

## CHALLENGES FACED BY THE EU'S ENERGY POLICY ON CO<sub>2</sub> EMISSIONS FROM 1997-2017, INCLUDING BILATERAL TRADE BETWEEN THE EU AND THE US

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**Purpose of research:** The European Union has three main objectives in its energy policy. The most crucial one is due by 2020, to reduce greenhouse gas emissions (mainly CO<sub>2</sub>) by at least 20% below 1990 levels. This research attempts to calculate Actual-Open CO<sub>2</sub> emission in the EU countries for the years 1997-2017, including in the calculation export and import of CO<sub>2</sub> in products and services from the USA.

**Design/methodology/approach:** This study takes into account the USA and 27 European countries (all the EU members without Malta). Actual-Open CO<sub>2</sub> emissions were obtained by applying the appropriate Actual Emission Factor. The calculation takes into consideration the transfer of CO<sub>2</sub> in exported products and services from the USA to the EU and vice versa.

**Findings:** It has become apparent, that Actual-Open CO<sub>2</sub> emission statistics in the EU member states are different from the Official-Closed CO<sub>2</sub> emission data. This has raised several challenges: 1) A change should be considered in the approach to the reduction of CO<sub>2</sub> emission in the EU energy policy, to take into account CO<sub>2</sub> emission balance with other countries. 2) To implement this, the EU needs an instrument that would lead other countries to look at their CO<sub>2</sub> emissions in a similar manner to the EU. 3) EU member states should redefine their approach to the import of goods from countries with a lower production cost due to their less stringent approach to environmental problems.

**Originality/value:** The survey presents actual CO<sub>2</sub> emission values in the EU countries incorporating net gain/loss from the US imports/exports.

**Keywords:** CO<sub>2</sub> emission, EU energy policy, the USA, the EU.

**Category of the paper:** Research paper.

### 1. Introduction

We live in a globalised world, where the activities of particular countries have a direct or indirect impact on others. Nevertheless, this does not mean that all countries function in the same way and follow the same rules. Some countries contribute significantly to the reduction

of global CO<sub>2</sub> emissions, bearing high costs in comparison to other countries. However, this does not bring about the intended effect of a real reduction in overall CO<sub>2</sub> emissions, and the aim of this study is to identify some of the causes by analysing the United States (US) and the European Union (EU) trade. The data analysed in this paper covers 27 of the 28 EU countries, with Malta being excluded because its emission of CO<sub>2</sub> was insignificant in the analysed period.

The struggle within the EU to reduce CO<sub>2</sub> emissions does not affect the US and, in this context, the study will show that between the years 1997-2017, the US had an impact on CO<sub>2</sub> emission in the EU. This shows that CO<sub>2</sub> emissions are a global problem and steps taken by individual countries or regions do not have a general impact. This raises the following basic questions: What should the EU do to make its energy policy more efficient? Should not all countries be involved in efforts to reduce CO<sub>2</sub> emissions? Should solutions be implemented to encourage other countries to take a similar approach on CO<sub>2</sub> emissions? Should the European Union change its method of calculating CO<sub>2</sub> emissions to take into account international trade? A new approach could help answer these questions.

The European Union and the US are leaders both in terms of CO<sub>2</sub> emission volumes and international exchange. The United States is the largest global importer, the 3<sup>rd</sup> largest export economy in the world and the 7<sup>th</sup> most complex economy according to the Economic Complexity Index (ECI). If the EU is considered as one economy, then, since 1970, the EU has the world's largest export and import. Taking into consideration just Germany (as the largest economy in the EU), in 2017, Germany was the 2<sup>nd</sup> largest export economy in the world and the 3<sup>rd</sup> most complex economy according to the Economic Complexity Index (The Observatory, 2020). This means that, considering international trade value, the EU, due to its economic growth and the size of the economy, is as dependent on other countries as these countries are dependent on the US. All actions planned and realised by the EU have international implications, therefore, the EU and its member states can use their position in international exchange to assist in the implementation of EU energy policy by encouraging other countries (such as the US) to achieve similar results through the use of relevant instruments, such as ecological and energy fees (Bielecki, Zalewski, Fortuński, 2016).

The main purpose of this paper is to present the impact of foreign trade on Actual-Open CO<sub>2</sub> emissions in the EU after taking into account trade with the US. It is not about the value of official emissions of CO<sub>2</sub>, but about its real volume, with regards to CO<sub>2</sub> transfer in exported and imported products and services. A significant aspect of this paper is to demonstrate that isolated actions (such as changes in the EU energy industry) will not achieve intended targets without the involvement on a similar level of all EU member states, as well as the world's largest economies. In literature, a similar approach is presented, among others, by (Hasanov, Liddle, and Mikayilov, 2018), (Knight, and Schor, 2014), (Liddle, 2018) and (Fezzigna, Borghesi, and Caro, 2019).

The calculations presented are based on a circular flow economic model that shows the flow of money through the economy. There are two kinds of models. Closed, inside a country, and Open, including exports and imports. Official CO<sub>2</sub> emission is similar to the concept of a closed circular flow model and the question must be raised as to whether this is the correct approach to this problem. We live in a global world, where international trade is one of the most important and influential factors in most economies. This factor has a big influence on CO<sub>2</sub> emission, because the production of goods and services generates CO<sub>2</sub> emissions. Therefore, it seems that if the EU wants to achieve reduction of CO<sub>2</sub> as one of the goals of its energy policy, it should rethink its approach to the CO<sub>2</sub> emission problem and take some more global actions.

## 2. Method

The main aim of the European energy policy is to achieve the so-called 3 × 20% reduction target by 2020. It includes a reduction of CO<sub>2</sub> emissions by 20%, increase by 20% the participation of renewable energy sources in the energy mix and improvement in energy use efficiency by 20%. Appropriate data for 1990 is the calculation base.

It should be emphasized, that these aims are interconnected with the last two goals, in particular significantly influencing the reduction of CO<sub>2</sub> emissions which, in turn, impacts the other EU energy policy objectives.

Actual-Open emission of CO<sub>2</sub> was determined as the CO<sub>2</sub> emissions of a specific country, reduced by emissions exported in goods and services and increased by emissions imported in products and services from other countries. This means that the CO<sub>2</sub> emissions balance should decrease Actual-Open CO<sub>2</sub> emissions. The formulas presented show the method used to calculate these Actual-Open emissions of CO<sub>2</sub> for a specific EU member (but this method could, in fact, be applied for any country):

$$S_B = \left(\frac{E_x}{GDP}\right)\% \times E_{OC} - \left(\frac{I_m}{GDP}\right)\% \times E_{OCC} \quad (1)$$

$$E_{AO} = E_{OC} - S_B \quad (2)$$

$S_B$  – EU member balance CO<sub>2</sub> emissions;

$E_{OC}$  – EU member Official-Closed CO<sub>2</sub> emissions;

$E_{OCC}$  – Official-Closed CO<sub>2</sub> emissions for a country, from which the EU member imports (e.g. USA);

$E_x$  – Value of EU member exports to a specific country (USA);

$I_m$  – Value of EU member imports from a specific country (USA);

GDP – EU member gross domestic product;

$(I_m/GDP)\%$  – portion of GDP of a specific country, from which the EU member imported (USA);

$(E_x/GDP)\%$  – portion of EU member GDP exported to a particular country (USA);

$(I_m/GDP)\%*E_{OCC}$  – Quantity of CO<sub>2</sub> imported in goods and services from a specific country (USA) to the EU member;

$(E_x/GDP)\%*E_{OC}$  – Quantity of exported CO<sub>2</sub> from the EU member to a specific country (USA) in goods and services;

$E_{AO}$  – Actual-Open CO<sub>2</sub> emissions in the EU member.

To show Actual-Open emissions of CO<sub>2</sub> for a specific country, we need data for all its trading partners. However, in this survey, the only data used is for the EU member states and the US. This means that this analysis shows the impact of the EU countries on Official-Closed emission of CO<sub>2</sub> in the US and the equivalent impact of the US on the EU countries ( $S_B$ ). This will be presented as a percentage of Actual-Open CO<sub>2</sub> emissions of the 27 EU member states and how one country (the USA) affects CO<sub>2</sub> emissions in the EU (Actual-Open emission in the EU countries can actually be changed just by one country).

### 3. Results

#### 3.1. Trade between the USA and 27 members of the EU – 1997-2017

The USA is the biggest economy in the world, but if we consider the EU as one economy, then the EU would be the largest. US total yearly export had a growth trend until 2014 (Tab. 1 and Tab. 2), whereas for the analysed period this declined in the years 1998, 2001, 2002, 2009 and 2015-2017. US total export reached values in a range from USD 612 billion (B) to USD 1,450 B, more than doubling in volume in the twenty-one years covered in this survey. There was a similar situation with US exports to the EU countries. Between 1997-2017, US exports to the EU grew from USD 157 B in 1997 to USD 290 B in 2017. For the 21 years considered, the volume of US exports to the EU was USD 4.82 trillion with exports to the EU over this period constituting between 17.8% (1997) and 24.17% (2007) of total US exports. In 1997-2000, 2003-2008, 2009-2011, 2012-2015 and 2016-2017 US exports to the EU increased, whereas between 2001-2002 and in 2009, 2012, and 2016 it decreased. This shows that, in international trade, the EU is an important partner for the US and, because of this, the EU could try to influence the US to make its CO<sub>2</sub> emission policy more restrictive.

