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Examining the Integrity of Climate Protection Goals and Climate Change Policy Objectives in the Policies of the European Union

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Nowadays, the effects and consequences of climate change can be directly felt. As a result, the mitigation of climate change and the fight against its effects are of high priority both from the point of view of the European Union and the world, for which strategies and guidelines define an effective climate policy as an essential tool. At the same time, the vast majority of research related to climate change has so far focused on the greenhouse gas emissions of individual countries, their sectoral distribution and mitigation options, as well as the situation and difficulties in meeting their objectives in this direction. The aim of this study is to examine the integration of the policy objectives related to climate change of the individual European Union member states, as well as to explore the path these states are taking in achieving the emission targets for greenhouse gases planned for 2050. In our study, we examine to what extent the evaluations aimed at achieving the sustainable development goals of individual countries take into account the extent to which the projected climate protection trajectory of the same member states is fulfilled. Based on our results, it can be concluded that there are significant differences in the level of development of each country from a sustainable development point of view, the amount of greenhouse gas emissions of the given member countries, and the degree of consideration and adaptation of individual climate protection goals. Based on our findings, it can be said that the global climate policy plays a significant role in reducing greenhouse gas emissions, but the regulation and target system at the member state level is even more pronounced. Achieving the 2050 climate neutrality goals requires a fundamental transformation of some regulations, and if the limitations arising from the dissonance of these specialized sectors with decarbonization are resolved or managed to an adequate extent, and the actual integrity of the individual goals is achieved, then net zero carbon dioxide emissions can be achieved.

1. Introduction

The EU's climate policy dates back to the late 1970s when thoughts about the impact of greenhouse gases on the atmosphere started emerging (Le Treut et al., 2007). The EU's environmental policy is fundamentally based on the principles of pollution prevention, precaution principles, and the polluter pays principle. In its early stages, climate policy mainly consisted of informal goals and comprehensive strategies with very few concrete political tools to achieve them (Jordan and Moore, 2020).

These soft law instruments, such as those mentioned, appear as a kind of "legal passpartu" in the scientifically and politically complex field of international and EU environmental and climate law (Tahyné Kovács, 2018). Since 1973, the European Commission has issued several multi-year Environmental Action Programs (EAP) that define the future legislative proposals and objectives of the EU's environmental policy. Over the years, the EU's climate policy has evolved gradually, culminating in the significant milestone of the 1997 Kyoto Conference, which highlighted the need for cross-border expansion of environmental strategies.

In 2001, the EU introduced its first Sustainable Development Strategy (SDS) and contributed to the formation of various international agreements, including the 2015 United Nations-approved 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change. In response to the 2030 Agenda for Sustainable Development, the European Commission issued a communication in 2016 titled "Next steps for a sustainable

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European future – European action for sustainability," outlining the integration of the Sustainable Development Goals (SDGs).

As the EU's political network expanded further, with the Green Deal (EGD) published by the European Commission on December 11, 2019, the EU became a leading force in the global fight against climate change. European Commission President Ursula Gertrud von der Leyen referred to it as "Europe's 'man on the moon' moment." It is widely recognized that the EU has established the most advanced climate policy framework among major global players, substantiating its role as an international climate leader (Delbeke and Vis, 2019).

According to Oberthür and Homeyer (2022), despite more than three decades of climate policy and analysis, the EU still lacks a coherent set of criteria to assess whether its climate mitigation efforts are "fit for purpose" (Dupont, 2015).

The EGD can be considered a multidimensional policy proposal that addresses various crises with a focus on achieving climate neutrality. Different approaches can be observed in the combined national strategies and policies aimed at overcoming diverse problems influenced by energy policy preferences and various other factors (Kulovesi and Oberthür, 2020). According to the United Nations Environment Programme's latest Emissions Gap Report (EGR) in 2022, unconditional nationally determined contributions (NDCs) indicate a temperature increase of 2.6 °C by 2100, far exceeding the long-term goals of the Paris Agreement. Inger Andersen, the Executive Director of the United Nations Environment Programme (UNEP) United Nations Environment Assembly (UNEA), stated that since the 2021 COP26 in Glasgow, the new and updated NDCs have had little impact on the expected temperature by the end of the century, painting an extremely worrisome future. A survey conducted by Hickman et al. (2021) among young people aged 16-25 in ten countries, including EU countries such as Finland, France, Portugal, and then the United Kingdom, also reflects a similar sentiment. According to the survey, 56 % of respondents believe that "humanity is doomed." (Hickman et al., 2021). In recent years, there has been a growing demand to treat climate change as a human rights issue in both public discourse and legal contexts, which could imply that participants in the research conducted by Hickman et al. (2021) might have the opportunity to bring their situation before the court against the international government due to their involvement in climate change.

