ENERGY CONSUMPTION IN THE IRON & STEEL INDUSTRY IN EU MEMBER STATES IN LIGHT OF THE THEORY OF ENVIRONMENTAL ECONOMICS

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Abstract

The article presents the use of different energy sources in the iron & steel industry in the European Union in the period between 2005 and 2013. The analysis was based on data from Eurostat. It has been found that the iron & steel industry has, during the studied period, decreased its share in final energy consumption from 5.31% to 4.6%. The largest portion of this, 47%, is derived from Solid fuels, with Oil the smallest at only 2.44%. Over the studied period the structure of energy sources used in the iron & steel industry underwent changes. The consumption of Coke oven coke, which in 2005 accounted for 28.38% of energy sources calculated in kilo tonnes of oil equivalent (ktoe) decreased and in 2013 amounted to only 24.57%. However, this was offset by an increase in consumption of other bituminous coal. Great diversity in the structure of energy sources was observed in the iron & steel industry in the surveyed countries. In 2013, the largest share of Solid Fuels was observed in the United Kingdom - 68.96%. The smallest was recorded in Spain and Italy, but those countries were characterised by the decidedly largest share held by Electricity (over 30%).

Keywords: Metallurgy, consumption, energy source, environmental economics

1. INTRODUCTION

In a modern economy, issues related to energy consumption and energy efficiency of industry are becoming increasingly important. Such an approach has both, a strong theoretical and practical base. Firstly, it should be noted that for the most part industry uses non-renewable energy sources. This is especially clear in the case of raw materials, such as crude oil, and the related concept of 'peak oil'. According to this idea, oil extraction by conventional means will reach its maximum at some point and then start to gradually decline. These predictions have been proven in the USA, where the Peak Oil status was reached in 1971 [1]. Of course, possibilities for obtaining oil from unconventional sources, such as tar sands in Canada, have appeared in the meantime. In case of other energy sources, such as coal, recent studies give estimates between tens and hundreds of years - natural gas 60 years, oil 40 years, coal 160 years [2]. Even resources of uranium, the fuel in nuclear power plants, are limited. Existing deposits will be depleted in 85 years, while all conventional deposits in 270 years [3]. CO_2 emissions are another very important issue related to the use of fossil fuels. Even though stone coal is the most easily available and widely used energy source, it also causes extremely high CO_2 emissions. This greenhouse gas has a significant impact on the state of Earth's atmosphere. The increase in atmospheric CO_2 from 280 ppm to nearly 400 ppm [4] has resulted in its highest level in 800 000 years [5]. According to the IPCC report it is human CO_2 emissions that are responsible for climate change occurring in the world [6].

The results of these and other studies have forced the EU authorities to take firm actions aimed at reducing the EU economy's CO_2 emissions. A system of CO_2 emissions trading, aimed mainly at curbing them, has been introduced [7]. Such actions have theoretical foundations based on environmental economics. It is a branch of economics that studies the conditions for optimum use of environmental resources and assets, considering the need to preserve the aforementioned resources for future generations and the impact of their consumption on social well-being as a whole. The issue of social welfare distribution over time and the associated intertemporal Pareto optimum are an extremely important element of this. The latter determines a

social condition where one cannot improve the situation of any member of society without deteriorating that of at least one other member.

Assuming that the production of goods is equal to a given value and each can be attributed a level of utility for individual members of society, the graph can then show the utility functions of such goods as part of a plane bound by the curve of possible utility (CPU). Points below this curve are achievable at a given level of production, while those above are not. Given the Pareto criterion, it should be stated that a particular society prefers distribution of wealth b over distribution c. However, neither distribution b nor c, is optimal in reference to Pareto. Only distributions depicted by points a and c on the CPU curve are optimal. Initially, they were defined only from a static point of view, but attempts have also been made to determine them from a dynamic perspective. As such, it depicts a state when it is impossible to improve the well-being of even one person in any of the examined periods without detriment to the well-being of others in other periods. [8]. Despite many critical voices, Sandler's and Smith's version of the Pareto optimum can serve as a general criterion for the rationality of management of non-renewable natural resources, which clearly include fossil fuels (coal, oil). Decision-making regarding these issues is crucial for the iron & steel industry, which observes unusually high demands for energy [9].