**Table 1.**  
*US exports to the EU in 1997-2006 in USD billion*

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Austria	1.02	1.11	1.16	1.37	1.41	1.43	1.52	1.96	1.87	2.06
2,3	Belgium & Luxembourg	2.02	2.06	1.88	1.72	1.69	1.80	1.66	2.34	2.11	2.63
4	Bulgaria	0.16	0.20	0.16	0.13	0.12	0.16	0.22	0.21	0.23	0.26
5	Croatia	2.21	2.43	2.48	2.25	2.08	1.97	1.92	2.32	2.41	2.46
6	Cyprus	21.00	23.90	23.80	25.80	25.00	23.00	22.50	26.90	27.20	30.70
7	Czech Republic	29.20	32.50	33.60	37.80	37.10	34.10	38.90	45.10	46.60	54.00
8	Denmark	0.93	1.35	1.53	1.18	1.07	1.34	2.20	2.44	1.93	1.18
9	Estonia	0.78	0.90	0.94	1.18	1.36	1.29	1.75	1.32	1.17	1.28
10	Finland	4.98	5.95	6.78	7.97	7.45	7.54	8.10	8.39	9.48	8.28
11	France	9.95	10.00	9.96	12.20	11.20	11.50	11.20	11.90	12.60	12.40
12	Germany	0.10	0.09	0.09	0.09	0.09	0.08	0.11	0.11	0.12	0.14
13	Greece	0.12	0.13	0.13	0.12	0.20	0.21	0.30	0.27	0.48	0.51
14	Hungary	16.40	15.50	16.70	19.40	17.80	16.60	18.00	21.80	24.20	27.30
15	Ireland	1.84	1.71	1.56	2.06	1.61	1.72	1.71	1.98	2.19	2.66
16	Italy	1.06	1.02	1.10	1.22	1.50	0.94	0.94	1.35	1.30	0.98
17	Latvia	0.40	0.45	0.34	0.39	0.58	0.51	0.56	0.91	1.11	1.18
18	Lithuania	0.34	0.35	0.27	0.25	0.26	0.33	0.41	0.43	0.43	0.81
19	Netherlands	0.28	0.29	0.29	0.31	0.29	0.32	0.33	0.42	0.40	0.50
20	Poland	7.14	7.16	7.59	7.64	6.70	6.29	7.18	8.67	8.90	10.00
21	Portugal	3.72	3.70	3.79	4.77	3.39	3.21	3.32	3.43	3.78	4.38
22	Romania	37.80	40.50	39.70	43.60	41.80	34.30	35.30	37.70	38.10	43.80
23	Slovakia	1.02	1.11	1.16	1.37	1.41	1.43	1.52	1.96	1.87	2.06
24	Slovenia	2.02	2.06	1.88	1.72	1.69	1.80	1.66	2.34	2.11	2.63
25	Spain	0.16	0.20	0.16	0.13	0.12	0.16	0.22	0.21	0.23	0.26
26	Sweden	2.21	2.43	2.48	2.25	2.08	1.97	1.92	2.32	2.41	2.46
27	United Kingdom	21.00	23.90	23.80	25.80	25.00	23.00	22.50	26.90	27.20	30.70
<b>US export to the EU</b>											
		157.02	167.03	169.59	188.23	179.32	164.87	176.41	200.60	208.67	232.38
<b>% of total US export to the EU</b>											
		17.8%	18.0%	18.3%	18.9%	19.5%	19.3%	21.1%	21.8%	22.2%	22.5%
<b>Total US export</b>											
		616	612	615	776	721	687	717	811	884	994

Source: own study based on The Observatory of Economic Complexity data.

Over the considered period, the United States exported more than all the EU countries (such as Germany, the United Kingdom (UK), France and the Netherlands). The US exports of goods and services to Germany amounted to USD 1,039.2 B in 1997-2017 USD. In the period considered for this survey, the highest volume of US exports to Germany was in 2015 – USD 63.3 B and the lowest in 1997 – USD 29.2 B. In the same period, the US exported to the UK goods and services with the value of USD 889.8 B with the highest export value to the UK in 2008 – USD 51.8 B and the lowest in 2002 – USD 34.03 B. Total US exports to France in 1997-2017 equalled to USD 656.8 B, with the lowest volume in 1997 – USD 21 B and the highest in 2013 – USD 41 B. Over the considered period, the US exported to the Netherlands goods for a value of USD 554.5 B. In the considered years, the highest value was in 2017 – USD 35.2 B and the lowest in 1998 – USD 15.5 B. In all the EU member states, there was a noticeable increase in US export volumes.

**Table 2.**  
*US exports to the EU in 2007-2017 in USD billion*

No. <sup>1</sup>	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	4.83	4.68	3.41	3.99	4.85	5.11	5.28	5.46	5.47	3.91	5.94
2, 3	23.4	25.7	20.8	22.1	26.6	28.4	34.2	34	33.8	31.4	29.4
4	0.524	0.808	0.435	0.182	0.288	0.239	0.266	0.377	0.278	0.246	0.253
5	0.471	0.616	0.534	0.563	0.514	0.459	0.226	0.386	0.336	0.318	0.395
6	0.163	0.206	0.134	0.128	0.224	0.136	0.0986	0.103	0.0726	0.14	0.0896
7	2.52	2.78	2.07	2.63	2.81	2.91	2.97	3.58	3.13	3.12	3.71
8	3.01	3.22	2.48	2.34	2.30	2.25	1.97	2.46	2.11	2.17	1.75
9	0.33	0.36	0.23	0.26	0.32	0.28	0.36	0.39	0.33	0.33	0.27
10	2.62	2.71	1.81	2.24	2.05	2.48	2.36	2.88	1.99	2.01	2.05
11	34.30	36.90	33.10	33.50	37.40	38.20	41.00	39.30	38.10	37.90	37.30
12	56.10	61.50	50.20	53.60	61.20	60.30	60.70	61.60	63.30	60.20	61.60
13	2.23	2.38	2.00	1.57	1.17	0.75	0.63	0.67	0.67	0.78	0.74
14	1.53	1.90	1.48	1.54	1.88	1.88	2.12	2.00	1.89	1.97	2.14
15	9.23	9.02	9.80	8.06	8.25	6.65	6.93	7.45	12.00	12.30	17.30
16	13.90	16.60	12.40	13.90	17.20	15.70	15.00	16.40	15.50	15.20	16.60
17	0.22	0.20	0.16	0.14	0.21	0.18	0.17	0.18	0.12	0.14	0.22
18	0.67	0.69	0.37	0.40	0.46	0.63	0.72	0.62	0.51	0.46	0.55
19	32.90	36.30	23.50	28.10	33.50	34.20	34.40	34.60	34.90	33.20	35.20
20	3.27	4.82	3.21	4.16	4.37	4.68	5.17	5.17	4.91	5.29	6.09
21	1.31	1.71	1.18	1.07	1.51	1.61	1.50	1.22	0.99	1.01	1.01
22	0.92	1.19	0.67	0.86	1.07	1.08	0.82	0.95	0.75	0.72	1.25
23	0.99	0.99	0.52	0.56	0.67	0.65	0.68	0.86	0.79	0.73	0.86
24	0.72	0.93	0.68	0.69	0.92	0.63	0.77	0.62	0.65	0.42	0.26
25	13.10	15.90	11.30	11.80	13.70	11.80	13.20	13.20	13.70	13.80	14.90
26	4.66	5.24	4.56	4.68	5.28	5.30	4.31	3.99	3.74	3.64	3.52
27	49.60	51.80	42.70	43.10	47.60	42.80	37.80	44.40	44.80	46.00	46.60
<b>US export to EU</b>											
	263.51	289.16	229.74	242.16	276.35	269.30	273.64	282.85	284.83	277.41	290.00
<b>% of total US export to EU</b>											
	24.17%	23.32%	23.73%	21.06%	20.62%	19.51%	19.27%	19.51%	20.64%	21.02%	23.20%
<b>Total US export</b>											
	1090	1240	968	1150	1340	1380	1420	1450	1380	1320	1250

Source: own study based on The Observatory of Economic Complexity data.

Total US imports grew in 1997-2000 and 2001-2008 (Tab. 3 and Tab. 4), whereas between 2012-2017 they remained at a similar level. Over the surveyed period, total US imports declined in 2001 and 2009. They reached values ranging from USD 754 B up to USD 2,190 B. For the 21 years covered in this survey, they increased more than threefold. A similar situation occurred with US imports from the EU countries and in 1997-2017 US imports from the EU grew from USD 150.81 B (1997) to USD 403.25 B (2015).

For the 21 years studied, the volume of US imports from the EU equalled USD 6.255 trillion. US imports from the EU in the years 1997-2017 were about 30% higher than US export to the EU with these imports constituting between 16.85% (2012) and 21.52% (1998) of total US imports. Over the years 1997-2017, the value of US imports from the EU fluctuated, but with a general downward trend. This shows that, in international trade, the EU is a more valuable partner for the US than vice versa, as the EU had a positive trade balance with the US. Because of this, the EU could try to influence the US to implement a more restrictive CO<sub>2</sub> emission policy. If the trade balance for the EU was negative, this would be harder to achieve, because the US would have less to lose.

<sup>1</sup> Number of the country from table 1.

