

# Progress in Sustainable Consumption and Production in Slovakia in Comparison with other EU Countries – Energy Intensity of the Sector

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## Abstract.

**Research background:** Problematic of sustainable consumption and production is a broad conception that is integrating application of advanced methods and techniques of business management, in all areas, including eco-design and innovation, sustainable marketing, risk management and strategic management with a focus on sustainable development for the environment. The European Union has established numerous strategies to support it, the success of which depends on building a sufficient awareness and above all the involvement of all countries in the process of improving the environmental performance of products throughout their life cycle. Building of sustainable consumption and production on the widest scale is influenced by the social and economic dimension, which awareness and understanding makes it possible to encourage and motivate to socially responsible behaviour. In order to face the current challenges, it is essential to change the way we produce and consume.

**Purpose of the article:** Analyse the financial and economic parameters of selected sectors in dependence on the fulfilment of selected indicators that are measuring progress in sustainable consumption and production in Slovakia in comparison with other EU countries

**Methods:** Time series analysis, spatial analysis.

**Findings & Value added:** Systematizing the ways to measure progress in achieving sustainable consumption and production with regards to defined indicators in strategies, policies and action plans of EU following the structure of national economies.

**Keywords:** *sustainable consumption; sustainable production, energy intensity of the sectors*

**JEL Classification:** *O12; O13; Q56*

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## 1 Introduction

Countries are increasingly being faced with the dual challenge of promoting economic growth and addressing climate change. Problematic of sustainable consumption and production is a broad conception that is integrating application of advanced methods and techniques of business management, in all areas, including eco-design and innovation, sustainable marketing, risk management and strategic management with a focus on sustainable development for the environment [1]. The European Union (EU) has established numerous strategies to support it, the success of which depends on building a sufficient awareness and above all the involvement of all countries in the process of improving the environmental performance of products throughout their life cycle. Sustainable consumption and production have been recognized as an integral part of the Sustainable Development Agenda until 2030. It is identified separately as objective number 12, and at the same time as a link for some other agreed objectives. Goal 12 "Responsible consumption and production" is divided into 11 indicators with a quantitative target. To achieve agreed targets, industry must become more resource-efficient. To this end, two viable strategies exist: energy efficiency and material efficiency. Despite the inherent interdependence of energy and materials in industrial processes, policy and industry treat these two strategies as isolated pursuits, which provide only a partial insight into potential gains from resource efficiency [2].

Insufficient progress towards the European Union target under Goal 12 was recorded under the indicators. Primary energy consumption, Generation of waste excluding major mineral wastes and movement away from the EU target was recorded under the indicator Final energy consumption [3]. For further analysis, we selected one of these indicators, Final energy consumption. In 2018, gross final energy consumption among the European countries was the highest in Germany with 223.3 Mtoe, followed by France with 154.5 Mtoe, the United Kingdom with 133.7 Mtoe, Italy with 121.5 Mtoe and Turkey with 105.0 Mtoe, respectively [4]. With power generation being the largest contributor to anthropogenic CO<sub>2</sub> emissions, that is why decarbonization of the sector ranks high on policy agendas worldwide. To this end, many countries are targeting the deployment of renewable energy technologies, some of which have grown rapidly since the turn of the century [5]. The share of renewable sources in gross final energy consumption in EU reached from 8.5% in 2004 to 18.0% in 2018. The EU targets to raise this share up to 20% by 2020 and 32% by 2030 [6]. Renewable energy appears to be a mean to decarbonize economies. To fight global warming, which might have substantial impacts on ecosystems and economies, it is essential to understand the empirical determinants of RE deployment for public policy guidance and to foster future research [7].

Directive (EU) 2018/2002 on energy efficiency puts forward a binding EU-wide 32.5 % energy savings target for 2030, following on from the previously set 20 % target by 2020. Member States are requested to set indicative targets [8]. Forecasting of this target has been subject to many researchers. Even since the last two years, grey prediction models have been widely used as a forecasting tool by many researchers in this field [9, 10, 11]. Forecasting of energy consumption plays a key role of energy management [12]. Another important area of research is the Environmental Kuznets Curve (EKC) hypothesis, that states that CO<sub>2</sub> emissions will continue to increase until average income reaches a turning point, then environmental quality will begin to improve. When considering the relationship between GDP and CO<sub>2</sub> emissions, it is important for policy-makers to know whether their economies have a conventional EKC and, if so, whether the turning point has been reached. If the turning point has been reached, higher GDP will not result in higher CO<sub>2</sub> emissions [13]. However, the calculated turning points are at very high GDP levels, and thus most

countries worldwide are expected to witness dramatic further e-waste growth if the existing patterns are not radically transformed through effective e-waste prevention measures [14].

