The Analysis of Low-carbon Development of Czech Republic Economy

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Abstract: The Czech Republic is one of the dynamically developing countries of the European Union. However, economic development should take place while maintaining the quality of the environment. Air quality in the Czech Republic is worse than in most of the old European Union countries (EU-15). Air quality is negatively affected by road transport, heating buildings, agriculture and industry. Despite a number of actions taken to pursue low-carbon development, a lot remains to be done. Poor air quality contributes to over 11,000 premature deaths each year. The article evaluates the eco-efficiency of currently used solutions in the energy, industry and other sectors of the economy that have a negative impact on the environment. The publication also indicates the potential of using renewable energy sources (RES), which are an important element of low-carbon development. In addition, the article is to present the economic determinants of low-carbon development. In addition, the article analyses the development of renewable energy sources and ways to reduce greenhouse gas emission (GHG).

Keywords: economy; low-carbon development; energy; emission; Czech Republic

JEL Classification: O11; Q53; Q56

1. Introduction

The economic development that has taken place in the Czech Republic over the past three decades has largely translated into the quality of life of the inhabitants. However, economic development has gone hand in hand with improving the quality of the environment (Zarębska and Dzikuć 2013). To a significant extent, this concerns the emission of greenhouse gases into the atmosphere. It should be noticed that in the Czech Republic, in addition to excessive GHG emission, other substances that are harmful to human health and the environment are released into the air, e.g. benzo(a)pyrene – B(a)P (Frankowski 2020; Woźniak and Pactwa 2018). Harmful substances that often accompany GHG emission contribute to the premature death of approximately 11,000 people in the Czech Republic each year (European Environment Agency 2018). It needs to be emphasized that the changes caused by excessive GHG emission are spread over time. However, an increasing number of violent atmospheric phenomena, such as fires in early 2020 in Australia.

The article evaluates the eco-efficiency of currently used solutions in the energy, industry and other sectors of the economy that have a negative impact on the environment (Usubharatana and Phungrassami 2018). The publication also indicates the potential of using renewable energy sources (RES), which are an important element of low-carbon development (Effiong et al. 2020).

2. Methodology and Goal

The aim of the article is to present the economic determinants of low-carbon development. In addition, the article analyses the development of renewable energy sources and ways to reduce greenhouse gas emission. The aim of the article is to analyse low-carbon development in the Czech Republic. Moreover, the purpose of the research is to identify, describe and explain phenomena that are associated with low-carbon development and its impact on the Czech economy (Oroszet et al. 2019; Poór et al. 2015). The research was carried out as part of the: Economic aspects of low carbon development in the countries of the Visegrad Group grant.

The methodology of own research was adapted to the assumed goal and scope of research. The presented research goal was a determinant of the use of methods characteristic of social sciences. To successfully achieve the research objectives, several research methods were used.

- 1. Analysis of the literature on the subject.
- 2. Analysis of source documents
- 3. Tabular and descriptive methods and charts.
- 4. Deductive method
- 5. Methods of descriptive and mathematical statistics.

The collected data was used to conduct low-carbon development in the Czech Republic. The conducted research also partly helped to indicate the directions and perspectives of further low-carbon development.

During the research, a number of statistical data and other information related to the studied issue were based. The acquired data became the basis for the socio-economic characteristics of the assumed scope of research. The research methods used in the article contributed to the achievement of the assumed research goal.

3. Analysis of Gross Domestic Product (GDP) Level and GHG Emissions in the Czech Republic and the EU

Real GDP per capita in the years 2004-2017 grew faster in the Czech Republic than it did in the EU (Eurostat 2019). This indicator is calculated as the ratio of real GDP to the average population in a particular year. Real GDP per capita is a measure of economic activity and also serves as an indicator of the development of the material standard of living in a particular country. However, it should be remembered that this is a limited measure of economic well-being. For instance, GDP does not cover the majority of unpaid homework, nor does it take into account the negative effects of economic activities, such as environmental degradation, which is extremely important due to the subject of the publication.