**Table 3.***US imports from the EU in USD billions in 1997-2006*

No.		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Austria	2.29	2.46	2.74	3.23	3.96	3.87	4.53	5.98	6.29	8.23
2,3	Belgium & Luxembourg	5.92	6.68	6.95	7.56	7.94	8.57	8.62	10.90	11.70	13.40
4	Bulgaria	0.18	0.19	0.20	0.25	0.35	0.34	0.45	0.54	0.46	0.51
5	Croatia	0.10	0.10	0.14	0.17	0.17	0.18	0.23	0.27	0.36	0.36
6	Cyprus	0.02	0.03	0.03	0.03	0.03	0.02	0.00	0.02	0.00	0.05
7	Czech Republic	0.61	0.66	0.74	1.02	1.16	1.45	1.41	1.73	2.30	2.45
8	Denmark	2.11	2.19	2.49	3.04	3.52	3.13	3.79	4.03	5.45	5.68
9	Estonia	0.10	0.14	0.22	0.46	0.23	0.18	0.20	0.39	0.49	0.61
10	Finland	2.90	3.22	3.24	3.74	4.52	4.27	4.27	4.15	4.29	5.24
11	France	18.30	21.80	22.40	27.70	28.00	26.70	27.30	30.30	32.80	35.20
12	Germany	42.40	48.90	53.20	56.60	58.70	62.50	67.60	77.50	83.40	90.70
13	Greece	0.47	0.53	0.59	0.64	0.57	0.57	0.82	0.79	0.90	1.02
14	Hungary	1.00	1.41	1.73	2.21	2.18	1.85	2.07	2.24	2.49	2.41
15	Ireland	5.70	8.69	11.10	16.10	16.90	21.80	25.80	26.80	28.50	26.80
16	Italy	17.70	19.70	21.00	25.30	24.10	24.30	25.60	28.30	31.10	32.60
17	Latvia	0.12	0.10	0.10	0.23	0.15	0.17	0.39	0.34	0.38	0.24
18	Lithuania	0.10	0.12	0.15	0.22	0.24	0.33	0.36	0.53	0.63	0.63
19	Netherlands	6.72	6.64	7.43	9.12	8.82	9.30	10.30	12.10	13.90	16.50
20	Poland	0.74	0.80	0.82	1.16	1.01	1.30	1.42	1.96	2.08	2.47
21	Portugal	1.19	1.28	1.36	1.58	1.59	1.70	2.01	2.46	2.42	3.01
22	Romania	0.40	0.41	0.47	0.48	0.53	0.76	0.77	0.87	1.23	1.15
23	Slovakia	0.17	0.16	0.18	0.24	0.22	0.26	1.08	1.42	1.19	2.02
24	Slovenia	0.27	0.29	0.28	0.32	0.29	0.36	0.66	0.62	0.44	0.57
25	Spain	4.56	4.55	4.82	5.90	5.34	5.62	6.76	7.66	8.68	10.10
26	Sweden	6.93	7.52	7.39	9.35	8.71	9.34	11.10	12.10	13.80	13.70
27	United Kingdom	29.80	31.40	35.00	40.70	38.30	38.00	41.20	45.00	49.30	51.00
<b>Total US Import from the EU</b>											
		150.81	169.99	184.77	217.35	217.51	226.87	248.74	279.01	304.59	326.65
<b>% of total US import from the EU</b>											
		20.00%	21.52%	20.90%	18.74%	20.14%	20.44%	20.73%	19.93%	19.16%	18.45%
<b>Total US import</b>											
		754	790	884	1160	1080	1110	1200	1400	1590	1770

Source: own study based on The Observatory of Economic Complexity data.

US imports from the EU were mostly from Germany, UK, France and Italy. From Germany, in the years 1997-2017, the US imported goods and services for a value of USD 1,777.1 B. In the period considered for this survey, the highest volume of US imports from Germany was in 2015 (USD 123 B) and the lowest in 1997 (USD 42.4 B). Over the same period, the US imported from the UK goods and services for a value of USD 959.5 B. The highest volume being in 2008 – USD 56.4 B and the lowest in 1997 – USD 29.8 B. Total US imports from France in 1997-2017 reached a value of USD 680.2 B. The lowest volume was in 1997 (USD 18.3 B) and the highest in 2016 (USD 40.4 B). From Italy, over the analysed period, the United States imported USD 655.2 B. In these years, the highest value for imports was in 2017 (USD 45 B) and the lowest in 1997 (USD 17.7 B). Over the studied period, the volume of the US imports increased for all the EU member states.

**Table 4.**  
*US imports from the EU in USD billions in 2007-2017*

No. <sup>2</sup>	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	10.10	8.18	5.95	6.83	9.08	9.42	9.73	10.40	11.00	10.90	10.50
2,3	16.60	18.20	12.60	14.20	15.80	15.00	16.10	16.50	18.60	17.50	14.10
4	0.46	0.40	0.26	0.31	0.44	0.54	0.53	0.54	0.59	0.57	0.59
5	0.39	0.39	0.27	0.35	0.43	0.43	0.39	0.39	0.45	0.54	0.44
6	0.01	0.00	0.02	0.00	0.00	0.06	0.08	0.07	0.04	0.07	0.05
7	2.57	2.64	1.98	2.47	3.35	3.79	3.87	4.18	4.27	4.14	3.88
8	6.14	6.62	6.02	6.32	6.98	7.01	5.75	7.62	7.85	7.92	6.87
9	0.37	0.52	0.28	0.62	1.09	0.71	0.50	0.64	0.57	0.93	0.59
10	6.09	6.57	5.33	5.26	4.37	5.14	4.94	5.20	4.58	4.73	5.55
11	38.30	39.50	30.70	33.50	35.50	36.60	39.80	40.30	39.10	40.40	36.00
12	94.40	98.40	70.80	83.40	98.60	108.00	113.00	121.00	123.00	113.00	112.00
13	1.25	1.32	0.96	0.87	1.05	1.07	1.00	1.04	1.35	1.29	1.14
14	2.48	2.96	2.07	2.27	2.64	2.77	3.42	4.88	5.19	5.26	4.20
15	28.80	28.70	25.80	28.50	31.30	27.30	22.20	28.50	34.30	41.20	40.20
16	34.70	35.70	25.80	28.60	34.40	35.70	38.10	40.80	43.00	43.70	45.00
17	0.27	0.23	0.15	0.20	0.32	0.23	0.27	0.25	0.28	0.31	0.44
18	0.46	0.78	0.56	0.63	0.96	1.00	1.39	1.11	1.11	1.23	1.55
19	17.70	18.50	12.50	15.50	20.00	20.50	18.20	19.80	16.40	15.50	16.40
20	2.27	2.77	2.65	3.17	4.43	4.48	4.96	5.22	5.33	5.63	5.71
21	3.01	2.37	1.55	2.11	2.51	2.59	2.85	3.07	3.28	3.20	3.50
22	1.08	1.11	0.71	0.98	1.39	1.55	1.63	1.96	2.01	1.86	1.97
23	2.20	1.31	0.61	1.14	1.37	1.73	1.75	1.99	2.14	2.39	2.88
24	0.52	0.48	0.35	0.43	0.51	0.52	0.55	0.64	0.64	0.68	0.69
25	10.50	11.10	8.39	8.71	11.30	11.70	11.70	14.00	13.60	13.40	14.20
26	12.90	12.30	8.13	10.70	11.50	10.40	9.53	10.20	9.87	9.69	9.82
27	54.30	56.40	45.10	48.80	49.80	52.30	50.20	51.00	54.70	52.00	45.20
<b>Total US Import from the EU</b>											
	347.88	357.46	269.54	305.86	349.12	360.55	362.44	391.29	403.25	398.04	383.46
<b>% of total US import from the EU</b>											
	18.70%	17.87%	18.46%	16.99%	16.95%	16.85%	17.02%	17.87%	18.67%	18.78%	17.75%
<b>Total US import</b>											
	1860	2000	1460	1800	2060	2140	2130	2190	2160	2120	2160

Source: own study based on The Observatory of Economic Complexity data.

The US had a positive trade balance with 7 EU members in all survey periods. They are: Belgium & Luxembourg, Cyprus, France, the Netherlands, Spain and UK. The same situation was present when taking the whole EU as one economy. The US had a negative trade balance with 5 EU members in 1997-2017, namely: Bulgaria, Czech Republic, Estonia, Hungary and Romania. With the remaining 15 EU members, the US had both a positive and a negative trade balance for different years of the survey.

### 3.2. Official-Closed emission data for the US and the EU

Reduction of CO<sub>2</sub> emissions is one of the major priorities of the EU energy policy. However, this reduction of CO<sub>2</sub> emissions concerns only the EU and, except for encouragement, there are few other possibilities to convince other countries to undertake similar actions.

Official-Closed CO<sub>2</sub> emission is the value of CO<sub>2</sub> emitted by a country's economy. Tab. 5, 7 present data for the US and 27 members of the EU. Until 2004, the United States was the world's largest CO<sub>2</sub> emitter and, in 2017, was responsible for 15.08% of total global CO<sub>2</sub>

<sup>2</sup> Number of the country from table 3.



emissions. Since 2005, the US is in second position after China. In the same year, the 27 EU countries included in this survey were responsible for 10.65% of the world's CO<sub>2</sub> emissions. In the years 1997-2017, the US emitted a total of 115.33 BT of CO<sub>2</sub>. In 1997-2017, the US emission of CO<sub>2</sub> had values between 5,014.4 and 5,851.3 MT of CO<sub>2</sub>. In 1997-2000, 2001-2005, 2006-2007, 2009-2010, 2012-2014, CO<sub>2</sub> emission in the US increased. However, the last four years of the survey were the longest period of decline of US CO<sub>2</sub> emission. The highest volume of US CO<sub>2</sub> emissions in the considered time period was in 2005 and the lowest in 2017. The biggest emitters of CO<sub>2</sub> inside the EU in the studied period were: Germany, UK, Italy, France, Spain and Poland.