Based on the above facts, it can be stated that there is a high dependence of final energy consumption, CO<sub>2</sub> emissions and the performance of national economies on the structure of individual economies. In this article, we examine the energy intensity of selected sectors in relation to the gross value added of the sector and compare the calculated energy intensity of the V4 countries and the EU (27 countries from 2020).

## 2 Methods

The paper uses the indicators of final energy consumption and value added at factor from the Eurostat database. **Final energy consumption** - the indicator measures the energy end-use in a country excluding all non-energy use of energy carriers (e.g. natural gas used not for combustion but for producing chemicals). "Final energy consumption" only covers the energy consumed by end users, such as industry, transport, households, services and agriculture; it excludes energy consumption of the energy sector itself and losses occurring during transformation and distribution of energy [15]. This indicator should be used also for tracking progress towards Europe 2030 targets. In the energy balance [16], the final energy consumption is further disaggregated into Industry sector, Transport sector and Other sectors. Each of these sectors have several subsectors. The paper analyzes in total 8 subsectors of the industry sector. The division is shown in the table below (Table 1).

**Table 1.** Subsectors of Industry Sector based on NACE Rev. 2 [12]

Industry sector		NACE Rev. 2
+	Iron & steel	Groups 24.1, 24.2, 24.3 and classes 24.51 and 52
+	Chemical & petrochemical	Divisions 20 and 21
+	Non-ferrous metals	Groups 24.4, classes 24.53 and 24.54
+	Non-metallic minerals	Division 23
+	Transport equipment	Divisions 29 and 30
+	Machinery	Divisions 25, 26, 27 and 28
+	Mining & quarrying	Divisionos 07(excluding 07.21), 08(excluding 08.92), group 09.9
+	Food, beverages & tobacco	Divisions 10, 11 and 12
+	Paper, pulp & printing	Divisions 17 and 18
+	Wood & wood products	Division 16
+	Construction	Divisions 41, 42 and 43
+	Textile & leather	Divisions 13, 14 and 15
+	Not elsewhere specified (industry)	Divisions 22, 31 and 32

The data for the different products must be expressed in a common energy unit. The unit kilograms of oil equivalent (KgOE) was selected for the purpose of our analysis. The value of final energy consumption was compared to the value added at factor cost (INDIC\_SB) for individual subsectors of industry sector. The data were drawn from Eurostat (Annual enterprise statistics by size class for special aggregates of activities NACE Rev. 2 - sbs\_sc\_sca\_r2). Due to the requirement to compare time series between countries, the value added at factor cost was expressed in purchasing power parities (PPPs) valid for gross domestic product.

Annual enterprise statistics by size class for special aggregates of activities NACE Rev. 2 were not complete, therefore some data had to be tracked in other Eurostat databases. Data that could not be ascertained were calculated as average values.

### 3 Results

Energy intensity of subsectors of the industry sector is expressed as energy demand in kilograms of oil equivalent (KgOE) per 1000€ generated value added at factor cost. In order to evaluate the energy intensities of individual economic activities of the Slovak economy, we compared the calculated values with other V4 countries and with the EU - 27 countries from 2020.

The first industry sector evaluated is Iron & Steel (Table 1), which consists of groups: Manufacture of basic metals, Manufacture of basic iron and steel and of ferro-alloys, Manufacture of tubes, pipes, hollow profiles and related fittings, of steel, Manufacture of other products of first processing of steel and classes Casting of iron and Casting of steel (Table 2).

**Table 2.** Industry Sector - Iron & Steel (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	740	727	786	764	696	714	685	628	578
Czechia	1 053	879	1 105	815	587	626	642	786	632
Hungary	297	287	354	259	195	215	193	203	172
Poland	772	693	745	789	689	685	572	741	645
Slovakia	1 732	1 605	1 803	1 483	1 254	1 116	1 071	877	889

Energy of 889 kilograms of oil equivalent (KgOE) was needed in Slovakia in 2018 to produce 1000€ value added at factor cost in subsector iron & steel. Compared to 2010, energy intensity decreased by 49%, but compared to the EU, the iron & steel subsector in the Slovak Republic has almost 54% higher energy intensity.

Industry sector - chemical & petrochemical (Table 1) consists of groups: Manufacture of chemicals and chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations, Casting of other non-ferrous metals (Table 3).