In recent years, the Czech Republic has developed economically, catching up with the socalled the old Union (EU 15). There are at least several reasons for the dynamic economic development of the Czech Republic, e.g. EU funding, growing internal demand, good condition of the global economy. However, despite the dynamic growth of DGP in the Czech Republic, it still deviates from the EU average. Real GDP per capita in the Czech Republic was 17,200 EUR (Table 1).

GHG emission level can be regulated to some extent by humans. However, these activities are expensive and often the authorities of individual countries are willing to take measures to increase GDP than to introduce solutions that will have less impact on the environment. Reducing GHG emission is possible through the wider use of low-carbon energy generation technologies (Dzikuć et al. 2019a; Llano-Paz et al. 2018). A large part of the efforts to improve the quality of the environment is aimed at decreasing GHG emission. There are several main sources of air pollution: industry, agriculture, transport, energy, households, waste management (Shane et al. 2018; Sztubecka et al. 2020; Piwowar 2019). Analysing the current low-carbon development in the Czech Republic, it should be noticed that there was a decrease in GHG intensity of energy consumption in 2017 compared to 2004. GHG intensity of energy consumption in the entire analysed period should be lower than the EU average. Moreover, this ratio was lower in the Czech Republic than in all neighbouring countries. The Czech Republic has already reached its designated share of RES in total energy production, which has been set for 2020. However, there is still potential for development of RES in the Czech Republic, since fossil energy sources still dominate (Fig. 1).

In analyses regarding low-carbon development, it is important to present how greenhouse gas emission per capita in the Czech Republic have changed compared to the EU average. In 2007-2017, average greenhouse gas emission per capita in the EU decreased. A similar situation also occurred in the Czech Republic. Economic growth did not prevent the Czechs from reducing GHG per capita.

Reducing (carbon dioxide) CO₂ and other greenhouse gas emissions is very important because of the need to slow down global warming (Piwowar and Dzikuć 2019). However, particulate matter PM2.5 and other air pollutants, which contribute to approximately 11,000 of premature deaths annually, are particularly dangerous to human health in the Czech Republic. Despite the measures taken to reduce emissions, concentrations of harmful substances in the air are still too high and contribute to a reduction in the quality of life of the Czechs (Table 2).



Figure 1. Total primary energy supply (TPES) by source, Czech Republic 1990-2018 (International Energy Agency 2019).