Despite the increasing number of climate policies, achieving climate goals requires coordinated and comprehensive societal efforts. The task for member states now is to consider how to allocate their efforts until 2050 to reach the target. Climate goals affect the entire economy, thus necessitating a typically interdisciplinary approach to the issue, with the responsibility of polluting states and their approach to achieving the goals being crucial.

The regional contributions to global anthropogenic greenhouse gas emissions continue to vary significantly. The reasons for these differences need to be examined from multiple perspectives, including income levels, land use, and consumption habits. International climate agreements, the climate policy ambitions implemented within the EU's own policy framework, and the growing societal awareness all contribute to the development and implementation of climate policies for managing climate change. Examples include the Kyoto Protocol and the Paris Agreement, which led to emissions reductions in certain countries, and the declaration of climate-related priorities, ambitions, and actions.

The primary means of achieving the goals set out in the Paris Agreement are the previously mentioned Nationally Determined Contributions (NDCs) commitments and active social engagement facilitated by the media, which can pave a clearer path towards accelerating climate action (Mayer, 2018). In the case of climate adaptation, the role of legislation, subnational actions, and commitments is extremely important. However, it is essential to emphasize that coordinated and consistent action from all societal actors is crucial.

Although significant progress has been made in integrating climate policy in recent years, particularly in the field of energy policy, and there is increasing evidence of political integration, including climate adaptation, the processes of integration are not thoroughly examined, especially at the EU level, and are not straightforward. This is because multiple factors and conditions enable or restrict political integration (Runhaar et al., 2017). Taking these into account during the design and implementation of policy integration reduces the likelihood of policy failure (Domorenok et al., 2021).

The comprehensive WMO report "State of the Global Climate 2022" and the IPCC Report 2022 AR6 provide a detailed overview of the current state of climate change and its potential impacts, based on rigorous scientific research and experiences from 2023.

Until now, the majority of climate-related research has focused on individual countries' greenhouse gas emissions, their sectoral distribution, mitigation possibilities, as well as the status and challenges in achieving their climate-related objectives. This study examines how individual member states integrate climate policy goals into their sectoral policies and the progress they have made in achieving these goals. Based on the available literature, we can confidently assert that this study contains outstanding significance and provides valuable contributions. The study significantly enriches the existing literature in the fields of policy integration and European Union integration, making a unique contribution to the fresh and rapidly evolving research on the

European Union's decarbonization efforts. The achievement of climate protection goals is closely tied to the policy frameworks of individual countries, and their coordination is crucial for success, as elaborated in detail within the study.
It is essential to note that the EU's climate policy covers various areas, but the aim of this study is not to encompass all relevant policy areas. Instead, it provides a brief overview of member states' efforts and their current progress.

2. Materials and methods

As the most important element of the research, we used an index formation procedure suitable for the uniform handling of multidimensional data of different dimensions to explore the situation of climate policy integration in relation to the member states of the European Union (EU-27). During the calculation, various indexes were used, such as the SDG index score, the indexing value of the environmental performance index (EPI) for climate policy, and the population ratio for the respective member state defined by the association of mayors through the EUROSTAT database. The examined period is the cycle between 2012 and 2022. According to the primary and secondary data obtained after the taxonomic analysis, between the two closing years of the examined period, a varied but at the same time stably low state was typical. Among the examined EU member states, the value of Cyprus in 2012 and 2022 showed a negative result during the taxonomic analysis, but due to its negligible level, we considered it as 0 when the investigation continued. The elements of the taxonomic assessment used to determine the climate policy integration index were structured similarly to Oliinyk et al. (2023) were only accepted for climate policy indicators:
Eq(1) Standardization of initial data with different units and dimensions in order to reduce them to a single metric scale, using the following formula: Eq(1), where Z_{ij} is the standardized value of the i-th indicator of the j-th EU member state ($i = \overline{1,n};\ j = \overline{1,m}$); x_{ij} the arithmetic mean value of the i-th indicator of the j-th EU member state; σi is the standard deviation value of the i-th indicator.