**Table 5.**

*US and EU Official-Closed CO<sub>2</sub> emissions in MT in 1990, 1997-2006*

No.		1990	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Austria	55.9	61.8	61.9	61.5	61.6	66.4	67.3	73.3	72.0	74.0	71.9
2,3	Belgium & Luxembourg	138.8	146.3	150.0	143.8	148.1	148.9	147.6	155.2	155.5	151.8	153.6
4	Bulgaria	74.3	56.2	53.9	46.1	43.4	46.8	45.4	49.0	47.2	48.9	50.1
5	Croatia	21.5	16.9	18.2	18.8	17.7	18.5	19.6	21.0	20.3	20.8	20.9
6	Cyprus	5.0	6.9	7.2	7.6	8.0	8.1	7.9	8.5	8.3	9.3	9.1
7	Czech Republic	155.3	127.3	121.6	113.9	124.0	124.8	121.0	124.2	125.0	123.5	125.4
8	Denmark	55.8	69.2	64.9	61.5	57.5	57.7	56.8	62.0	56.0	53.3	61.7
9	Estonia	38.3	20.0	18.5	16.9	17.4	17.8	17.8	19.6	20.2	19.6	19.1
10	Finland	57.5	63.1	60.5	60.2	59.7	64.6	67.8	76.2	70.0	59.4	69.6
11	France	369.7	362.2	385.0	384.6	381.9	383.5	380.2	387.1	389.1	390.0	380.3
12	Germany	1003.1	883.3	874.2	851.8	849.5	866.0	852.6	857.9	843.7	822.2	840.1
13	Greece	82.6	94.2	99.6	98.0	103.6	105.8	105.1	108.4	108.6	109.1	110.1
14	Hungary	72.5	57.6	58.0	59.2	55.5	57.3	56.0	58.5	57.2	57.4	57.2
15	Ireland	31.0	37.3	40.0	42.1	43.4	46.4	45.7	45.3	45.5	47.7	47.5
16	Italy	401.9	413.2	426.3	430.7	435.2	432.6	434.5	453.1	471.1	472.3	470.2
17	Latvia	18.4	8.3	8.0	7.4	6.9	7.7	7.9	7.8	8.5	8.7	8.4
18	Lithuania	36.1	14.1	14.7	12.7	10.9	12.1	11.6	11.8	12.3	13.1	13.4
19	Netherlands	195.9	218.9	219.9	216.6	218.4	228.5	228.6	228.6	235.1	237.7	235.3
20	Poland	374.0	349.7	330.1	323.3	299.4	297.7	294.2	303.4	301.7	307.0	320.2
21	Portugal	39.9	51.5	57.4	63.0	62.0	61.0	64.3	60.6	62.3	65.1	60.3
22	Romania	178.2	115.0	101.5	86.0	88.5	90.8	93.9	98.0	98.9	94.2	99.2
23	Slovakia	55.3	40.3	40.1	39.1	37.2	38.9	38.5	38.8	37.8	38.6	37.2
24	Slovenia	13.3	15.2	14.7	14.3	14.0	14.7	14.9	14.8	15.0	15.2	15.7
25	Spain	216.2	263.7	274.4	298.6	309.6	313.6	332.2	338.4	359.5	373.0	366.9
26	Sweden	67.6	61.5	68.7	65.5	57.9	59.4	60.1	64.6	62.2	60.7	61.7
27	United Kingdom	593.0	554.6	556.1	547.0	563.0	574.3	553.9	563.9	569.3	576.3	579.9
28	US	4946.6	5490.3	5528.4	5577.1	5748.3	5636.8	5651.9	5717.5	5816	5851.3	5771

Source: own study based on BP report data.

Between 1997-2017, country emissions of CO<sub>2</sub> within the EU were as follows: Germany (17,042 MT), UK (11,038.8 MT), Italy (8,664 MT), France (7,540 MT), Spain (6,610.9 MT), and Poland (6,537.1 MT). In 1997-2017, the highest emission of CO<sub>2</sub> in Poland was in 1997 (349.7 MT) and the lowest in 2014 and 2015 (292.9 MT). In the surveyed period, the highest emission of CO<sub>2</sub> in Spain was in 2007 (378.7 MT) and the lowest in 1997 (263.7 MT). In France, for the same period, the highest emission of CO<sub>2</sub> was in 2005 (390 MT) and the lowest in 2014 (302.3 MT). In Italy, for the years 1997-2017, the highest emission of CO<sub>2</sub> was

in 2005 (472.3 MT) and the lowest in 2014 (330.2 MT). In the UK, in the same period, the highest emission of CO<sub>2</sub> was in 2006 (579.9 MT) and the lowest in 2017 (403.2 MT). The highest emission of CO<sub>2</sub> in Germany was in 1997 (883.3 MT) and the lowest in 2014 (748.4 MT).

**Table 6.**

*EU and US % of Official-Closed CO<sub>2</sub> emissions in 1997-2006 in relation to 1990*

No.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	110.6%	110.7%	110.0%	110.2%	118.8%	120.4%	131.1%	128.8%	132.4%	128.6%
2,3	105.4%	108.1%	103.6%	106.7%	107.3%	106.3%	111.8%	112.0%	109.4%	110.7%
4	75.6%	72.5%	62.0%	58.4%	63.0%	61.1%	65.9%	63.5%	65.8%	67.4%
5	78.6%	84.7%	87.4%	82.3%	86.0%	91.2%	97.7%	94.4%	96.7%	97.2%
6	138.0%	144.0%	152.0%	160.0%	162.0%	158.0%	170.0%	166.0%	186.0%	182.0%
7	82.0%	78.3%	73.3%	79.8%	80.4%	77.9%	80.0%	80.5%	79.5%	80.7%
8	124.0%	116.3%	110.2%	103.0%	103.4%	101.8%	111.1%	100.4%	95.5%	110.6%
9	52.2%	48.3%	44.1%	45.4%	46.5%	46.5%	51.2%	52.7%	51.2%	49.9%
10	109.7%	105.2%	104.7%	103.8%	112.3%	117.9%	132.5%	121.7%	103.3%	121.0%
11	98.0%	104.1%	104.0%	103.3%	103.7%	102.8%	104.7%	105.2%	105.5%	102.9%
12	88.1%	87.1%	84.9%	84.7%	86.3%	85.0%	85.5%	84.1%	82.0%	83.8%
13	114.0%	120.6%	118.6%	125.4%	128.1%	127.2%	131.2%	131.5%	132.1%	133.3%
14	79.4%	80.0%	81.7%	76.6%	79.0%	77.2%	80.7%	78.9%	79.2%	78.9%
15	120.3%	129.0%	135.8%	140.0%	149.7%	147.4%	146.1%	146.8%	153.9%	153.2%
16	102.8%	106.1%	107.2%	108.3%	107.6%	108.1%	112.7%	117.2%	117.5%	117.0%
17	45.1%	43.5%	40.2%	37.5%	41.8%	42.9%	42.4%	46.2%	47.3%	45.7%
18	39.1%	40.7%	35.2%	30.2%	33.5%	32.1%	32.7%	34.1%	36.3%	37.1%
19	111.7%	112.3%	110.6%	111.5%	116.6%	116.7%	116.7%	120.0%	121.3%	120.1%
20	93.5%	88.3%	86.4%	80.1%	79.6%	78.7%	81.1%	80.7%	82.1%	85.6%
21	129.1%	143.9%	157.9%	155.4%	152.9%	161.2%	151.9%	156.1%	163.2%	151.1%
22	64.5%	57.0%	48.3%	49.7%	51.0%	52.7%	55.0%	55.5%	52.9%	55.7%
23	72.9%	72.5%	70.7%	67.3%	70.3%	69.6%	70.2%	68.4%	69.8%	67.3%
24	114.3%	110.5%	107.5%	105.3%	110.5%	112.0%	111.3%	112.8%	114.3%	118.0%
25	122.0%	126.9%	138.1%	143.2%	145.1%	153.7%	156.5%	166.3%	172.5%	169.7%
26	91.0%	101.6%	96.9%	85.7%	87.9%	88.9%	95.6%	92.0%	89.8%	91.3%
27	93.5%	93.8%	92.2%	94.9%	96.8%	93.4%	95.1%	96.0%	97.2%	97.8%
28	110.99%	111.76%	112.75%	116.21%	113.95%	114.26%	115.58%	117.58%	118.29%	116.67%

Source: own study based on BP report data.

If we consider Official-Closed Emission of CO<sub>2</sub> for 2017, the US, as well as 12 EU countries, did not achieve one of the three main aims of the EU energy policy – reduction of CO<sub>2</sub> emission to a level of 80% of 1990 emissions. However, most of the EU countries (15) had already fulfilled this requirement by this same year (Tab. 6, 8).

In the whole survey period, the US never achieved a value of CO<sub>2</sub> emission lower than in 1990. At the same time, six members of the EU, namely: Bulgaria, Estonia, Latvia, Lithuania, Romania and Slovakia, met this value for the whole surveyed period. On the other hand, over this period, 11 EU members never achieved CO<sub>2</sub> emissions below 80% of 1990 emissions. These were; Austria, Belgium & Luxembourg, Cyprus, France, Greece, Ireland, Italy, the Netherlands, Portugal, Slovenia and Spain. The rest of the EU members achieved emissions of CO<sub>2</sub> in-line with the EU energy policy goal.