**Table 3.** Industry Sector - Chemical & Petrochemical (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	279	281	289	290	274	243	227	217	211
Czechia	491	468	460	474	370	315	345	310	327
Hungary	177	262	248	330	286	254	259	231	279
Poland	397	356	396	377	384	323	308	350	376
Slovakia	664	483	843	674	678	599	703	666	1 002

In Slovakia in 2018, energy of 1002 kilograms of oil equivalent (KgOE) was needed to produce 1000€ of value added at a factor cost in the chemical & petrochemical subsector. Compared to 2010, the energy intensity increased by 51%, while in 2017 the energy required was still approximately the amount of 2010.

Industry sector - non-ferrous metals (Table 1) consists of groups: Manufacture of basic precious and other non-ferrous metals and classes Casting of light metals and classes Casting of light metals (Table 4).

**Table 4.** Industry Sector - Non-Ferrous Metals (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	506	532	511	513	474	473	464	447	420
Czechia	179	172	162	174	142	153	175	192	179
Hungary	384	325	349	329	222	183	170	181	161
Poland	522	468	509	555	489	454	362	394	388
Slovakia	846	789	1 026	940	1 066	1 103	964	980	916

To produce 1000€ of value added at a factor cost in the non-ferrous metals subsector in Slovakia in 2018, energy of 916 kilograms of oil equivalent (KgOE) was needed. Compared to 2010, the energy intensity increased by 8% and compared to the EU, the non-ferrous metals subsector in the Slovak Republic has almost 120% higher energy intensity.

Industry sector - machinery (Table 1) consists of groups: Manufacture of fabricated metal products, except machinery and equipment, Manufacture of computer, electronic and metal products, Manufacture of electrical equipment and Manufacture of machinery and equipment n.e.c (Table 5).

**Table 5.** Industry Sector – Machinery (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	42,0	39,0	38,1	38,3	35,6	34,4	33,7	31,9	29,7
Czechia	58,3	51,1	47,5	43,0	36,8	39,2	38,4	38,8	34,4
Hungary	27,9	24,8	28,7	36,2	34,4	32,2	40,0	39,6	38,7
Poland	35,6	32,4	33,8	34,0	32,5	31,6	30,3	30,1	27,5
Slovakia	36,8	39,3	36,8	40,1	38,1	35,9	41,6	43,3	46,1

To produce 1000€ of value added at factor cost in subsector machinery in Slovakia in 2018, energy of 46.1 kilograms of oil equivalent (KgOE) was required. Compared to 2010, energy intensity increased by 30% and compared to the EU, subsector machinery in the Slovak Republic has almost 60% higher energy intensity.

Industry sector - food, beverages and tobacco (Table 1) consists of groups: Manufacture of food products, Manufacture of beverages and Manufacture of tobacco products (Table 6).

**Table 6.** Industry Sector - Food, Beverages and Tobacco (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	142,9	141,1	141,8	138,2	136,1	134,1	132,2	124,5	122,5
Czechia	146,4	146,3	145,1	140,8	139,4	144,9	132,9	136,1	124,4
Hungary	132,2	132,6	155,2	171,0	167,6	167,0	165,4	167,8	156,0
Poland	115,3	105,7	115,2	112,7	111,5	105,9	107,0	100,3	101,1
Slovakia	105,7	93,7	124,8	130,8	122,4	120,0	129,7	122,3	121,6

In Slovakia in 2018, energy of 121.6 kilograms of oil equivalent (KgOE) was needed to produce 1000€ of value added at factor cost in subsector food, beverages and tobacco. Compared to 2010, energy intensity increased by 15% and compared to the EU, the subsector food, beverages and tobacco in Slovakia has almost 1% lower energy intensity.

Industry sector - paper, pulp and printing (Table 1) consists of groups: Manufacture of paper and paper products and Printing and reproduction of recorded media (Table 7).

**Table 7.** Industry Sector - Paper, Pulp and Printing (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	502,0	489,4	501,0	514,2	469,1	489,0	480,9	473,1	438,1
Czechia	397,1	408,6	425,3	403,2	379,4	363,2	329,8	321,0	301,6
Hungary	179,7	173,7	188,1	198,2	197,2	177,6	184,7	205,1	185,1
Poland	307,3	273,6	281,8	317,1	294,1	284,6	285,3	293,7	264,2
Slovakia	843,3	828,5	749,5	752,6	761,5	818,0	761,3	845,4	724,5

In Slovakia in 2018, energy of 724.5 kilograms of oil equivalent (KgOE) was required to produce 1000€ of value added at factor cost in subsector paper, pulp and printing. Compared to 2010, energy intensity decreased by 14% and compared to the EU, subsector paper, pulp and printing in the Slovak Republic has almost 65% higher energy intensity

Industry sector wood and wood products (Table 1) consists of groups: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (Table 8).