$$Z_{ij}=\frac{x_{ij}-\bar{x}_{ij}}{s_i}, \tag{1}$$

Eq(2) Creation of reference point Z_{0i} ($Z_{01}, Z_{02}, \ldots Z_m$), which means comparing the values of the EU member states to the maximum value of the given value series.

$$Z_{0i}=\max z_{ij}^{'}\ i \in I, \tag{2}$$

where: I is the set of indicators.

Eq(3) Determination of the Euclidean distance, which shows the distance of the indicators relative to a given reference point, where d_{0i} is the Euclidean distance of the indicator value from the reference point.

$$d_{0i}=\sqrt{\sum_{i,j=1}^{n,m}(Z_{ij}-Z_{0i})^2}, \tag{3}$$

Eq(4) Calculation of the taxonomic index of the climate policy integral index, which reflects the alternative measure of climate policy integrity in the EU member states (Ki) with formula Eq(4), where: K_i is the picture of the given level of climate policy integrity in each EU state; $\overline{d_0}$ is the arithmetic mean of the corresponding Euclidean distance; σ_0 is the standard deviation of the corresponding Euclidean distance.

$$K_i=1-\frac{d_{0i}}{d_0},\ d_0=\overline{d_0}+2\cdot\sigma_0, \sigma_0=\sqrt{\frac{\sum(d_{0i}-\overline{d_0})^2}{n}}, \tag{4}$$

3. Results

In order to obtain an alternative, horizontally comprehensive picture of the policy climate protection integration of individual EU member states, as one of the most important elements of this research, we defined international indexes and indicators, along which we could determine the degree of climate policy integration for the years 2012 and 2022 in relation to the EU-27. After standardizing the selected initial data, we established the Euclidean distance along each value, thus defining an alternative index for the extent to which the individual climate policy objectives, such as the reduction of greenhouse gas emissions, the pace of achieving the 2050 objectives, as the amount of carbon emissions per capita, to what extent it is used in each country. Based on the primary and secondary results obtained after the taxonomic analysis, it can be established that between the

two cut-off years of the examined period, the magnitude of the adaptation of the climate policy objectives is extremely variable. Among the examined EU member states, the value of Cyprus showed a negative result during the taxonomic analysis, but at the same time, due to its negligible level, we considered it as 0 during the continuation of the study. The average size of the adaptation level in 2012 was 0.2319, which indicates a low value. There was no significant difference in the closing year of the examined period either. In 2022, the average integral index value was 0.2195, which also indicates a downward trend. The size of the average change along this line is -5.33 %, where the largest change was detected in the case of Luxembourg (+916.8 %), while the largest decrease can be attributed to Bulgaria (-79.9 %). Based on the results obtained, it can be stated that the integration of the climate policy objectives has been achieved, but at the same time, its extent is extremely insignificant and can be said to be low-scale. The results of the analysis showed that the EU-27 member states significantly differ from each other based on the trend between 2012 and 2022 (Table 2).