**Table 7.***US and the EU Official-Closed CO<sub>2</sub> emissions in MT in 2007-2017*

No.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	68.2	69.0	62.9	68.1	62.4	60.4	59.6	56.4	59.4	59.7	62.5
2,3	152.8	154.2	141.2	150.4	136.8	132.3	132.7	124.7	131.4	133.2	136.3
4	53.4	50.6	43.7	45.8	50.7	46.1	41.0	43.3	46.1	43.2	45.8
5	22.0	21.1	19.8	19.0	18.3	16.6	16.1	15.8	16.2	16.7	17.1
6	9.3	9.5	9.2	8.8	8.7	8.1	7.3	7.3	7.5	8.1	8.3
7	124.9	120.0	113.3	116.3	112.8	109.0	104.8	101.7	102.9	104.9	103.0
8	56.8	54.2	50.6	51.3	46.4	41.0	43.4	40.1	36.8	38.0	35.5
9	22.1	21.0	18.8	23.0	23.9	23.5	24.6	24.3	22.4	22.6	24.4
10	67.5	60.0	57.4	65.5	57.6	51.5	52.9	48.5	44.7	48.2	45.4
11	371.2	371.1	356.3	361.5	334.9	336.3	336.0	302.3	310.5	315.3	321.4
12	807.2	806.5	751.0	780.6	761.0	770.3	794.6	748.4	751.9	766.6	762.6
13	114.6	108.9	104.2	96.0	95.4	89.8	81.3	77.7	75.1	71.9	77.1
14	55.6	54.4	48.2	48.8	50.3	45.9	43.3	42.3	45.1	45.5	47.9
15	48.4	47.9	43.0	42.6	38.6	38.7	37.5	37.2	39.0	40.5	39.4
16	460.9	446.9	404.0	409.8	399.8	386.6	353.6	330.2	343.1	343.6	346.3
17	8.8	8.6	7.9	9.2	8.3	8.0	8.0	7.7	7.8	8.2	8.0
18	13.2	13.3	12.1	13.2	12.4	12.4	11.7	11.0	11.3	11.7	12.2
19	234.2	231.4	222.6	232.4	224.4	217.3	211.7	200.8	209.2	212.7	205.9
20	317.0	319.2	305.0	322.8	322.6	307.2	309.8	292.9	292.9	305.6	315.4
21	58.7	57.7	56.9	51.5	51.4	50.7	49.3	49.3	53.7	53.0	57.8
22	95.3	93.3	79.7	77.5	83.3	80.1	69.2	69.7	70.6	69.3	72.6
23	35.1	36.3	33.5	36.0	33.5	32.2	32.9	29.8	30.1	30.7	32.8
24	15.7	16.8	15.0	15.2	15.2	14.7	14.1	12.6	12.7	13.6	13.5
25	378.7	352.3	314.4	298.7	308.8	307.2	275.9	273.6	289.2	282.3	299.9
26	59.2	56.1	53.4	56.7	52.0	49.2	48.0	46.2	46.4	46.7	45.9
27	570.2	562.8	516.1	532.6	495.0	511.8	498.4	457.3	438.4	414.7	403.2
28	5861.1	5675.7	5263.9	5465.6	5355.7	5137	5260.5	5300.4	5153.7	5053.7	5014.4

Source: own study based on BP report data.

The Country/Year indicator can be used to verify the reduction of CO<sub>2</sub> level to 80% of the 1990 emission by members of the EU (bearing in mind that, for this survey, Belgium and Luxembourg are considered as one country). The number of “countries” (26) multiplied by 21 years included in this study gives 546 Country/Years (C/Y). So, if we consider E<sub>OC</sub>, then EU member “countries” achieved 201 C/Y, which means that the EU fulfilled the requirement to reduce CO<sub>2</sub> emissions 200 times in 21 years.

**Table 8.***EU and US % of Official-Closed CO<sub>2</sub> emission in 2007-2017 in relation to 1990*

No.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	122.0%	123.4%	112.5%	121.8%	111.6%	108.1%	106.6%	100.9%	106.3%	106.8%	111.8%
2,3	110.1%	111.1%	101.7%	108.4%	98.6%	95.3%	95.6%	89.8%	94.7%	96.0%	98.2%
4	71.9%	68.1%	58.8%	61.6%	68.2%	62.0%	55.2%	58.3%	62.0%	58.1%	61.6%
5	102.3%	98.1%	92.1%	88.4%	85.1%	77.2%	74.9%	73.5%	75.3%	77.7%	79.5%
6	186.0%	190.0%	184.0%	176.0%	174.0%	162.0%	146.0%	146.0%	150.0%	162.0%	166.0%
7	80.4%	77.3%	73.0%	74.9%	72.6%	70.2%	67.5%	65.5%	66.3%	67.5%	66.3%
8	101.8%	97.1%	90.7%	91.9%	83.2%	73.5%	77.8%	71.9%	65.9%	68.1%	63.6%
9	57.7%	54.8%	49.1%	60.1%	62.4%	61.4%	64.2%	63.4%	58.5%	59.0%	63.7%
10	117.4%	104.3%	99.8%	113.9%	100.2%	89.6%	92.0%	84.3%	77.7%	83.8%	79.0%
11	100.4%	100.4%	96.4%	97.8%	90.6%	91.0%	90.9%	81.8%	84.0%	85.3%	86.9%
12	80.5%	80.4%	74.9%	77.8%	75.9%	76.8%	79.2%	74.6%	75.0%	76.4%	76.0%
13	138.7%	131.8%	126.2%	116.2%	115.5%	108.7%	98.4%	94.1%	90.9%	87.0%	93.3%
14	76.7%	75.0%	66.5%	67.3%	69.4%	63.3%	59.7%	58.3%	62.2%	62.8%	66.1%
15	156.1%	154.5%	138.7%	137.4%	124.5%	124.8%	121.0%	120.0%	125.8%	130.6%	127.1%
16	114.7%	111.2%	100.5%	102.0%	99.5%	96.2%	88.0%	82.2%	85.4%	85.5%	86.2%
17	47.8%	46.7%	42.9%	50.0%	45.1%	43.5%	43.5%	41.8%	42.4%	44.6%	43.5%

Cont. table 8.

18	36.6%	36.8%	33.5%	36.6%	34.3%	34.3%	32.4%	30.5%	31.3%	32.4%	33.8%
19	119.6%	118.1%	113.6%	118.6%	114.5%	110.9%	108.1%	102.5%	106.8%	108.6%	105.1%
20	84.8%	85.3%	81.6%	86.3%	86.3%	82.1%	82.8%	78.3%	78.3%	81.7%	84.3%
21	147.1%	144.6%	142.6%	129.1%	128.8%	127.1%	123.6%	123.6%	134.6%	132.8%	144.9%
22	53.5%	52.4%	44.7%	43.5%	46.7%	44.9%	38.8%	39.1%	39.6%	38.9%	40.7%
23	63.5%	65.6%	60.6%	65.1%	60.6%	58.2%	59.5%	53.9%	54.4%	55.5%	59.3%
24	118.0%	126.3%	112.8%	114.3%	114.3%	110.5%	106.0%	94.7%	95.5%	102.3%	101.5%
25	175.2%	163.0%	145.4%	138.2%	142.8%	142.1%	127.6%	126.5%	133.8%	130.6%	138.7%
26	87.6%	83.0%	79.0%	83.9%	76.9%	72.8%	71.0%	68.3%	68.6%	69.1%	67.9%
27	96.2%	94.9%	87.0%	89.8%	83.5%	86.3%	84.0%	77.1%	73.9%	69.9%	68.0%
28	118.49 %	114.74 %	106.41 %	110.49 %	108.27 %	103.85 %	106.35 %	107.15 %	104.19 %	102.17 %	101.37 %

Source: own study based on BP report data.

### 3.3. Actual-Open CO<sub>2</sub> emissions – modified to include trade between the US and the EU

By using formula (1),  $S_B$  CO<sub>2</sub> emissions were calculated for 27 members of the EU plus the US to provide the CO<sub>2</sub> emission balance. If this value is positive, it means that US exports of CO<sub>2</sub> to a given member of the EU are higher than the import of CO<sub>2</sub> from this country. If the value is negative, then the impact was the opposite – imports of CO<sub>2</sub> from a given EU member to the US were higher than the export. If the result is positive, it is added to the amount of emission for the given EU member, but if it is negative, then it is deducted. The results of the calculation are presented in Table 9 and 10.

Over the entire period considered, the US CO<sub>2</sub> emission trade balance with the EU (taken as a whole) was positive. But, while analysing each EU member state separately, the situation looks different. For the EU as a whole, positive CO<sub>2</sub> balance had values of 34.93 MT (1997) and 9.92 MT (2016). From 1990-2017, the US had a negative CO<sub>2</sub> balance with 5 EU countries: Bulgaria, Czech Republic, Estonia, Hungary and Romania. Poland would also be in this group, if not for 1997 (the only year when the US had a positive CO<sub>2</sub> balance with Poland). The US had, for the whole survey period, a positive CO<sub>2</sub> balance with 6 EU countries: Belgium & Luxembourg, Cyprus, France, the Netherlands, Spain and the UK.

