REDUCTION OF GREENHOUSE GASES EMISSION AND SUSTAINABILITY – THE MULTI-CRITERIA APPROACH

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Abstract
It is becoming increasingly urgent to solve the problem of climate change and other related matters. Actions to reduce greenhouse gas emissions of anthropogenic origin – the major cause of climate change – are taken in the increasing number of economic sectors. This also applies to agriculture. The European Union's climate policy assumes that the reduction of emissions in agriculture will be taken pursuit to national commitments. A basis for international comparisons is the criterion of emissions per sector in a given country. In the opinion of the authors, this approach is groundless because it does not take into account the size of the countries, the role of the agricultural sector in the economy and the population. For this reason, what is proposed is the more balanced approach based on three criteria: economic, social and environmental.

The presented comparative analysis of 10 major emitters of greenhouse gases in European Union agriculture shows that the situation is different depending on the criterion applied. Such a multi-criterion approach may be a hint for policy makers, in whose countries the actions for the reduction of climate change can be more effective.
The studies were conducted based on the Eurostat data.

Keywords: greenhouse gas emission, agriculture, country comparison, sustainable development, climate policy.

Introduction

Climate change is a growing global problem. Numerous scientific papers (IPCC, 2018; Steffen et al., 2015) indicate that the rise in temperature on the Earth results in many adverse effects affecting the people life's quality. In extreme cases, there are even warnings against the risk of the collapse of human civilisation.
One of the economic sectors, strongly related to climate change, is agriculture, which, on the one hand, like any other sector, is responsible for greenhouse gas emissions (the main cause of climate change) and, on the other hand, becomes one of the largest victims of climate change as a sector closely linked with nature, whose productivity is largely dependent on natural and climate conditions. This situation enforces taking measures to change agricultural practices for the purpose of lower greenhouse gas emissions. The reduction of emissions will have a positive impact on the stability of climate, as well as, in the long run, on the sustainability of agriculture and its development.

The European Union is the undisputed world leader in reducing greenhouse gases emission. The Community's climate policy is based on the criterion of reducing emission per given Member State. This approach allows achieves the final objective i.e. the reduction of emission, but, at the same time, is not much grounded since it does not take into account the basic differences among the countries. What is indicated is the more complex method of comparing greenhouse gases emission at the national and sectoral level, which will ultimately enable the more thought-out determination of reduction objectives and thus the more effective reduction of greenhouse gases emission.

The objective of this article is to present a multi-criterion, sustainable approach to the issue of measuring greenhouse gases emission in general and in the sectors, including the agricultural sector. The proposed approach is based on three basic orders of sustainable development i.e. economic, social and environmental ones.

The application of the proposed method has been shown using the comparative analysis of the agricultural sectors in the selected European Union countries. The Eurostat data was used.

1. Literature review

The problem of climate change is widely described in the literature. Publications contain both observations of the process of change, its scale and pace (Grubb, 2014; IPCC, 2013), as well as global environmental and socio-economic consequences (De Sherbinin, Schiller, & Pulsipher, 2007; EC, 2014; Nachmany, Fankhauser, Setzer, & Averchenkova, 2017). The issue of climate change is also widely described in the context of agriculture (Challinor et al., 2014; Prandecki, 2014; Wolkovich et al., 2012).

In the European Union, climate change has been one of the priority issues for a longer time (EC, 1993; EU, 2001). Originally, corrective measures were taken within the framework of the environmental policy, but along with the progress of implementing the concept of sustainable development and the promotion of a horizontal approach, the problem of climate change is undertaken in many sectors and attempts to tackle it are coordinated at the cross-sectoral level.