Table 2: Results of integral index and Euclidean distance calculation

State	SDG: 2012	EPI: 2012	CoM: 2012	SDG: 2022	EPI: 2022	CoM 2022	$\sum(d_{0i}-d_0)^2$ 2012	$\sum(d_{0i}-d_0)^2$ 2022	Eucl. 2012	Eucl. 2022	K_i: 2012	K_i: 2022
Belgium	-2.41	-1.80	-3.08	-2.22	-3.26	-3.19	18.53	25.74	4.30	5.07	**0.2885**	**0.2253**
Bulgaria	-3.01	-1.70	-3.20	-3.70	-3.14	-3.96	22.19	39.15	4.71	6.26	**0.2214**	**0.0445**
Czechia	-2.03	-2.88	-3.50	-1.49	-2.92	-3.93	24.63	26.20	4.96	5.12	**0.1798**	**0.2184**
Denmark	-0.42	0.00	-3.16	-0.33	0.00	-3.90	10.18	15.30	3.19	3.91	**0.4727**	**0.4026**
Germany	-1.48	-2.62	-1.12	-1.03	-3.33	-2.33	10.32	17.59	3.21	4.19	**0.4690**	**0.3595**
Estonia	-2.40	-2.98	-3.48	-1.55	-2.98	-4.15	26.74	28.45	5.17	5.33	**0.1454**	**0.1855**
Ireland	-1.80	-1.84	-3.37	-2.01	-3.26	-3.90	17.97	29.86	4.24	5.46	**0.2994**	**0.1656**
Greece	-3.20	-2.56	-3.04	-2.55	-3.06	-3.46	26.01	27.86	5.10	5.28	**0.1571**	**0.1941**
Spain	-2.32	-4.96	0.00	-1.93	-3.76	-0.98	30.01	18.85	5.48	4.34	**0.0946**	**0.3371**
Portugal	-2.59	-1.38	-3.27	-2.05	-4.04	-3.54	19.29	33.04	4.39	5.75	**0.2740**	**0.1222**
France	-1.86	-3.48	-1.52	-1.43	-3.16	-2.44	17.88	17.98	4.23	4.24	**0.3010**	**0.3524**
Croatia	-2.45	-3.28	-3.28	-1.60	-2.64	-3.98	27.53	25.38	5.25	5.04	**0.1328**	**0.2307**
Italy	-2.48	-3.24	0.00	-2.43	-3.26	0.00	16.67	16.49	4.08	4.06	**0.3252**	**0.3799**
Cyprus	-4.35	-2.40	-3.48	-4.34	-2.84	-4.15	36.83	44.20	6.07	6.65	**0.0000**	**0.0000**
Latvia	-2.13	-2.52	-3.40	-1.85	-2.49	-4.10	22.45	26.40	4.74	5.14	**0.2169**	**0.2154**
Lithuania	-3.24	-2.24	-3.35	-3.03	-3.34	-4.07	26.75	36.88	5.17	6.07	**0.1452**	**0.0726**
Luxembourg	-3.04	-3.68	-3.54	-2.77	-1.84	-4.20	35.31	28.72	5.94	5.36	**0.0179**	**0.1817**
Hungary	-2.28	-1.12	-3.22	-2.24	-3.26	-3.69	16.84	29.29	4.10	5.41	**0.3218**	**0.1735**
Netherlands	-2.18	-2.30	-3.02	-2.23	-2.79	-3.73	19.14	26.71	4.37	5.17	**0.2770**	**0.2108**
Austria	-1.28	-3.40	-3.27	-1.36	-3.10	-4.00	23.91	27.47	4.89	5.24	**0.1918**	**0.1996**
Poland	-2.22	-2.60	-3.08	-1.51	-3.95	-3.62	21.20	30.95	4.60	5.56	**0.2390**	**0.1504**
Malta	-3.56	-1.76	-3.53	-3.42	-0.74	-4.19	28.22	29.79	5.31	5.46	**0.1220**	**0.1666**
Romania	-3.09	-1.66	-2.77	-2.83	-3.03	-3.65	19.97	30.48	4.47	5.52	**0.2613**	**0.1570**
Slovenia	-1.60	-1.92	-3.47	-1.75	-2.17	-4.10	18.30	24.61	4.28	4.96	**0.2929**	**0.2425**
Slovakia	-2.42	-1.58	-3.46	-2.33	-2.87	-4.12	20.34	30.58	4.51	5.53	**0.2547**	**0.1556**
Finland	-0.01	-3.80	-3.30	0.00	-0.65	-3.97	25.35	16.16	5.04	4.02	**0.1678**	**0.3862**
Sweden	0.00	-2.18	-2.97	-0.24	-1.25	-3.73	13.55	15.56	3.68	3.94	**0.3917**	**0.3977**