**Table 9.**

*US CO<sub>2</sub> emissions balance ( $S_B$ ) in 1997-2006 in MT*

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Austria	1.19	1.00	1.02	1.02	0.81	0.72	0.42	0.23	0.24	0.16
2, 3	Belgium & Luxembourg	3.39	3.20	3.04	3.17	2.76	2.56	3.15	3.41	3.54	3.57
4	Bulgaria	-0.23	-0.21	-0.22	-0.24	-0.40	-0.37	-0.49	-0.51	-0.35	-0.39
5	Croatia	0.10	0.09	0.06	0.05	0.06	0.07	0.09	0.06	0.05	0.03
6	Cyprus	0.33	0.20	0.16	0.17	0.20	0.12	0.18	0.05	0.04	0.08
7	Czech Republic	-0.03	-0.03	-0.04	-0.21	-0.30	-0.48	-0.41	-0.43	-0.78	-0.76
8	Denmark	0.47	0.48	0.33	0.20	0.07	0.20	-0.06	0.26	-0.05	-0.03
9	Estonia	-0.09	-0.11	-0.22	-0.51	-0.22	-0.13	-0.14	-0.35	-0.39	-0.43
10	Finland	0.08	0.13	0.16	-0.04	-0.44	-0.47	-0.64	-0.28	-0.09	-0.51
11	France	7.25	7.55	7.11	7.22	6.54	5.81	5.29	6.57	6.06	6.87
12	Germany	1.64	1.16	0.53	1.83	0.41	-1.91	-1.71	-1.55	-2.31	-1.72
13	Greece	0.26	0.42	0.47	0.28	0.24	0.36	0.64	0.74	0.46	0.11
14	Hungary	-0.21	-0.39	-0.57	-0.61	-0.52	-0.33	-0.25	-0.46	-0.60	-0.50
15	Ireland	0.80	0.34	0.07	-0.53	-1.14	-2.04	-2.59	-2.41	-2.39	-2.34
16	Italy	1.13	0.48	0.03	0.21	-0.02	-0.01	-0.71	-1.24	-1.66	-2.11
17	Latvia	-0.02	-0.01	-0.01	-0.06	-0.03	-0.04	-0.10	-0.08	-0.09	-0.02

Cont. table 9.

18	Lithuania	-0.01	-0.01	-0.02	-0.04	-0.02	-0.05	-0.01	-0.09	-0.04	-0.02
19	Netherlands	5.85	5.25	5.42	6.14	5.21	4.43	4.62	5.48	5.70	5.94
20	Poland	0.01	-0.07	-0.13	-0.13	-0.20	-0.39	-0.50	-0.78	-0.79	-0.92
21	Portugal	0.21	0.13	0.10	0.11	0.23	-0.07	-0.14	-0.10	-0.15	-0.39
22	Romania	-0.22	-0.17	-0.22	-0.21	-0.16	-0.36	-0.35	-0.24	-0.34	-0.26
23	Slovakia	0.04	0.05	0.00	-0.05	-0.03	-0.02	-0.49	-0.63	-0.47	-0.66
24	Slovenia	0.01	0.01	0.02	0.02	0.02	0.00	-0.10	-0.04	0.01	0.00
25	Spain	2.34	2.23	2.17	1.89	1.56	1.22	1.27	1.54	1.25	1.30
26	Sweden	0.62	0.34	0.47	0.81	0.22	0.04	-0.28	-0.27	-0.31	-0.07
27	United Kingdom	10.01	10.43	8.79	8.89	8.25	5.39	4.92	4.84	3.73	5.15
28	27 EU	34.93	32.48	28.51	29.38	23.11	14.26	11.61	13.74	10.26	12.07

Source: own study based on BP report, CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION Highlights and The Observatory of Economic Complexity data.

For 21 the surveyed years, the US had the highest positive  $S_B$  CO<sub>2</sub> emission with: France (152.93 MT), the UK (132.24 MT), Netherlands (127.68 MT) and Belgium & Luxembourg (91.52 MT). At the same time, the US had the biggest negative  $S_B$  CO<sub>2</sub> with: Ireland (-30.09 MT), Germany (-28.23 MT), Italy (-19.83 MT) and Poland (-14.45 MT). The highest US  $S_B$  value was in 1998 with the UK (10.43 MT) and the lowest in 2015 with Germany (-5.35 MT).

**Table 10.**

*US balance of CO<sub>2</sub> emissions ( $S_B$ ) in 2007-2017 in MT*

No.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	0.14	0.36	0.26	0.27	0.30	0.29	0.32	0.35	0.11	-0.38	0.20
2, 3	4.36	4.48	4.08	4.08	5.40	5.75	7.47	7.42	6.14	5.33	5.24
4	-0.30	-0.09	-0.07	-0.21	-0.33	-0.41	-0.33	-0.32	-0.41	-0.36	-0.38
5	0.05	0.11	0.10	0.09	0.05	0.03	-0.03	0.02	-0.02	-0.05	0.00
6	0.06	0.08	0.04	0.05	0.08	0.02	0.01	0.01	0.01	0.02	0.01
7	-0.56	-0.43	-0.36	-0.43	-0.80	-1.01	-0.96	-0.82	-0.98	-0.95	-0.59
8	0.13	0.14	-0.07	-0.15	-0.18	-0.14	-0.10	-0.11	-0.19	-0.21	-0.17
9	-0.22	-0.35	-0.19	-0.63	-1.13	-0.67	-0.43	-0.54	-0.44	-0.77	-0.49
10	-0.56	-0.48	-0.62	-0.57	-0.27	-0.24	-0.27	-0.08	-0.21	-0.29	-0.37
11	8.05	8.47	7.70	7.63	8.75	8.06	8.70	8.40	7.39	6.75	6.76
12	-0.25	0.46	1.88	0.49	0.35	-3.47	-4.96	-4.67	-5.35	-4.86	-4.19
13	0.44	0.47	0.41	0.29	0.04	-0.13	-0.12	-0.11	-0.21	-0.15	-0.14
14	-0.40	-0.44	-0.23	-0.28	-0.34	-0.35	-0.40	-0.83	-1.04	-1.04	-0.69
15	-2.21	-2.58	-1.56	-2.53	-2.34	-2.38	-1.26	-1.73	-0.50	-1.33	0.58
16	-1.73	-0.93	-0.52	-0.45	-0.38	-1.46	-1.62	-1.24	-2.37	-2.67	-2.55
17	0.00	0.01	0.01	-0.02	-0.03	-0.01	-0.02	-0.01	-0.04	-0.05	-0.05
18	0.11	0.02	-0.05	-0.08	-0.14	-0.10	-0.15	-0.08	-0.12	-0.18	-0.24
19	7.96	8.80	5.13	5.99	6.56	6.05	6.88	6.68	6.86	6.21	6.52
20	-0.39	-0.14	-0.59	-0.62	-1.30	-1.15	-1.25	-1.17	-1.29	-1.43	-1.24
21	-0.22	0.08	0.05	-0.07	-0.02	-0.05	-0.14	-0.28	-0.47	-0.43	-0.55
22	-0.26	-0.12	-0.09	-0.14	-0.31	-0.36	-0.36	-0.43	-0.51	-0.43	-0.30
23	-0.52	-0.15	-0.06	-0.26	-0.26	-0.38	-0.38	-0.33	-0.39	-0.48	-0.62
24	0.11	0.19	0.13	0.12	0.17	0.04	0.09	0.03	0.03	-0.06	-0.10
25	2.40	3.38	2.23	2.48	2.36	1.28	1.99	1.51	1.46	1.53	1.49
26	0.26	0.56	0.70	0.47	0.67	0.73	0.53	0.40	0.31	0.27	0.23
27	7.11	7.00	5.73	5.12	6.86	3.54	2.85	5.71	5.00	5.91	7.00
28	23.57	28.89	24.02	20.63	23.75	13.48	16.04	17.77	12.75	9.92	15.34

Source: own study based on BP report, CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION Highlights and The Observatory of Economic Complexity data.

The EU had negative  $S_B$  CO<sub>2</sub> emissions in all 21 years included in this survey. This means that the value of EU  $E_{AO}$  was higher than  $E_{OC}$ . When considering each member of the EU separately, the situation was different and indicated the degrees of compliance with the requirements of the EU energy policy (20% less emission of CO<sub>2</sub> compared to 1990). The same applied in the case of  $E_{OC}$ . Verification was also carried out using the Country/Year indicator for  $E_{AO}$  (Tab. 11, 12). In this survey, there were 546 C/Y in the EU. So, if we consider  $E_{AO}$ , then the EU member countries achieved 201 C/Y. It means that the EU members fulfil the requirement of reduction of CO<sub>2</sub> emission 201 times in 21 years, considering 26 countries. Thus, despite a negative  $S_B$  for the whole EU, the C/Y indicator for  $E_{AO}$  is precisely on the same level as for  $E_{OC}$ .