Specification	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU	24 410	24820	25 560	26 220	26 240	25 020	25 500	25 900	25 730	25750	$26\ 140$	26 680	$27\ 140$	27 780
Belgium	31 640	$32\ 200$	$32\ 800$	33 760	33 640	32 700	33 330	33 460	33 490	33490	33 870	34360	$34\ 700$	35 250
Bulgaria	3890	4190	4500	4820	5140	4 990	$5\ 050$	5300	5350	5400	5530	5790	$6\ 050$	6310
Czech Republic	$12\ 780$	13570	$14\ 460$	$15\ 190$	15430	14610	14900	$15\ 200$	$15\ 060$	14980	15370	$16\ 160$	16520	$17\ 200$
Denmark	43 520	44 400	45990	$46\ 210$	$45\ 700$	43220	$43\ 840$	44 240	44 170	44410	$44\ 890$	45 630	46~720	47360
Germany	29 470	29 730	30 930	31 920	32 320	30580	$31 \ 940$	33 200	33 280	33 330	33 930	34 220	$34\ 700$	35 420
Estonia	$10\ 090$	$11 \ 110$	$12\ 260$	$13\ 270$	12 640	10830	$11\ 150$	$12\ 010$	$12 \ 430$	12640	$13\ 060$	$13 \ 330$	13650	$14 \ 440$
Ireland	$38\ 190$	$39\ 470$	40400	41300	38 600	36 300	36 790	36 760	36 690	37010	39890	$49\ 470$	50710	$54\ 240$
Greece	20850	$20 \ 910$	22 030	22 690	22 560	21 530	20 320	18500	$17\ 240$	16800	$17\ 040$	$17\ 080$	$17\ 110$	17 410
Spain	23 020	23 420	$24\ 000$	24380	$24\ 200$	$23\ 100$	$23\ 040$	22 770	22 080	21840	22 210	$23\ 080$	23 760	24 410
France	$30\ 050$	30320	30850	$31\ 400$	$31 \ 310$	30250	30 690	31 210	$31\ 160$	31170	$31\ 320$	31540	31~770	32 370
Croatia	062 6	$10\ 200$	$10\ 700$	$11\ 260$	11460	10630	10480	10480	$10\ 280$	10260	$10\ 290$	10590	$11 \ 050$	$11\ 500$
Italy	28 030	28 090	28 480	28 730	28 230	26 590	26 930	27 020	26 090	25480	25 420	25 640	$26\ 010$	26500
Cyprus	22 300	23 050	23 740	24 420	24 680	23 550	23 400	22 900	21 780	20400	$20\ 240$	$21 \ 040$	22 360	23 120
Latvia	7 290	$8\ 170$	9 220	$10\ 220$	066 6	$8\ 710$	8 500	9 200	9 700	10030	10310	10740	$11 \ 030$	11560
Lithuania	7 260	7 950	8 670	9 750	$10\ 110$	$8\ 710$	9 030	6 790	10300	10780	$11\ 250$	11590	$12 \ 040$	12 720
Luxembourg	75 270	76460	79 190	84 420	$81\ 880$	76900	$79\ 160$	79 310	77 240	78030	79 490	81300	82 880	82 550
Hungary	9 490	9910	10330	10370	10500	9810	006 6	$10\ 110$	$10\ 010$	10230	10690	$11 \ 130$	$11 \ 410$	$11 \ 930$
Malta	$14 \ 340$	$14\ 790$	$15\ 000$	15550	15960	15450	15920	$16\ 070$	16370	16910	$18\ 030$	19520	$20\ 180$	20.940
Netherlands	35 920	36570	37 780	39 120	$39\ 810$	$38\ 160$	38 470	38 880	38 340	38180	38580	$39\ 170$	39810	40~730
Austria	33 200	33710	$34\ 700$	35870	$36\ 280$	34830	35390	36 300	36390	36180	$36\ 130$	$36\ 140$	36430	37 090
Poland	7 250	7510	7 980	8550	8910	9 070	6 390	9860	$10\ 020$	10170	10510	10920	$11\ 260$	$11\ 820$
Portugal	16500	16600	16840	$17\ 230$	$17\ 260$	$16\ 710$	16990	$16\ 720$	$16\ 110$	16050	$16\ 260$	16620	$17\ 010$	17 650
Romania	4860	$5\ 120$	5560	$6\ 050$	6 730	6410	6 190	6 350	6510	6 760	7 020	7 320	7 720	8 320
Slovenia	15990	16570	17460	18570	$19\ 190$	17570	17750	17870	17360	17160	$17\ 620$	17990	18540	19430
Slovakia	9 350	9 960	10800	11960	$12\ 600$	$11\ 890$	12540	12 980	$13\ 200$	13270	13 620	$14\ 270$	14550	$14 \ 970$
Finland	33 440	$34\ 250$	35490	$37\ 210$	37 330	$34\ 150$	$35\ 080$	35810	$35\ 140$	34660	34390	$34\ 470$	35 280	36 270
Sweden	36860	37 770	39 290	$40 \ 340$	39 930	37910	39 920	40820	40 270	40360	$41\ 060$	42 430	42 910	43 350
United Kingdom	29 460	$30\ 160$	30790	$31\ 280$	30.940	29 420	29 750	29 960	30 200	30660	31 220	$31\ 700$	$32\ 050$	32 460

Table 1. Real GDP per capita in 2004-2017. (Eurostat 2019)

