive sectors (pulp & paper, non-metallic products, basic and fabricated metals, and chemicals). We also compare regional industry-level intensity in the European Union and account for region-specific characteristics such as carbon taxes.

Overall, we find some evidence that technological innovation negatively influences manufacturing energy intensity, in particular having a much stronger effect on energy-intensive industries as opposed to less energy-intensive industries. The study finds evidence of asymmetric response of energy intensity to energy prices whereby price rises leads to greater efficiency improvements than when prices falls. The implementation of carbon tax policies in Northern European countries has also significantly enabled the decline in energy intensity in the region. Of the energy-intensive sectors, the chemicals industry (the only one not covered by the EU Emissions Trading Scheme) appears to be more susceptible to energy prices relative to other covered sectors.

Our study provides some suggestions for further enhancing manufacturing energy intensity in the EU. First, technological innovation offers potential opportunities for improving energy efficiency and developing new lower-emission technologies. Second, wider adoption of national, regional or EU-level carbon tax policy to complement the EU ETS could play an important role in industrial decarbonization given the evidence that the implementation of carbon taxes to date has resulted in substantial energy efficiency improvements.

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