**Table 11.**  
*EU and US % of  $E_{AO}$  in 1997-2006 in relation to 1990*

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	Austria	112.68%	112.53%	111.84%	112.02%	120.23%	121.68%	131.88%	129.22%	132.81%	128.90%
2,3	Belgium & Luxembourg	107.84%	110.37%	105.79%	108.99%	109.27%	108.18%	114.09%	114.49%	111.91%	113.23%
4	Bulgaria	75.33%	72.26%	61.75%	58.09%	62.44%	60.61%	65.30%	62.84%	65.34%	66.91%
5	Croatia	79.05%	85.07%	87.71%	82.55%	86.35%	91.47%	98.09%	94.71%	96.96%	97.37%
6	Cyprus	144.68%	148.05%	155.18%	163.35%	165.92%	160.44%	173.63%	166.91%	186.87%	183.63%
7	Czech Republic	81.95%	78.28%	73.31%	79.71%	80.17%	77.60%	79.71%	80.21%	79.02%	80.26%
8	Denmark	124.85%	117.16%	110.81%	103.40%	103.53%	102.14%	111.00%	100.82%	95.43%	110.52%
9	Estonia	51.99%	48.02%	43.55%	44.09%	45.91%	46.13%	50.82%	51.83%	50.16%	48.74%
10	Finland	109.88%	105.45%	104.97%	103.75%	111.58%	117.10%	131.41%	121.25%	103.15%	120.16%
11	France	99.93%	106.18%	105.95%	105.25%	105.50%	104.41%	106.14%	107.03%	107.13%	104.72%
12	Germany	88.22%	87.27%	84.97%	84.87%	86.37%	84.81%	85.35%	83.96%	81.74%	83.58%
13	Greece	114.36%	121.09%	119.21%	125.76%	128.38%	127.68%	132.00%	132.37%	132.65%	133.43%
14	Hungary	79.15%	79.46%	80.87%	75.71%	78.32%	76.79%	80.34%	78.27%	78.34%	78.20%
15	Ireland	122.91%	130.12%	136.04%	138.28%	145.99%	140.85%	137.76%	138.99%	146.15%	145.66%
16	Italy	103.09%	106.19%	107.17%	108.34%	107.63%	108.11%	112.56%	116.91%	117.10%	116.47%
17	Latvia	44.98%	43.43%	40.16%	37.19%	41.71%	42.71%	41.82%	45.75%	46.81%	45.54%
18	Lithuania	39.04%	40.69%	35.13%	30.07%	33.46%	32.00%	32.65%	33.83%	36.17%	37.05%
19	Netherlands	114.73%	114.93%	113.33%	114.62%	119.30%	118.95%	119.05%	122.81%	124.25%	123.14%
20	Poland	93.51%	88.24%	86.41%	80.02%	79.55%	78.56%	80.99%	80.46%	81.88%	85.37%
21	Portugal	129.61%	144.18%	158.16%	155.67%	153.47%	160.98%	151.54%	155.89%	162.78%	150.15%
22	Romania	64.41%	56.86%	48.14%	49.55%	50.87%	52.49%	54.80%	55.37%	52.67%	55.52%
23	Slovakia	72.94%	72.60%	70.70%	67.18%	70.28%	69.58%	69.28%	67.22%	68.95%	66.08%
24	Slovenia	114.37%	110.62%	107.67%	105.41%	110.67%	112.05%	110.53%	112.46%	114.37%	118.07%
25	Spain	123.05%	127.95%	139.12%	144.08%	145.77%	154.22%	157.11%	166.99%	173.10%	170.30%
26	Sweden	91.89%	102.14%	97.58%	86.85%	88.19%	88.96%	95.15%	91.61%	89.33%	91.17%
27	United Kingdom	95.21%	95.54%	93.73%	96.44%	98.24%	94.32%	95.92%	96.82%	97.81%	98.66%
28	27 EU	95.22%	95.56%	94.20%	94.31%	95.77%	95.14%	97.48%	98.05%	97.89%	98.76%
29	US	110.29%	111.10%	112.17%	115.61%	113.49%	113.97%	115.35%	117.30%	118.08%	116.42%

Source: own study based on BP report, CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION Highlights and The Observatory of Economic Complexity data.

Actual-Open emission of CO<sub>2</sub> was calculated using formula (2) and showed very small changes in the percentage of AO CO<sub>2</sub> emission in relation to 1990. Because of this, the influence of  $S_B$  on AO CO<sub>2</sub> emission in all the EU members was insignificant and did not result in changes in the degree of fulfilment of the EU energy policy (CO<sub>2</sub> 20% below the 1990 level). None of the EU members in any of the surveyed years managed to reduce CO<sub>2</sub> emission levels below 80% of 1990 emission. Positive  $S_B$  in the case of the US was so small, that there were no significant differences between the percentage of  $E_{AO}$  and  $E_{OC}$  CO<sub>2</sub> emission, especially in

relation to 1990. Thus, one can conclude that the US did not fulfil the EU energy policy (reduction of CO<sub>2</sub> emission) in any of the surveyed years.

Considering AO Emission of CO<sub>2</sub>, in 2017, neither the US nor 12 of the EU countries achieved a reduction of CO<sub>2</sub> emission to the level of 80% of 1990. However, most of the EU countries (15) already fulfilled this requirement in 2017 (Tab. 11, 12). The same situation was in the case of OC CO<sub>2</sub> emissions.

The US, in the whole survey period, never achieved a value of AO CO<sub>2</sub> emission lower than in 1990. At the same time, 6 EU members achieved this in the whole survey period (Bulgaria, Estonia, Latvia, Lithuania, Romania and Slovakia). On the other hand, 11 EU members never achieved CO<sub>2</sub> emission below 80% of the 1990 emission levels (Austria, Belgium & Luxembourg, Cyprus, France, Greece, Ireland, Italy, the Netherlands, Portugal, Slovenia and Spain). The remaining surveyed EU members met the EU energy policy CO<sub>2</sub> emissions target at least once. This was likewise the case for OC CO<sub>2</sub> emissions.

**Table 12.**  
*EU and US % of  $E_{AO}$  in 2007-2017 in relation to 1990*

No.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	122.25%	124.08%	112.98%	122.30%	112.17%	108.56%	107.20%	101.52%	106.45%	106.12%	112.17%
2, 3	113.23%	114.32%	104.67%	111.30%	102.45%	99.46%	100.99%	95.19%	99.09%	99.80%	101.97%
4	71.47%	67.98%	58.72%	61.36%	67.79%	61.50%	54.74%	57.84%	61.49%	57.66%	61.13%
5	102.57%	98.64%	92.58%	88.80%	85.35%	77.35%	74.73%	73.59%	75.26%	77.43%	79.52%
6	187.16%	191.56%	184.79%	176.93%	175.58%	162.50%	146.15%	146.23%	150.17%	162.39%	166.17%
7	80.06%	76.99%	72.72%	74.61%	72.12%	69.54%	66.86%	64.96%	65.63%	66.93%	65.95%
8	102.03%	97.38%	90.55%	91.66%	82.83%	73.23%	77.59%	71.67%	65.61%	67.72%	63.31%
9	57.13%	53.91%	48.58%	58.40%	59.46%	59.60%	63.10%	62.02%	57.33%	56.99%	62.44%
10	116.42%	103.52%	98.75%	112.92%	99.71%	89.15%	91.53%	84.21%	77.37%	83.31%	78.31%
11	102.58%	102.67%	98.46%	99.85%	92.95%	93.15%	93.24%	84.04%	85.98%	87.11%	88.76%
12	80.45%	80.45%	75.06%	77.87%	75.90%	76.45%	78.72%	74.14%	74.42%	75.94%	75.61%
13	139.27%	132.40%	126.64%	116.58%	115.55%	108.56%	98.28%	93.93%	90.67%	86.87%	93.17%
14	76.14%	74.43%	66.16%	66.92%	68.92%	62.83%	59.17%	57.20%	60.77%	61.33%	65.12%
15	149.01%	146.20%	133.67%	129.26%	116.96%	117.15%	116.90%	114.40%	124.19%	126.36%	128.97%
16	114.25%	110.96%	100.39%	101.85%	99.38%	95.83%	87.58%	81.85%	84.78%	84.83%	85.53%
17	47.85%	46.78%	42.98%	49.87%	44.92%	43.42%	43.34%	41.78%	42.17%	44.31%	43.19%
18	36.88%	36.90%	33.38%	36.35%	33.97%	34.08%	32.00%	30.26%	30.96%	31.92%	33.13%
19	123.61%	122.61%	116.25%	121.69%	117.90%	114.01%	111.58%	105.91%	110.29%	111.75%	108.43%
20	84.65%	85.31%	81.39%	86.14%	85.91%	81.83%	82.50%	78.00%	77.97%	81.33%	84.00%
21	146.56%	144.81%	142.73%	128.91%	128.77%	126.93%	123.22%	122.86%	133.41%	131.76%	143.47%
22	53.34%	52.29%	44.67%	43.41%	46.57%	44.75%	38.63%	38.87%	39.33%	38.65%	40.57%
23	62.54%	65.36%	60.48%	64.64%	60.10%	57.54%	58.81%	53.29%	53.73%	54.64%	58.18%
24	118.91%	127.77%	113.79%	115.16%	115.53%	110.85%	106.67%	94.98%	95.75%	101.82%	100.75%
25	176.27%	164.52%	146.45%	139.31%	143.92%	142.68%	128.54%	127.25%	134.44%	131.28%	139.40%
26	87.96%	83.82%	80.03%	84.56%	77.91%	73.86%	71.79%	68.93%	69.10%	69.49%	68.23%
27	97.35%	96.09%	88.00%	90.68%	84.63%	86.90%	84.53%	78.08%	74.77%	70.93%	69.17%
28	97.55%	95.88%	88.81%	90.87%	87.98%	86.42%	84.43%	79.72%	80.60%	80.82%	81.72%
29	118.01%	114.16%	105.93%	110.08%	107.79%	103.58%	106.02%	106.79%	103.93%	101.96%	101.06%

Source: own study based on BP report, CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION Highlights and The Observatory of Economic Complexity data.

## 4. Discussion

It is worth emphasizing, that the actions undertaken by the EU with regard to implementing the EU energy policy are limited only to the EU area. Between 1997 and 2017, the US had a positive trade balance with the EU as a whole only in 1997. Over the period of the survey, the total foreign trade balance of the EU reached a value of USD 1,432.14 billion. Despite this, in every analysed year, the EU imported more CO<sub>2</sub> than it had exported to the US and the total volume of this excess was 416.49 MT of CO<sub>2</sub>. One conclusion must be that a positive trade balance with the US does not guarantee a lower Actual-Open CO<sub>2</sub> emission for the EU.

What influences this figure are CO<sub>2</sub> emissions for a particular country inside the EU (without including other countries), % of GDP exported from a particular country, % of GDP of other countries imported into a particular country.

In the aspect of CO<sub>2</sub> transfer, the impact of trade between the US and the EU was found to be insignificant. But it must be remembered, that the EU as a whole does not have a positive trade balance with every country and the same applies for each of the EU members. An assumption is possible in the case of countries that have a positive trade balance with the EU, which will have a much bigger impact on increasing E<sub>AO</sub> inside the EU.