Specification	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU	97.6	96.7	96.1	96.3	94.8	93.8	92.5	92.1	91.8	90.5	89.1	88.7	87.6	86.6
Belgium	101.5	100.2	99.7	99.4	96.1	93.4	90.5	87.1	90.3	86.5	85.5	89.4	82.9	82.4
Bulgaria	108.1	104	103.3	113.2	113.5	114.9	117.8	122.3	115.4	108.8	109.9	111.5	106.1	107.9
Czech Republic	89.2	89.5	87.6	88.4	86.4	87.6	83.3	84.9	82.4	77.8	78.2	78.8	80.6	76.9
Denmark	97.5	93.3	100.6	94.4	90.9	91.8	87.6	84.2	78.4	81.9	77.3	72.5	73.1	67.3
Germany	96.9	94.9	93.4	95.3	95	94.1	94.2	96.4	9.96	9.96	95.3	95.4	95	93.5
Estonia	100.4	100.7	98.7	107.4	98.4	95	105.9	105.4	100.5	98.9	101.8	92.5	92.3	101.6
Ireland	98.2	100	98.4	94.8	96	90.8	90.8	90.2	89.5	90.4	88.1	87.5	86.2	84.9
Greece	97.7	9.66	98	100	96.6	95.4	94.9	96.3	93.5	93.5	89.7	85.4	81.8	83.1
Spain	99.7	101.8	99.1	99.7	95	92.2	87.5	88.8	87.9	84.8	86.6	88.6	84	84.8
France	94.2	94.4	93.2	91.4	89.8	90	88.7	84.3	84.9	84.8	80.1	80.4	82.4	83.2
Croatia	101.8	101.8	102.6	104.4	101.5	99.5	96.6	97.5	95.9	93.7	93	90.5	91.7	90.6
Italy	98	96.3	95.8	94	93.5	90.1	06	90	89.6	86.6	87.6	86.1	86.3	82.4
Cyprus	105.3	106.5	105.1	105	101.7	103.2	103.2	100.9	100.5	100	100.8	100.5	9.66	97.8
Latvia	93.6	92.7	94.2	95.4	94.1	89.6	96.4	91.5	84.6	85.4	83.6	86.5	87.2	83.9
Lithuania	87.1	66	100.9	95.3	93.7	93.7	125.7	113.6	112.6	112.7	108.9	106.6	106.7	102.5
Luxembourg	108.3	108.8	108.5	104.7	103.9	105.4	104.5	105	105.5	102.9	100.5	96.2	92.9	91.6
Hungary	98.6	90.6	90.3	89.7	90.1	86.5	84.6	83.3	81.6	79.7	79.2	79.4	80.2	79.8
Malta	86.3	88.8	88.9	89.6	90.5	90.5	86.3	89.2	90.3	88.7	87.2	72.4	62.8	62.2
Netherlands	97.7	96.8	95	95.5	98.2	97.3	97.3	96.2	94.4	96	96.9	100	98	95.8
Austria	105.5	103.5	98.5	95.3	93	93	91.4	90.5	87.7	86.2	82.9	84.1	84.8	86.2
Poland	100.2	99.1	97.4	97.1	94.4	95.2	93	92	93.7	92.2	91.9	92.1	90.7	90.2
Portugal	96.1	97.3	95.2	06	88.9	88.3	83.5	84.5	87	82.9	80.8	85.4	83.6	86.8
Romania	97.1	97.6	95.3	96.6	97.2	96.7	90.4	93.6	93.1	92.2	92.2	90.9	88.5	83.1
Slovenia	96.3	95.5	96.3	96.8	97	97.8	95.7	95.9	96.2	94.2	86.1	87.9	90.3	86.2
Slovakia	97	96.2	94.6	94.4	93.3	94.5	90.4	91.8	88	86.6	84.6	84.5	84.8	83
Finland	105.8	94	104.1	102.3	92.4	95.3	99.7	90.6	84.8	87.3	78.7	76	78	73.5
Sweden	93.1	90.3	92.4	91	87.9	93.1	90.3	82.7	78.3	76.6	74.5	76.2	70.7	70.5
United Kingdom	100.1	98.7	99.8	101.2	100.3	99.2	98.2	97	98.7	97.7	94.8	89.4	86.1	84.6