The climate policy objectives have been presented in the long-term perspective. The objectives laid down for 2050 assume the reduction of basic greenhouse gases emission by 80-95% in relation to 2005 emission (EC, 2007, 2011). Detailed plans are not yet known but taking into account the arrangements for the period 2021-2030 (EU, 2018), which assume the ambitious emission reduction of all economic sectors, it must be assumed that the European Union, regardless of the measures taken all over the world, will consistently and decisively strive for reducing greenhouse gases emission. For individual economic sectors, this means a need for new, innovative production solutions and a substantial organisational effort.

The modern policy of reducing greenhouse gases emission in the EU is based on two solutions:

- Emission Trading System (ETS) – reduction is based on cap and trade mechanism,
- Effort Sharing (non ETS) – reduction per country is based on multilateral agreements.

ETS (EU, 2003) is oriented towards reducing emission in large entities of the selected economic sectors, for example, energy sector. The implementation of this system was the first step in the reduction of emissions. Now, in the fourth phase of operation, the ETS system works smoothly and steadily, which allowed taking more decisive actions in the area of non-ETS, including in agriculture.

Economic sectors not covered by the ETS are commonly referred to as non-ETS. The official name of this mechanism is Effort Sharing (EU, 2018). Their role in the reduction of greenhouse gases emission is smaller than that of ETS, but still growing. Reduction decisions in the non-ETS sector are made based on intergovernmental negotiations. This also applies to agriculture, which is included in the group of non-ETS sectors (EU, 2009).

2. Greenhouse gases emission per country in EU – multicriteria approach

As on indicated in the introduction, the emission reduction policy is mainly based on the criterion of reducing emission per country. Owing to this, we compare emissions of large countries with those of small countries, not only in terms of the area, but also of the number of inhabitants or the size of the economy. In the opinion of the authors, this approach is not advisable as it does not allow for a clear assessment of making the given country and society responsible for emission. Of course, negotiations conducted at the level of the European Union and being a basis for introducing the specific objectives of climate policy, in particular in the non-ETS sector, are conducted based on bilateral and multilateral talks, taking into account a number of more complex analyses and arguments. However, the public is presented with a result based on emission per country. This approach seems to be incorrect and misleading.

The authors of this study suggest including a new, multi-criterion approach to international comparisons in terms of greenhouse gases emission. It is based on the concept of sustainable development and, in particular, on the assessment of the three main spheres of this concept, i.e., economic, social and environmental development. The authors suggest that emission of each country was assessed in the light of these three criteria altogether. In the case of the environmental criterion, they propose to assess emission per unit area, in the environmental criterion – emission *per capita*, and in the economic criterion – emission per income unit.

Table 1 shows the rankings of the 10 biggest emitters of greenhouse gases depending on the adopted criterion. The first column is expression the traditional, general approach showing the place of the country according to the criterion of emission per country.

Table 1. Ten biggest emitters of greenhouse gases according to different criteria

	General	**Economic**	**Social**	**Environmental**
1.	Germany	Bulgaria	Luxembourg	Malta
2.	United Kingdom	Poland	Estonia	Netherlands
3.	France	Estonia	Ireland	Luxembourg
4.	Italy	Czech Republic	Czech Republic	Belgium
5.	Poland	Romania	Netherlands	Germany
6.	Spain	Hungary	Germany	United Kingdom
7.	Netherlands	Greece	Belgium	Czech Republic
8.	Czech Republic	Lithuania	Poland	Italy
9.	Belgium	Croatia	Finland	Poland
10.	Romania	Slovakia	Cyprus	Denmark

Source: Own study based on Eurostat data.

The multi-criterion approach shows a significantly different picture of the situation. Only two out of the 10 biggest emitters of greenhouse gases are present in all three categories. These are the Czech Republic and Poland. Both countries, despite of great differences between them, show high greenhouse gases emission. This illustration that whatever point of view, in their development effort should take greater account of the emission issues. In turn, the biggest emitter per country – Germany, is not included at all in the ranking according to the economic criterion. This means that according to this criterion, the German economy is efficient. However, it looks much worse in terms of the social and environmental criteria. This example is only an illustration showing that the adoption of only one criterion can be

misleading. The more accurate comparative analysis based on the three sustainability criteria allows bettering assessing the situation of the country or sector of the economy.