What can – or should – the EU do in this situation? What challenges does the EU face? There are two possibilities. One is doing nothing and trying to “live through it” without any changes. The EU will be content with its energy policy, with a reduction of CO<sub>2</sub> emission inside the EU. But it will change very little. The EU will still import CO<sub>2</sub> from outside the region through products and services and will continue to contribute to CO<sub>2</sub> emission reduction programmes, not only inside, but also outside the EU. The second option is to change the EU approach to energy policy to be a more global one. The EU should take into account CO<sub>2</sub> emissions, which are imported into the EU. The EU should think about some instruments, which would encourage countries from outside the EU to undertake similar activities to reduce CO<sub>2</sub> emission. An example of this are various kinds of ecological taxes (Fortuński, 2012, 2013, 2016; Fortuński, *Wykorzystanie...*, 2013; Fortuński, *Wpływ...*, 2016; Fortuński, *Globalna...*, 2016; Bogrocz, 2008; Graczyk, Jakubczyk, 2005; Kaczmarek, 2010; Kryk, 2012, Kryk, *Wzrost...*, 2012). The actual emission of CO<sub>2</sub> also highlights the ineffectiveness of international agreements, such as the Kyoto Agreement for reducing emissions of CO<sub>2</sub>.

The main challenges in the case of the second solution are retaliatory actions by the countries, from which the EU imports and on which each of these “ecological taxes” or other instruments would be imposed, which will, among others, increase transaction costs. The other challenge will still be how to promote the reduction of CO<sub>2</sub> emission in countries outside the EU?



## 5. Conclusion

The European Union is regarded as the leader in the fight against global warming, the battle for clean energy and reduction of CO<sub>2</sub> emissions. Unfortunately, its actions are isolated, which leads to a situation where even such a large economy as the EU, although strongly economically related to other countries through trade, is not able to change much with this issue. The EU and the US are leaders in world trade. The EU could use its position in international trade to achieve its own energy policy goals – the reduction of CO<sub>2</sub> emissions. Trade relates to the import of CO<sub>2</sub> hidden in goods and services imported into the EU from the US. It affects the Actual-Open CO<sub>2</sub> emissions in all the member countries of the EU. 12 members of the EU, already in 2017, had achieved a reduction of CO<sub>2</sub> emissions at least 20% below 1990 levels. Because of an insignificant influence on E<sub>AO</sub>, for a number of countries that achieved this goal in 2017, their E<sub>OC</sub> figure did not change after including trade with the US. The impact of US international trade with the EU was positive in the whole period considered in the survey. Thus, the impact of the trade on CO<sub>2</sub> emissions was small because of the positive trade balance the EU had with the US. If there had been a negative trade balance with the EU, then the influence of the US on the EU CO<sub>2</sub> emissions would be much greater. This situation was caused by four indicators: GDP of a country, % of exported GDP, % of imported GDP and the Official-Closed emission of CO<sub>2</sub>. All of these together caused an insignificant difference between E<sub>OC</sub> and E<sub>AO</sub> in both the US and the EU. This was also shown by the Country/Year Indicator when the numbers were the same for both E<sub>OC</sub> and E<sub>AO</sub>.

The effectiveness of implementing the UE energy policy by its members is limited only to the territory of the EU. This can result in the EU energy policy not being seen as a sustainable development strategy, because of its potential high cost. If the EU is interested in the reduction of CO<sub>2</sub> emissions, it must consider this factor. Because of those high costs, EU countries try to reduce it by importing parts, components and products from cheaper countries, which very often had a bigger CO<sub>2</sub> emission component, which could be due to the fact that, in those countries, environmental law is not as strict as in the EU.

This situation brings some challenges ahead for the EU, especially in terms of the CO<sub>2</sub> energy policy. The survey presented has shown that the EU should consider some changes in its energy policy to take into account more global aspects of CO<sub>2</sub> emissions. The results of this research indicate that CO<sub>2</sub> emission is a global problem and it requires consideration by the EU of the introduction of new instruments that would be an incentive for countries outside the EU to undertake effective actions aimed at reducing CO<sub>2</sub> emissions. For this purpose, new instruments, such as an eco-energy tax, could be introduced, which the EU would apply to all trading partners, individual countries or groups of countries, based – for instance – on the total volume of particular countries' export to the EU (Bielecki, Zalewski, Fortuński, 2016, pp. 43-46). Unfortunately, however, implementing these instruments could also result in retaliatory actions from trading partners outside the EU, and so, as part of a potential implementation process, the matter would need to be clearly defined and discussed.

## References

1. Bielecki, S., Zalewski, P., and Fortuński, B. (2016). *Wybrane Problemy zarządzania energetyką*. Warszawa: Texter.
2. Bogrocz-Koczwara, M., and Herlender, K. (2008). Bezpieczeństwo energetyczne a rozwój odnawialnych energii. *Energetyka, Vol. 3*, 194-197.
3. CO2 EMISSIONS FROM FUEL COMBUSTION, IEA, 2019, <https://webstore.iea.org/co2-emissions-from-fuel-combustion-2019-highlights>, 25.02.2020.
4. Fezzigna, P., Borghesi, S., Caro, D. (2019). Revising Emission Responsibilities through Consumption-Based Accounting: A European and Post-Brexit Perspective. *Sustainability, Vol. 11*, 488-500. doi:10.3390/su11020488.
5. Fortuński, B. (2012). „Wyniki” proekologicznego podejścia do energetyki w Unii Europejskiej w oparciu o model EFQM. In: T. Borys, P. Rogala (Eds.), *Orientacja na wyniki we współczesnej gospodarce*, 265 (pp. 113-125). Wrocław: Prace Naukowe Uniwersytetu Ekonomicznego.
6. Fortuński, B. (2013). Wykorzystanie wybranych surowców energetycznych w kontekście polityki energetycznej Unii Europejskiej. In: A. Graczyk (Eds.), *Efektywne gospodarowanie zasobami przyrodniczymi i energią*, 317 (pp. 13-22). Wrocław: Prace Naukowe Uniwersytetu Ekonomicznego.
7. Fortuński, B. (2013). Wyzwania i problemy zrównoważonego rozwoju w energetyce światowej w kontekście polityki energetycznej UE. In: B. Kryk (Eds.), *Handel wewnętrzny* (pp. 300-310). Warszawa: IBRKK.
8. Fortuński, B. (2016). Globalna sprawiedliwość a polityka energetyczna Unii Europejskiej. In: O. Janikowska, J. Słodczyk (Eds.), *Globalna sprawiedliwość* (pp. 163-183). Opole: Wydawnictwo Uniwersytetu Opolskiego.
9. Fortuński, B. (2016). Polityka energetyczna Unii Europejskiej – 3x20. Diagnoza i perspektywy w kontekście zrównoważonego rozwoju. In: A. Becla, K. Kociszewski (Eds.), *Ekonomia środowiska i polityka ekologiczna*, 453 (pp. 179-189). Wrocław: Prace Naukowe Uniwersytetu Ekonomicznego.
10. Fortuński, B. (2016). Wpływ handlu zagranicznego Unii Europejskiej na rzeczywista emisję CO<sub>2</sub>. In: W. Michalczyk (Eds.), *Ekonomia XXI Wieku* (pp. 109-120). Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego.
11. Graczyk, A., Jakubczyk, Z. (2005). Rozwój rynku energii elektrycznej w Polsce w kontekście integracji z Unią Europejską. *Prace Naukowe Akademii Ekonomicznej we Wrocławiu*, 156. Wrocław: Wydawnictwo AE, pp. 155-168.
12. Hasanov, F.J., Liddle B., Mikayilov, J.I. (2018). The impact of international trade on CO<sub>2</sub> emissions in oil exporting countries: Territory vs consumption emissions accounting. *Energy Economics, Vol. 74*, 343-350.

13. Kaczmarek, M. (2010). *Bezpieczeństwo energetyczne Unii Europejskiej*. Warszawa: Wydawnictwa Akademickie i Profesjonalne.
14. Knight, K.W., Schor, J.B. (2014). Economic Growth and Climate Change: A Cross-National Analysis of Territorial and Consumption-Based Carbon Emissions in High-Income Countries. *Sustainability, Vol. 6*, 3722-3731. doi:10.3390/su6063722.
15. Kryk, B. (2012). Kontrowersje polskiej polityki energetycznej w kontekście realizacji wymogów unijnych. *Ekonomia i Prawo, Vol. 11*, pp. 151-166.
16. Kryk, B. (2012). Wzrost efektywności energetycznej – wyzwanie inwestycyjne dla polskiego sektora energetycznego. In: Ł. Dymek, K. Bedrunka (Eds.), *Kapitał ludzki i społeczny w rozwoju regionalnym, t. I* (pp. 149-168). Opole: Politechnika Opolska.
17. Liddle, B. (2018). Consumption-Based Accounting and the Trade-Carbon Emissions Nexus in Asia: A Heterogeneous, Common Factor Panel Analysis. *Sustainability, Vol. 10*, 3227-3239. doi:10.3390/su10103627.
18. The Observatory of Economic Complexity. Available <http://atlas.media.mit.edu/en/profile/country/deu/#Exports>, 25.02.2020.
19. The World Bank Data Catalog, <https://data.worldbank.org/indicator/NE.EXP.GNFS.CD?locations=US-CN-RU-IN-EU>, 25/02/2020.
20. The World Bank Data Catalog, <http://data.worldbank.org/data-catalog/world-development-indicators>, 25.02.2020.