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Evaluating perspectives of economy "decarbonation" – environmental aspect

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Abstract. The present paper deals with evaluation of economy "decarbonation" perspectives in post-Soviet states. The dynamics of this process over the period of 1990–2014 has been studied and the countries have been ranked respectively. Decoupling of GDP growth and CO2 emissions has been identified. The authors suggest a classification of tools to manage the process.

Introduction
Despite natural resource depletion, growing society's needs, and environmental challenges, current economic systems are based on intensive use of conventional energy sources. This necessitates a reexamination of prevailing management approaches and implementation of new management modes. The promising solution is "decarbonation" of national economies, which implies implementation and development of green economy policies by the end of the 21st century. By 2050, minimum 50% to 70% of electricity will be supplied from renewable energy sources [1]. The decreased technogenic load upon the environment makes decarbonation a promising trend in economic development, which implies intensive development of civil society based on alternative economic approaches.

1. Materials and Methods
The previous research has indicated that the dynamics of greenhouse gas emission depends on the following factors: 1) GDP growth; 2) changes in production patterns, opening up new industries; 3) dynamics of prices for energy sources; 4) implementation of enhanced technologies and innovations; 5) introduction of measures directly or indirectly reducing the amount of emissions.

The 90s of the 20th century turned out to be a hard time for the post-Soviet countries. Breaking of the ties existing within the former economic complex, development of independent national policies, and integration into the global market caused GDP decrease by 18–72%. Country ranking by GDP (PPP) per capita growth (absolute) over the period from 1990 to 2014 is shown in table 1.

Table 1. Dynamics in country ranking by GDP (PPP) per capita growth (absolute) over the period from 1990 to 2014 (dollars, sorted in ascending order)*

Country	1990		2014		GDP (PPP) growth per capita over 25 years	Country's rank by GDP (PPP) growth per capita
	GDP (PPP) per capita	Rank	GDP (PPP) per capita	Rank		
Kazakhstan	3073	5	24020	4	20947	1
Lithuania	6 660	3	27051	1	20391	2
Estonia	7 160	2	26999	2	19839	3
Russia	5709	4	24805	3	19096	4
Latvia	7 720	1	23707	5	15987	5
Azerbaijan	1669	10	17618	7	15949	6
Belarus	2328	8	18161	6	15833	7
Turkmenistan	2191	9	14165	8	11974	8
Armenia	1144	12	7374	11	6230	9
Ukraine	2641	6	8668	9	6027	10
Georgia	2500	7	7653	10	5153	11
Uzbekistan	547	15	5609	12	5062	12
Moldova	1611	11	4979	13	3368	13
Kyrgyzstan	699	14	3361	14	2662	14
Tajikistan	708	13	2688	15	1980	15

**Data provided by International Monetary Fund*

The countries which have improved their rating in terms of GDP based on PPP over 25 years are as follows: Kazakhstan (moved from 5th place in 1990 to 4th place in 2014), Lithuania (moved from 3d to 1st), Estonia (remained at 2nd place), Russia (moved from 4th to 3d), Azerbaijan (moved from 10th to 7th), Belarus (from 8th to 6th). Moldova, Kyrgyzstan, and Tajikistan are at the bottom of the list: Kyrgyzstan remained at the same place, while Tajikistan and Moldova had lower rating in 2014 compare to 1990.

Table 2 presents data on carbon dioxide emissions per capita in post-Soviet countries, as well as country ranking in terms of the emissions. The countries which have significantly decreased their rating over the 25-year period are western post-Soviet states, except for Belarus and Georgia. Russia improved its ranking in 2014 compared to that at the beginning of the period.