 Table 2. Greenhouse gas emissions intensity of energy consumption in 2004-2017. (Eurostat 2019)

4. Prospects for Low-carbon Development in the Czech Republic

Low One of the important elements supporting low-carbon development, which until now has not been used effectively in the Czech Republic, is taxation of environmentally harmful activities. The share of environmental taxes in GDP in the Czech Republic is one of the lowest in the EU (Fig. 2). One of the taxes supporting environmental protection is the air pollution charge that has existed in the Czech Republic since 1967, which was last changed in 2012, when charges increased by around 37%. At the same time, fossil fuel subsidies have been reduced over the past decade, mainly through the gradual abolition of excise duty refunds for diesel fuel used in agriculture (Eurostat 2019; Tucki et al. 2019).



Figure 2. Environmental tax revenues as % of GDP in 2017. (Eurostat 2019)

The Czech tax structure is characterized by a high percentage of labour taxation income in the country's total income. Increasing the taxation of environmentally damaging activities could reduce the taxation of income from work. However, the point is not to reduce taxes for all employees, because such a reduction would be imperceptible to them. Consideration should be given to extending the offer of solutions (e.g. tax deduction) for people who decide, e.g. to build small installations producing energy based on renewable sources (photovoltaics, biomass, wind energy) (Koryś et al. 2019).

Decreasing the burning of fossil fuels is one important element in reducing greenhouse gas emissions to the air. Maintaining sustainable low-carbon development over the longer term (Azevedo et al. 2019). However, supporting low-carbon development entails significant costs (Adamczyk and Graczyk 2019). In 2017, energy efficiency in the Czech Republic was about twice lower than the average in EU countries (Eurostat 2019). Activities for low-carbon development in the Czech Republic should be oriented towards the implementation of modern technologies that will be more energy-efficient. Moreover, further reduction of the use of fossil energy resources that contribute to excessive greenhouse gas emissions is necessary. The suggested actions are in line with the EU's long-term goals, which are focused on a radical reduction of greenhouse gas emission to the atmosphere (Dzikuć et al. 2019b). In addition, the EU, thanks to its economic and legal tools, can effectively put pressure on the Czech Republic. The attention should be paid to the Europe 2020 strategy, in which the EU allocated approximately 1 trillion EUR to sustainable economic growth. Furthermore, over 20% of the EU budget was dedicated to the transition to a low-carbon European economy (in the 2014-2020 budget). Reducing the use of fossil fuels for low-carbon technologies, including renewable energy, is a serious challenge for the Czech economy and its energy system. However, not investing in low-carbon development may result in high fines being imposed by the EU bodies. Moreover, rising CO₂ emission charges will also be a factor that can help speed up decisions that will increase the share of low-carbon technologies (Lubecki et al. 2019).

An important element of low-carbon development outside the industry and the production of electricity and heat is road transport (Burchart-Korol et al. 2018; Olszowski 2019). Much of the low-carbon development efforts should be geared to reducing the CO₂ emission that arises during road transport (Czekała et al. 2018; Dzikuć and Dzikuć 2018). The increasing number of cars in the Czech Republic in recent years is contributing to the higher level of CO₂ emission. It should be emphasized that in order to effectively reduce GHG emission, various solutions should be implemented, including the development of public transport and the development of electro-mobility. However, in the Czech Republic, almost half of the energy is still produced on the basis of coal, therefore it is necessary to further reduce the share of this fuel, so that the majority of energy is used on the basis of low-carbon technologies (Dzikuć and Łasiński 2014; Szatyłowicz and Skoczko 2019). It should be emphasized, however, that the share of carbon dioxide emissions from the Czech Republic in total global emissions has been limited in the last few decades (Table 3).