**Table 8.** Industry Sector - Wood and Wood Products (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	273,3	272,9	293,5	300,0	280,7	278,4	283,8	278,7	254,3
Czechia	190,1	166,7	183,4	192,4	174,6	181,2	177,7	158,1	141,3
Hungary	111,1	130,4	166,4	201,4	165,2	167,4	194,6	239,1	273,2
Poland	281,9	264,6	290,3	288,9	249,1	261,9	274,9	305,0	276,7
Slovakia	101,1	130,8	181,9	133,2	103,9	133,5	123,6	131,8	136,2

To produce 1000€ value added at a factor cost in the subsector wood and wood products in Slovakia in 2018, energy of 136.2 kilograms of oil equivalent (KgOE) was needed. Compared to 2010, energy intensity increased by 35% and compared to the EU, subsector wood and wood products in the Slovak Republic have almost 46% lower energy intensity.

Industry sector - textile and leather (Table 1) consists of groups. Manufacture of textiles, Manufacture of wearing apparel and Manufacture of leather and related products (Table 9).

**Table 9.** Industry Sector - Textile and Leather (1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	90,4	81,1	82,1	77,9	71,0	71,2	69,7	66,9	65,7
Czechia	131,3	121,9	119,4	109,8	99,9	97,6	94,2	95,4	93,2
Hungary	34,8	31,1	37,9	46,7	49,6	54,9	54,9	51,6	50,7
Poland	44,7	36,2	39,3	39,9	39,1	35,5	35,5	35,2	36,6
Slovakia	76,0	80,3	65,3	52,1	62,0	48,0	44,2	42,7	36,2

In Slovakia in 2018, energy of 36.2 kilograms of oil equivalent (KgOE) was needed to produce 1000€ of value added at a factor cost in the textile and leather subsector. Compared to 2010, the energy intensity decreased by 52% and compared to the EU, the subsector textile and leather in the Slovak Republic has almost 55% lower energy intensity

Industry sector - construction (Table 1) consists of groups Construction of buildings, Civil engineering and Specialized construction activities (Table 10).

**Table 10.** Industry Sector – Construction 1000 eur/KgOE)

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU - 27 countries (from 2020)	15,8	18,1	19,9	20,0	19,2	18,2	17,6	17,0	18,0
Czechia	20,7	19,4	20,4	21,6	20,1	20,1	22,5	19,8	17,9
Hungary	12,9	27,8	33,8	44,9	42,9	40,9	56,0	42,9	38,7
Poland	10,7	8,0	9,5	6,9	6,8	7,2	7,2	7,9	7,2
Slovakia	14,7	18,4	9,7	13,1	11,2	9,5	11,2	9,3	9,9

In Slovakia, the energy of 9.9 kilograms of oil equivalent (KgOE) was required in Slovakia in 2018 to produce 1000€ value added at factor cost in subsector Construction. Compared to 2010, the energy intensity decreased by 32% and compared to the EU, the Construction subsector in the Slovak Republic has almost 45% lower energy intensity.

In accordance with European state aid rules, the Ministry of Economy of the Slovak Republic provided financial compensation for energy-intensive companies exposed to international trade for the introduction of a national surcharge to finance the support for electricity from renewable energy sources. Energy-intensive companies will get back part of the fees they contribute to supporting the production of electricity from renewable sources. These are companies from sectors such as iron, steel, non-ferrous metallurgy, cement production, chemical industry, pulp/paper production, wood industry, but also companies involved in the recycling of materials.

## 4 Discussion and Conclusion

Despite a certain decline in energy consumption, Slovakia is still one of the most energy-intensive countries. Slovakia is one of the most energy-intensive countries. This means that energy consumption is significantly higher than in other EU Member States in relation to economic performance. The reason for the high energy intensity of the Slovak economy is mainly the high share of industry on GDP, especially energy-intensive sectors like the chemical, metallurgical and paper industries. In connection with the restructuring of industry and the introduction of new technologies into production, mainly in the automotive and electrical engineering industries in combination with GDP growth, the energy intensity of the economy has improved in recent years, but the energy efficiency of Slovak industry continues to lag significantly behind the EU average. Reducing energy consumption in the industry requires significant investments in new technological solutions. It should be in the best interest of the Slovak government to stimulate interest in energy savings both in industry and in households (support the purchase of technologies reducing energy consumption, investment in building insulation, use of energy-saving appliances, improve heat transfer, etc.)

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