Table 2. Dynamics in country ranking by carbon dioxide emissions per capita (absolute) over the period from 1990 to 2014 (sorted in ascending order)

Country	1990		2014		Reduction of CO_2 emissions per capita over 25 years, tons	Country's rank by reduction of CO_2 emissions per capita
	CO_2 emissions per capita, tons	Rank	CO_2 emissions per capita, tons	Rank		
Ukraine	15.10	12	5.50	10	-9.60	1
Estonia	23.58	15	15.14	15	-8.44	2
Lithuania	9.45	9	4.11	8	-5.34	3

Moldova	7.32	6	2.24	5	-5.08	4
Georgia	6.32	5	1.51	4	-4.81	5
Armenia	5.85	3	1.49	3	-4.36	6
Kyrgyzstan	5.37	2	1.31	2	-4.06	7
Azerbaijan	7.38	7	3.33	6	-4.05	8
Latvia	7.64	8	3.69	7	-3.95	9
Russia	16.10	14	12.40	12	-3.70	10
Belarus	10.40	10	7.28	11	-3.12	11
Tajikistan	2.30	1	0.43	1	-1.87	12
Uzbekistan	5.90	4	4.20	9	-1.70	13
Kazakhstan	15.50	13	14.20	14	-1.30	14
Turkmenistan	12.44	11	13.30	13	0.86	15

The dynamics of carbon dioxide emissions per capita in post-Soviet states is illustrated in figure 1.

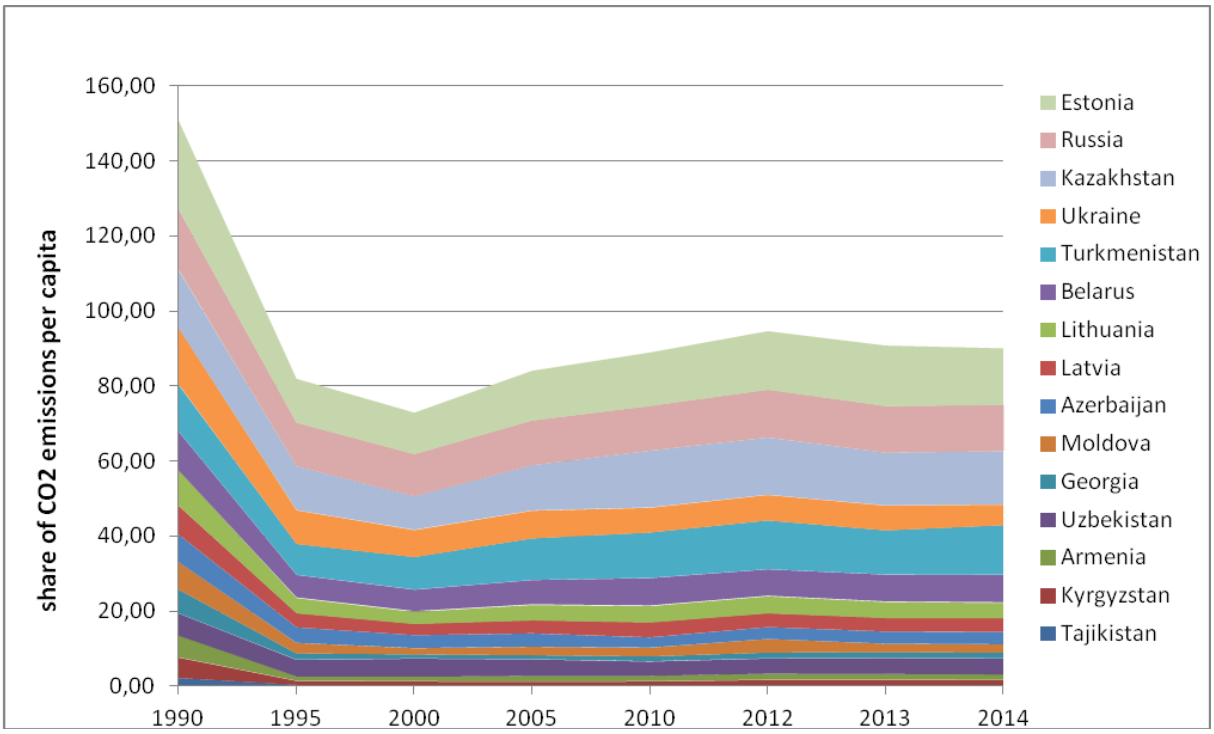

Fig. 1 Dynamics of CO_2 emissions, tons per capita

Over the period 1990–2014 carbon dioxide emissions reduced in all countries by 40 % on average (except for Turkmenistan, where the amount of emissions increased by 6%). Top five countries in terms of emission reduction are Armenia, Georgia, Kyrgyzstan, Moldova, and Tajikistan (75% on average).