Fig. 1 Utility functions - Pareto criterion [8]

This goal of the article is to determine the importance of iron & steel industry for energy consumption in the EU in relation to individual energy sources and the changes that have occurred in this area over the 2005-2013 period.

2. METHODS

The study used data from mass statistics from Eurostat. These figures relate to energy consumption from different sources in various sectors of the economy in the period between 2005 and 2013 in European Union member states. Energy consumption is presented in thousand tones' of oil equivalent (ktoe). Final energy consumption - Iron and steel covers quantities consumed in the Iron and steel industry (NACE Divisions 24.1, 24.2, 24.3, 24.51 and 24.52. - C24 - Manufacture of basic metals, C24.2 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel, C24.3 - Manufacture of other products of first processing of steel, C24.4 - Manufacture of basic precious and other non-ferrous metals, C24.5.1 - Casting of iron, C24.5.2 - Casting of steel) [10]. Countries with the highest production in this sector of the economy have been chosen for the comparison.

3. RESEARCH RESULTS

Energy consumption in the iron & steel industry is a problem that has been presently gaining in importance, one which has been directly affecting its efficiency [11]. Therefore, issues relating to proper management of businesses in this industry are extremely important, as exemplified by the application of Reliability-Centered Maintenance (RCM) approach. [12] This is quite important insofar, as this sector of the economy has a significant impact on energy consumption in EU member states, as it is responsible for an average of 4.6% of energy consumption. Particularly noteworthy here is Slovakia, where it accounted for 20.29% in 2013. EU authorities are also increasingly directing their attention towards energy. They emphasise the fact that in recent

years the iron & steel industry has achieved extremely good progress in reducing energy consumption and CO_2 emissions. [13, 16]. As can be seen, over the studied period, energy consumption calculated in ktoe has fallen by 7% across the EU. However, a particularly strong decline was recorded in the iron and steel industry, up to 19%.

Table 1 Final energy consumption in UE countries in 2005 and 2013

Final energy consumption	2013			2005		
	All consumption [ktoe]	Iron & steel industry [ktoe]	Share	All consumption [ktoe]	Iron & steel industry	Share
Germany	217 251	13 417	6.18%	218 456	13 228	6.06%
Poland	63 400	2 415	3.81%	58 986	3 276	5.55%
Austria	27 950	2 493	8.92%	28 164	2 505	8.89%
Czech Republic	23 860	2 085	8.74%	26 026	2 994	11.50%
France	152 821	5 540	3.63%	160 337	6 614	4.13%
Słovakia	10 864	2 205	20.29%	11 561	2 160	18.69%
Spain	81 138	3 202	3.95%	97 766	4 476	4.58%
Italy	118 696	5 207	4.39%	134 544	7 458	5.54%
United Kingdom	136 432	3 873	2.84%	152 728	4 525	2.96%
Total	**1 104 585**	**50 815**	**4.60%**	**1 186 444**	**62 968**	**5.31%**

Two issues influenced such a large reduction. First of all, environmental requirements and rising energy prices have forced companies to use energy-efficient technologies. Second of all, the period 2008-2011 has been, unfortunately, a period of major economic slowdown both in Europe and around the world. This has had particularly affected the iron & steel industry and resulted in many companies ending operations. Along with changes in energy consumption, the structure of energy sources changed as well.