Supporting low-carbon development in the Czech Republic will require expanding financial incentives to activities that will implement technologies, which reduce greenhouse gas emission. These co-financing activities should apply to both enterprises and households. Economic instruments supporting ecological low-carbon solutions constitute an effective and efficient element of environmental policy.

Year	Fossil CO ₂ Emissions	CO ₂ emissions change	CO2 emissions per capita	Population	Pop. Change	Share of World's CO2 emissions
2016	111,825,428	1.39	10.53	10,618,857	0.16	0.31
2015	110,295,387	2.22	10.40	10,601,397	0.10	0.31
2014	107,895,488	-3.86	10.19	10,591,108	0.04	0.30
2013	112,230,255	-3.78	10.60	10,586,533	0.05	0.31
2012	116,643,051	-1.77	11.02	10,581,293	0.14	0.33
2011	118,746,545	-1.14	11.24	10,566,517	0.28	0.33
2010	120,113,984	3.79	11.40	10,536,518	0.46	0.34
2009	115,726,118	-6.70	11.03	10,488,155	0.60	0.32
2008	124,040,652	-3.97	11.90	10,425,266	0.65	0.35
2007	129,174,906	1.14	12.47	10,357,538	0.57	0.36
2006	127,714,508	1.50	12.40	10,298,614	0.39	0.36
2005	125,825,458	-2.45	12.27	10,258,167	0.18	0.35
2004	128,979,027	1.13	12.60	10,239,439	0.00	0.36
2003	127,535,671	3.07	12.46	10,239,136	-0.13	0.36

Table 3. Fossil Carbon Dioxide (CO2) emissions of Czechia. (Worldometer 2020)

Year	Fossil CO2 Emissions	CO ₂ emissions change	CO ₂ emissions per capita	Population	Pop. Change	Share of World's CO2 emissions
2002	123,731,756	-4.33	12.07	10,252,261	-0.18	0.35
2001	129,331,507	-0.41	12.59	10,271,008	-0.18	0.36
2000	129,862,968	9.57	12.62	10,289,373	-0.17	0.36
1999	118,523,620	-5.66	11.50	10,306,411	-0.16	0.33
1998	125,629,761	-4.30	12.17	10,323,247	-0.15	0.35
1997	131,270,718	-1.79	12.70	10,338,339	-0.12	0.37
1996	133,663,770	1.18	12.91	10,350,309	-0.08	0.37
1995	132,109,099	0.40	12.75	10,358,193	-0.03	0.37
1994	131,588,352	-4.66	12.70	10,360,969	0.02	0.37
1993	138,027,264	-3.00	13.32	10,358,690	0.05 %	0.39
1992	142,298,702	-6.91	13.74	10,353,028	0.06 %	0.40
1991	152,869,100	-9.45	14.78	10,346,452	0.05 %	0.43
1990	168,823,230	-5.39%	16.33	10,340,875	0.05 %	0.47
1989	178,444,623	-4.48%	17.26	10,335,884	0.05 %	0.50

5. Conclusions

In The article has presented selected aspects of low-carbon development in the Czech Republic. Moreover, the activities were identified which, if implemented, could contribute to low-carbon development. It is necessary to emphasize that the Czech Republic, like other EU countries, is obliged to implement the requirements of EU policy, which places a significant emphasis on CO₂ reduction. There are also a number of options at national level that can affect low-carbon development. These include national fiscal policy, which until now has been used to a limited extent in the Czech Republic. However, educational activities that promote low-carbon solutions should not be restricted. The Czech Republic has some backlog compared to the EU average in terms of energy efficiency and limiting the share of fossil energy resources.

However, the Czech Republic is also successful in the field of renewable energy implementation, because a few years before the set date, they reached their 2020 share. It should be noticed that the implementation of subsequent low-carbon solutions, which will require significant financial outlays, may be more efficient due to growing public acceptance.

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