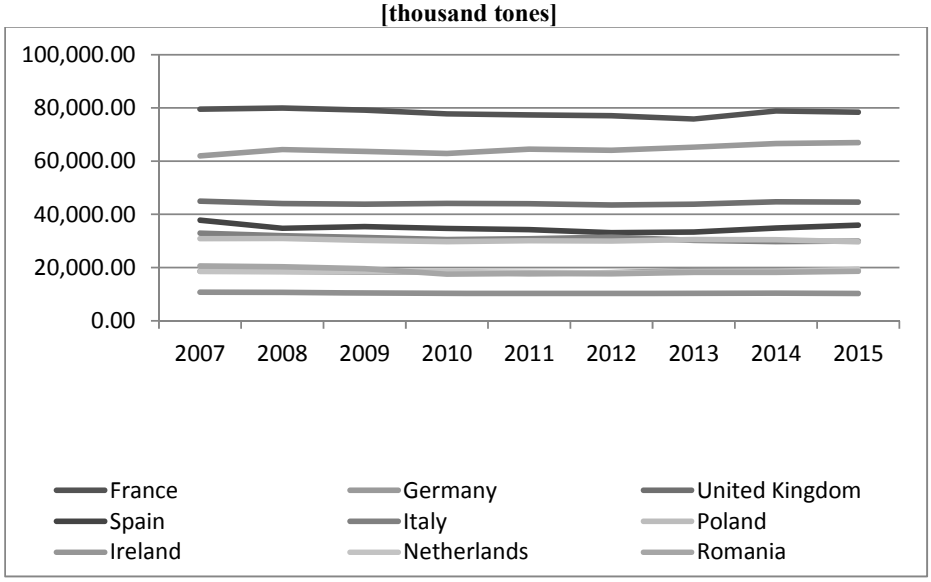
3. Reduction of greenhouse gases emission in agriculture

The agricultural sector is in the non-ETS group, which makes the emission reduction decisions be made pursuant to common arrangements accepted by all Member States in the forum of the European Union. This means that the Member States are committed to overall emissions reduction within non-ETS (at the level of the whole European Union), which is then distributed among the individual countries and their economic sectors. The way of reducing under the sector remains the responsibility of the Member State.

In general, agriculture across the European Union emitted in 2015 more than 436 million tonnes of carbon dioxide equivalent – 10.1% of the total Community emission (Eurostat 2018).

The reduction of emission in agriculture is not easy due to the impact of the environment on the volume of emission. Also, technological changes have limited use. This does not mean, however, that the reduction of emissions in this sector is not possible. An analysis of statistical data in a form of emission from the sector per country shows that in the analysed period, i.e. between 2007-2015, the reduction of emission was negligible, i.e. 0.5%. What is more, in recent years, despite the political efforts, on observe the increase in emissions at the level of the countries and the whole EU. These trends are also visible among the 10 biggest emitters of greenhouse gases of agricultural origin (Figure 1).

Figure 1. Greenhouse gases emission by agriculture of 10 biggest emitters [thousand tones]