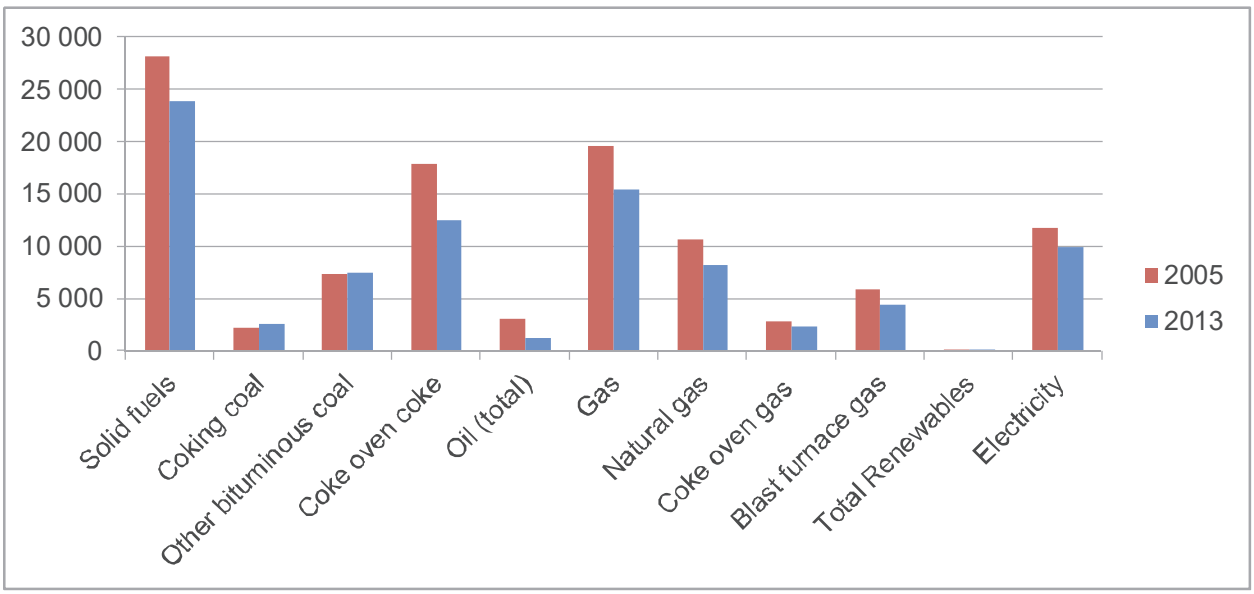

Fig. 2 Final energy consumption in UE countries in 2005 and 2013

In absolute terms, virtually all sources, with the exception of Other bituminous coal and Coking coal, declines were observed. However, the share of individual sources and the change in this share between 2005 and 2013 says much more about changes in the structure of energy consumption

Table 2 Final energy consumption in UE countries in 2005 and 2013

Solid fuels (total)	Coking coal	Other bituminous coal	Coke oven coke	**Oil (total)**	**Gas**	Natural gas	Coke oven gas	Blast furnace gas	**Total Renewables**	**Electricity**
47.07%	5.15%	14.77%	24.57%	2.44%	30.32%	16.17%	4.76%	8.66%	0.01%	19.47%
44.66%	3.54%	11.82%	28.38%	4.87%	31.18%	16.96%	4.48%	9.31%	0.03%	18.68%
2.41%	1.60%	2.95%	-3.81%	-2.43%	-0.85%	-0.79%	0.28%	-0.65%	-0.01%	0.79%

In general, Solid fuels, whose share in consumption increased from 44.66% to 47.07%, gained in significance. The increase in other bituminous coal played the most visible part here. This came at the expense of Oil, the consumption of which has decreased considerably. Among the other two main energy sources - Gas and Electricity - practically no change has been observed. One should note the lack of renewable energy use despite such possibilities [14]. The situation has not changed during the surveyed period, even though the EU has a strong policy supporting renewable energy sources.

It is worth noting the type of energy used in particular countries in the iron & steel industry. In virtually all countries surveyed Solid Fuels are dominant, but their share ranges from 38% in Austria to 69% in Great Britain [17, 18].