According to the calculated index values, the first three places in 2012 were Denmark (0.4727), Germany (0.4690), and Sweden (0.3917), while the last place was Luxembourg (0.01786) - if we do not consider Cyprus 0 - regarding the acceptance of climate policy goals. This year, Hungary was in fifth place (0.3218) in relation to the EU-27. By 2022, Denmark was still in first place, but at the same time, the value of the integral index was lower (0.4026). Sweden was still in second place (0.3977), while the third member state this time was Finland (0.3862). Hungary has already experienced such a significant decline. In 2022, it was in 18th place out of 27 member states. The weakest performing member state this time was Bulgaria (0.0445), while Luxembourg, which ranked last in 2012, overtook Hungary and was in 17th place. In the case of Hungary, a decline of almost -46.1 % could be identified. These results could have resulted from a number of reasons, since many events occurred during the period under review (e.g.: the COVID-19 pandemic, etc.), as a result of which the achievement of the sustainable development and climate protection goals of the individual member states was pushed into the background. For this reason, the largest declines were observed in Lithuania (-50.0 %), Portugal (-55.4 %) and Bulgaria (-79.9 %).

The maps shown in Figure 1 illustrate and compare the extent of the calculated integral index in relation to the EU-27. After the data visualization, it can be clearly shown that there was a significant shift between 2012 and

2022 in the degree of integration and acceptance of the climate policy objectives with regard to the path of achieving the sustainable development goals of the given member states, the climate protection measures and the proportion of the population whose direction of local settlement policy development deserves special attention translates into increasing energy efficiency and the use of renewable energy sources, climate protection mitigation, adaptation, and sensitization. While the first map shows that the individual EU member states are located around the middle value of the interval between 0 and 1, with some outlier states, by 2022, a stronger peripheral situation can be identified.

Based on the integral index values calculated for the years 2012 and 2022, it is possible to create and compare the groups of individual member states. The Member States with the best values, which had an index value above 0.3000 for both 2012 and 2022: Denmark (2012: 0.4727; 2022: 0.4026), Germany (2012: 0.4690; 2022: 0.3595), Sweden (2012: 0.3917; 2022: 0.3977), Italy (2012: 0.3252; 2022: 0.3799) and France (2012: 0.3010; 2022: 0.3524).

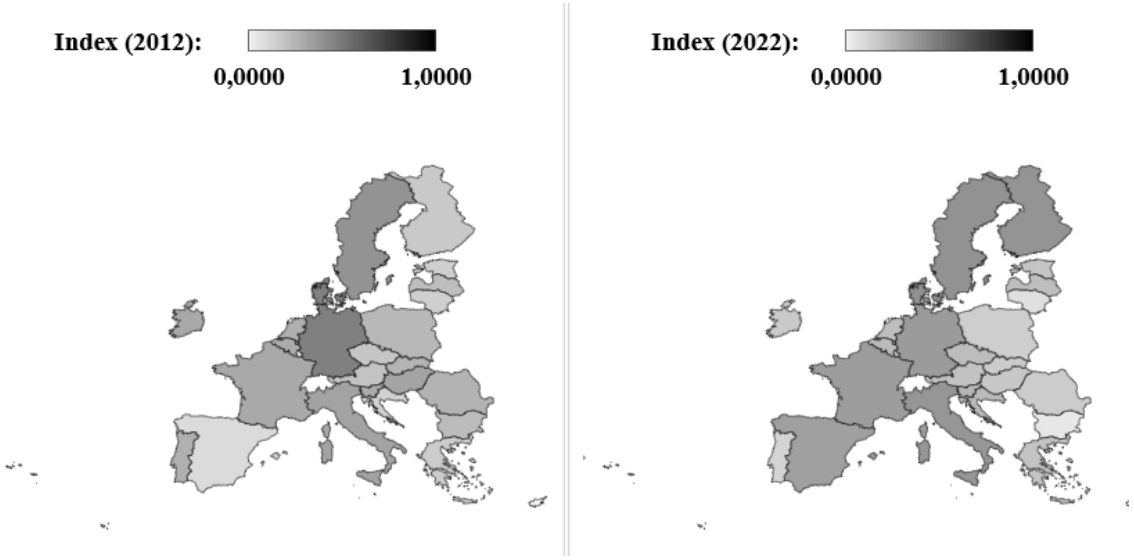

Figure 1: Map comparison of the values of climate policy integral indices in relation to the EU-27