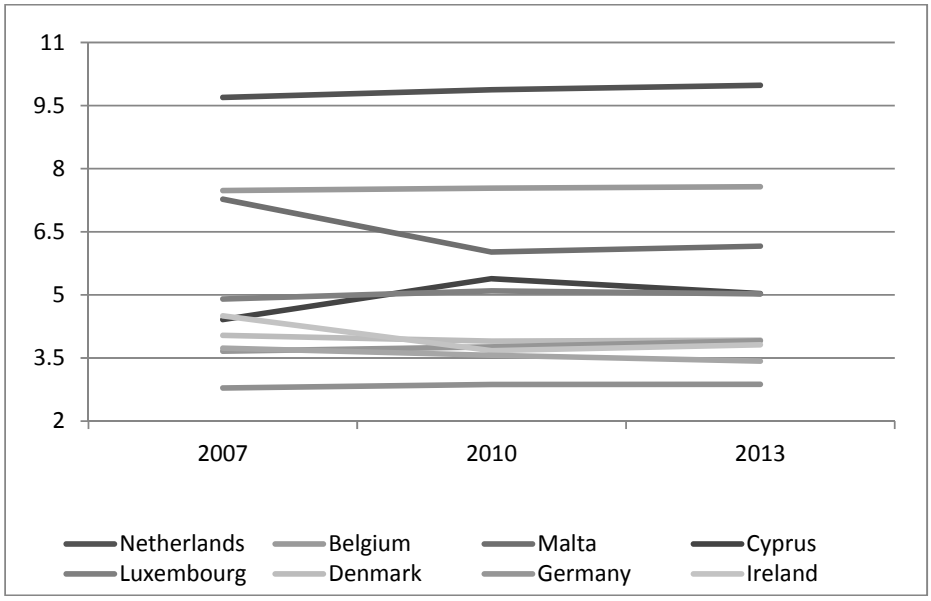
Source: Own study based on Eurostat data.

In contrast to total greenhouse gases emission per country, where the reduction is observed in all countries, in the case of agriculture, it is noted that most of these increased the level of emission. It happened like that, *inter alia*, in the case of Germany, the second biggest emitter

of greenhouse gases of agricultural origin. Nevertheless, the above comparison does not give us information about the reasons of this phenomenon.

A comparison of the volume of emission per sector in the given country with more detailed results obtained by the multi-criterion method gives a more clear picture of changes taking place in agriculture. The introduction of a clear environmental criterion i.e. emission per unit area shows that in some countries high emission can result from economies of scale, rather than from the low efficiency. Emission of agricultural origin per farmland, presented in Figure 2, show that the higher emission burden is generated by small countries rather than the large ones.

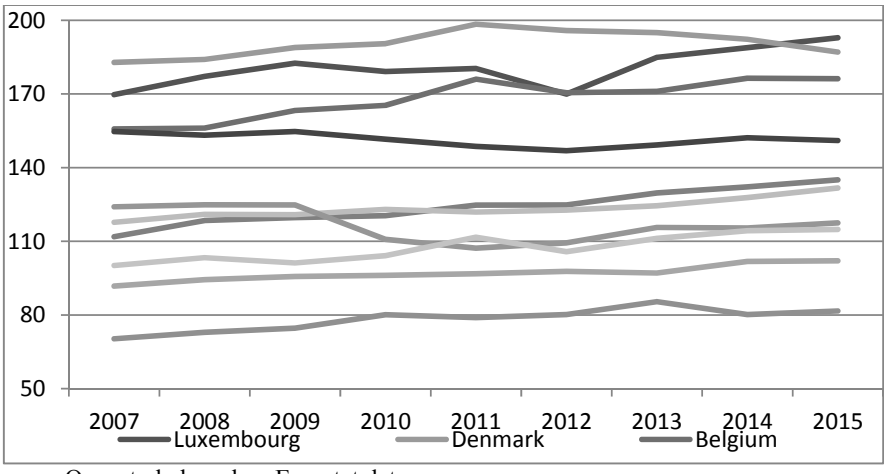
Figure 2. Greenhouse gases emission by agriculture of 10 biggest emitters [thousand tonnes/thousand utilised agricultural area – UAA]



Source: Own study based on Eurostat data.