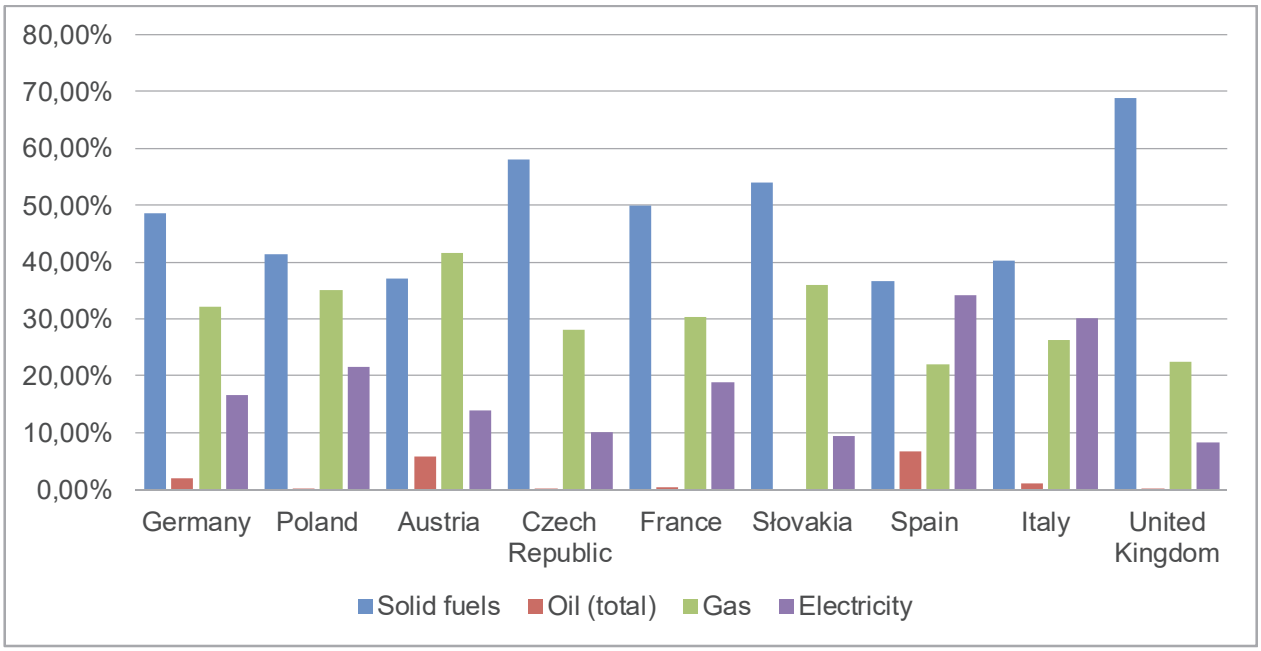

Fig. 3 Final energy consumption in UE countries in 2005 and 2013

Gas has great significance in Spain and Austria (in particular Natural Gas). The entire Spanish economy is largely based on this energy source - it is in the leading position among EU natural gas importers. However, in contrast to other countries, it uses mainly liquefied natural gas (LNG) imported by sea. It has 5 terminals (the largest number in Europe). In the case of Austria, it imports comparable amounts of gas as Poland and

the Czech Republic, and is practically dependent on Russian gas, which accounts for over 70% of deliveries [15].

4. CONCLUSION

The presented information makes it possible to draw the following conclusions:

1) In the years 2005-2013 energy consumption in the EU fell by 7%, while in the iron & steel industry the decrease amounted to 19%.
2) This is brought about by the EU's pro-environmental policies on the one hand and the economic slowdown, which has adversely affected the iron & steel industry, on the other.
3) The structure of energy consumption in the iron & steel industry divided by energy sources has been subject to small changes. Solid Fuels gained in importance at the expense of Oil.
4) Significant differences in the structure of energy source use in the surveyed countries have been noted. Although Solid Fuels occupy a dominant position in nearly all of them, in Spain and Austria Gas is surprisingly important.

The use of particular energy sources is becoming an increasingly important issue, not only for those managing enterprises. Recent events in the east of Europe have shown that it is also a key issue for national economies and even the EU as a whole. The iron & steel industry, responsible for almost 20% of industrial energy consumption has an important part in such considerations. Its needs and considerations must be taken into account when undertaking economic and environmental decisions at the level of both, the EU and the individual Member States.

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