The same trend can be observed when the countries are ranked in terms of CO2 emissions per 1,000 dollars of GDP (see figure 2).

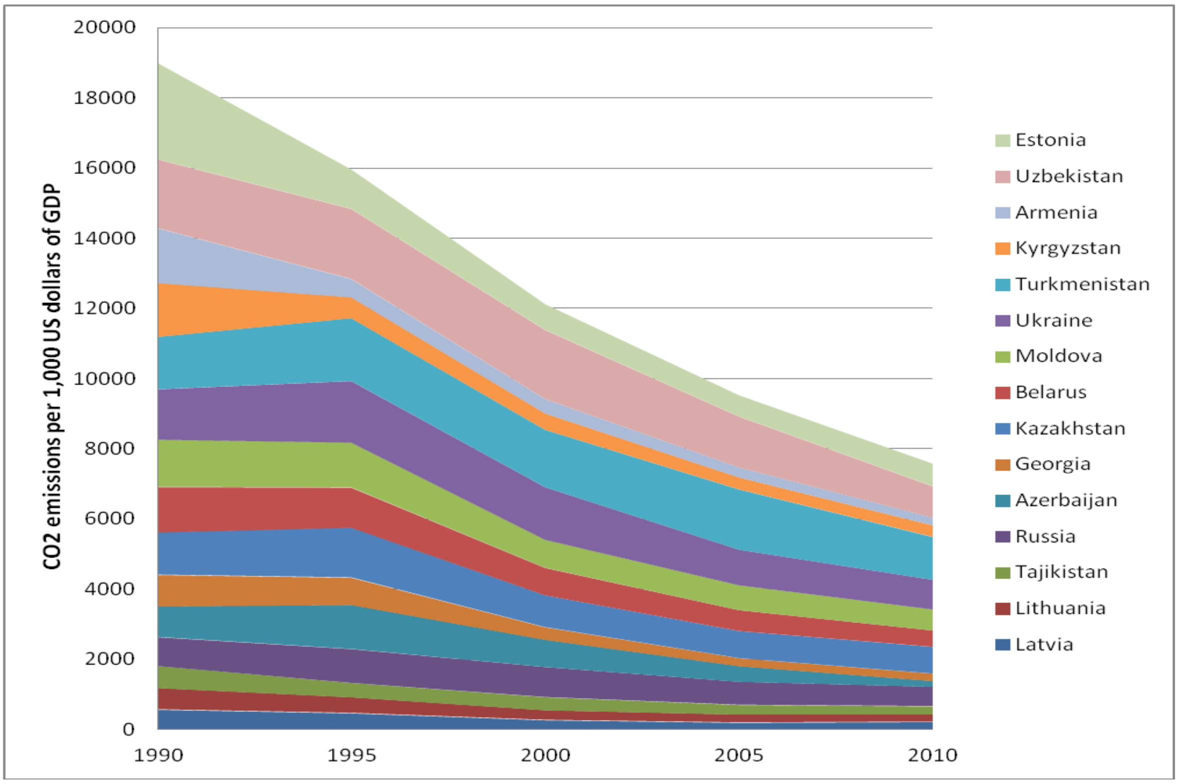

Fig. 2 Dynamics of CO2 emissions, tons per 1,000 US dollars

Table 3. Dynamics in country ranking by carbon dioxide emissions (absolute) (kg of CO2 per 1,000 dollars of GDP) over the period from 1990 to 2014 (sorted in ascending order)

Country	1990		2014		Reduction of CO_2 emissions per 1,000 dollars of GDP, kg over 25 years	Country's rank by reduction of CO_2 emissions per 1,000 dollars of GDP
	CO_2 emissions per 1,000 dollars of GDP, kg	Rank	CO_2 emissions per 1,000 dollars of GDP, kg	Rank		
Estonia	2743.23	15	572.14	11	-2171.09	1
Armenia	1566.63	13	192.34	4	-1374.29	2
Uzbekistan	1952.22	14	749.82	14	-1202.4	3
Kyrgyzstan	1547.04	12	399.8	7	-1147.24	4
Moldova	1346.22	9	461.43	9	-884.79	5
Belarus	1294.86	8	413.02	8	-881.84	6
Ukraine	1435.03	10	690.71	13	-744.32	7
Georgia	896.16	6	200.72	6	-695.44	8
Azerbaijan	874.27	5	197.53	5	-676.74	9
Kazakhstan	1204.55	7	591.75	12	-612.8	10
Turkmenistan	1489.68	11	900.47	15	-589.21	11
Tajikistan	632.05	3	171.26	3	-460.79	12
Lithuania	605.31	2	165.78	1	-439.53	13