4. Conclusions

This study examines the policy integration of climate protection in individual EU member states in order to gain an alternative, comprehensive understanding of how well the policies of the European Union align with climate protection and climate change objectives. The integration of climate policies depends on several factors, of which three are highlighted. Firstly, integration heavily relies on the commitment and willingness of political leaders in the member states, as addressing climate change as a high priority can lead to a high level of integration. Secondly, the effectiveness and ambition of climate policy measures in each member state depend on the country's economic condition and technological development. Last but not least, societal awareness and support play a significant role since policymakers are more likely to implement measures that are supported by society. During the investigations of our study, we used an index formation method that enables a uniform examination of indicators of different dimensions. Based on our research results, it can be established that the degree of integration of the climate protection policy varies across a broad spectrum between the individual member states. In 2012, the average integral index value was 0.2319, while in 2022, the average integral index value was 0.2195, which also indicates a downward trend. The size of the average change along this line is -5.33 %, where the largest change was detected in the case of Luxembourg (+916.8 %), while the largest decrease can be attributed to Bulgaria (-79.9 %). In the case of Hungary, a decline of almost -46.1 % could be identified. Despite the fact that between 2012 and 2022, the commitment to climate protection goals strengthened in some member states and their consideration in political decision-making, unfortunately, a worsening trend can be observed in some countries, which resulted in a decrease in the average ratio of the EU-27. The impacts of the COVID-19 pandemic and the energy crisis have both hindered individual member states in achieving their sustainable development and climate protection goals, leaving a clear mark on the level of integration and acceptance of climate policy objectives. We believe that research should be continued as climate policy gains momentum and its actual application.

References

Delbeke J., Vis P., 2019, Towards a climate-neutral Europe: curbing the trend, Abingdon, New York: Routledge, Brussels: European Union, 1-248.

Dupont C., 2015, Climate Policy Integration into EU Energy Policy: Progress and prospects (1st ed.). Routledge Studies in Energy Policy series, Routledge, London, UK, <https://climate.ec.europa.eu/system/files/2020-01/toward_climate_neutral_europe_en.pdf>, accessed 19.11.2023.

Domorenok E., Graziano P., Polverari L., 2021, Introduction: policy integration and institutional capacity: theoretical, conceptual and empirical challenges, 40(1). Policy and Society, Padua, Italy, 1–18.

Hickman C., Marks E., Pihkala P., Clayton S., Lewandowski R. E., Mayall E. E., Wray B., Mellor C., Susteren L., 2021, Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. The Lancet Planetary Health, 2021(5), 863–873.

Jordan A.J., Moore B., 2020, Durable by Design? Policy Feedback in a Changing Climate, Cambridge University Press, Cambridge, UK, 64–75.

Kulovesi K., Oberthür S., 2020, Assessing the EU's 2030 Climate and Energy Policy Framework: Incremental change toward radical transformation? Reciel Review of European. Comparative & International Environmental Law, 29(2), 151-166.

Le Treut H., Somerville R., Cubasch U., Ding Y., Mauritzen C., Mokssit A., Peterson T., Prather M., 2007, Historical Overview of Climate Change. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K. B., Tignor M., Miller H. L., 2019, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Mayer B., 2018, The International Law on Climate Change, Cambridge University Press & Assessment, Cambridge, UK, 1-332.

Oberthür S., Homeyer I., 2022, From emissions trading to the European Green Deal: the evolution of the climate policy mix and climate policy integration in the EU. Journal of European Public Policy, 30(3), 445-468,

Oliinyk O., Mischuk H., Vasa L., Kozma K., 2023, Social Responsibility: Opportunities for Integral Assessment and Analysis of Connections with Business Innovation. Sustainability, 15(6), 5608, 1-17.

Runhaar H., Wilk B., Persson Å., Uittenbroek C., Wamsler C., 2017, Mainstreaming climate adaptation: taking stock about "what works" from empirical research worldwide. Regional Environmental Change, 18, 1201-1210.

Tahyné Kovács Á., 2018, The role of the "soft-law" through the example of an environmental regulatory are. Iustum Aequum Salutare, 14:4, 43-54 (in Hungarian).