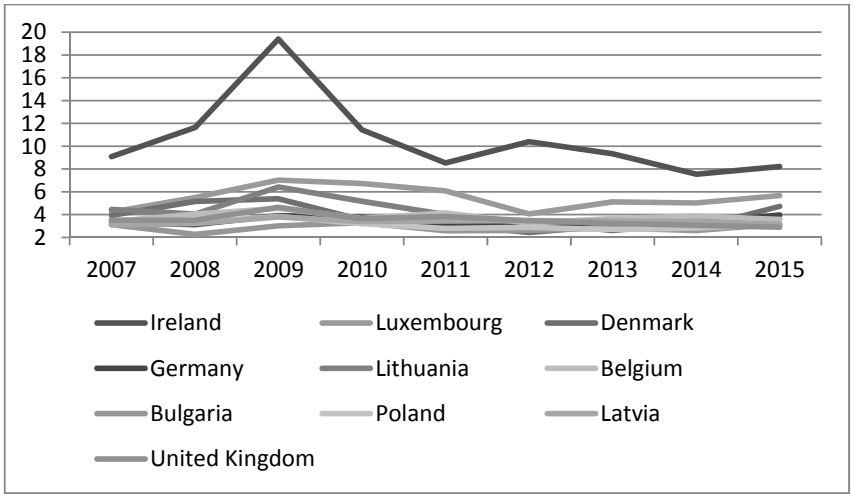
Figure 3 shows changes that have taken place among the ten biggest emitters analysed in a social context. To this end, the volume of domestic agricultural emission has been divided into the number of annual work units in this sector. The upward trend is visible in all the countries. Taking into account total emission per sector, it is known that this is not due to changes in emission, but due to changes in the number of the people employed in agriculture. The level of mechanisation and efficiency of labour are increasing, which results in an increase of this indicator.

Figure 3. Greenhouse gases emission by agriculture of 10 biggest emitters [thousand tonnes/thousand annual work units – AWU]



Source: Own study based on Eurostat data.

Figure 4. Greenhouse gases emission by agriculture of 10 biggest emitters [thousand tonnes/million EURO GAV]



Source: Own study based on Eurostat data.

The last of the analysed criteria applies to the economic aspects of emission. The authors decided that the best way to present a relationship between emission and the economic situation in the sector will be an assessment in the context of value added generated by the sector. The situation of the ten biggest emitters according to the adopted economic criterion, as shown in Figure 4, shows that in contrast to other analysed indicators, in this case, on cannot indicate a clear trend. Changes are strongly dependent on the situation of agriculture

and on the economic results of the sector. Different climatic conditions in the individual European countries or other conditions affecting the productivity and profitability of agriculture (e.g. animal diseases) made the external conditions affecting the individual countries significantly different.

In general, it can be said that unlike other analysed indicators, in the case of emission per added value unit, the differences in the results obtained among the individual countries are significantly smaller. The exception to this rule is Ireland, where the analysed indicator is almost two times higher than in the case of other countries belonging to the ten of the biggest emitters in terms of the adopted criterion.

Conclusions

The presented solution in a form of the multi-criterion approach to the analysis of greenhouse gases emission allows obtaining a more detailed picture of the situation in the country or in the economic sector. This allows learning in more detail the impact of greenhouse gases emission on societies and their economies. Adopting the approach taking into account three criteria: economic, social and environmental, not only increases the knowledge, but is also consistent with the concept of sustainable development. In this way, by the multi-criterion assessment of emission we may also pay attention to what areas of a the country which are far from achieving the sustainability.

The objective of applying the proposed multi-criterion method is better adaptation of the climate policy and the more effective reduction of greenhouse gases emission. This approach does not, however, mean the abandonment of the assumed reduction objectives, but stress their more efficient implementation.

Agriculture is the economic sector in which adaptation to the climate policy is one of the more difficult processes. This is due to the limited possibilities of changes to agricultural practices, a low pace of technical progress and, above all, the variability of emission depending on the climatic and meteorological conditions – in each year, the level of emission may vary regardless of the permanence of applied practices, cultivated area or number of livestock.

The proposed multi-criterion analysis should be regarded as a starting point for decision making in the context of the climate policy. In particular, its assessment should be carried out taking into account the specificities of agriculture in the given country (i.e. production profile).

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