Latvia	573.85	1	167.43	2	-406.42	14
Russia	829.09	4	519.16	10	-309.93	15

Over the 25-year period, carbon dioxide emissions reduced in all post-Soviet states. The top countries are Baltic states (75% reduction) and also Armenia and Kyrgyzstan. It is noteworthy that some of these countries occupy top positions in ranking by ecological effectiveness as well: Estonia, Latvia, and Lithuania are ranked 1st, 2nd, and 3d, respectively (Russia is ranked 5th).

One of the ways to decrease the amount of emissions is reducing dependence on conventional energy sources. The share of renewable energy is significant in Georgia (28.3%), Kyrgyzstan (39.4%), and Tajikistan (57.5%), while in Russia it makes up only 9%, and even less in Kazakhstan (1%).

Energy consumption within different economic sectors in Russia is shown in table 4 [2].

Table 4. Fossil fuel energy consumption within different economic sectors in Russia

Industrial sector	Unit of measurement	2012	2013	2014
Use of motor vehicles	reference fuel, kg per unit	2 127.2	2 065.7	2 022.6
Fertilizer production	reference fuel, kg per ton	494.3	487.0	470.1
Pulp and paper production	reference fuel, kg per ton	1 109.8	1 068.8	1 062.2
Ferrous metallurgy	reference fuel, kg per ton	650.6	657.4	647.8
Petrochemistry	reference fuel, kg per ton	1 027.7	1 000.1	956.1

According to the data, there is a decrease in fossil fuel energy consumption over the time period considered, moreover, it is possible to identify the economic sectors with enhanced manufacturing, which proves the potential for energy saving performance (see table 5).

Table 5. Potential for energy saving performance within different economic sectors in Russia

Industrial sector	**Unit of measurement**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Use of motor vehicles	reference fuel, kg per unit	1 986.3	1 948.2	1 893.8	1 849.7	1 811.0	1 771.7
Fertilizer production	reference fuel, kg per ton	457.9	441.7	427.1	408.1	393.5	381.0
Pulp and paper production	reference fuel, kg per ton	998.6	957.5	946.8	924.5	901.9	875.6
Ferrous metallurgy	reference fuel, kg per ton	650.2	640.2	624.9	601.0	579.5	558.1
Petrochemistry	reference fuel, kg per ton	953.9	951.8	948.1	898.7	873.9	857.6

According to the World Bank and the Center for Energy efficiency forecasts, Russia is capable to reduce energy consumption by 45% if the measures for energy efficiency are implemented. By 2020, the annual saving may be up to 250–270 million tons of reference fuel [3].

Conclusion

It is possible to conclude that economy "decarbonation" is attributed to current economic conditions. The trend is essential not only for alternative production, but also for present-day manufacturing based on conventional energy sources and proved to have potential for energy saving performance. The tools of economy "decarbonation" may be grouped as follows:

1. economic tools, which change the structure of the national economy, modify its technological characteristics, and imply the following processes [4–13]:

- enhancement of current manufacturing practices and implementation of new ones that allows reducing carbon intensity;
- development of alternative energy sources;
- forest conservation and management to improve carbon sequestering;

2. institutional tools, which imply revision of current rules and regulations (development of national strategy of carbon intensity reduction, modification of national energy strategy, etc.) and implementation of low carbon fuel standards for national enterprises; this can only be done by accepting the problem, on the one hand, and encouraging economic entities, on the other hand;
3. management tools, which introduce new approaches to business management and enhance the systems of economic interaction, personnel training, and forming personnel reserve, allow implementing innovations at all production stages, from "making" product to placing it at the market, etc.

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