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Resource efficiency and decarbonisation of economies in the European Union

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Abstract. *People have always been interested in improving their quality of life. But how is this possible when the population is constantly growing, and the planet's resources are dwindling? The efficient use of resources is not only believed to increase the general quality of life but also to contribute to the creation of a cleaner environment. But what is the relation between resource efficiency and a cleaner environment? The European Commission and the United Nations have been dealing with this key issue for many years now and the EU has forced member countries to meet certain targets. This paper presents some of the UN and EU's policies with regard to climate change and resource efficiency and offers an independent evaluation of the achievements of Member States. We assumed that the implementation of the objectives of the EU climate and energy package improves the resource productivity and reduces its negative impact on the environment, relation analysed with the help of a linear regression model. Further, we have performed a critical study on the performance of EU-member states in meeting their GHG-emission targets correlated with the resource intensity of their economies, modelled using Microsoft Excel. Resource efficiency and the low-carbon economy have emerged as central themes in global discussions on the transition to a sustainable economy, and this paper sheds new light onto the connection between the two subjects.*

Keywords: resource efficiency, resource productivity, greenhouse gas emissions, circular economy, correlations, linear regression.

Please cite the article as follows: Clodnitchi, R. and Tudorache O. (2022), "Resource Efficiency and Decarbonisation of Economies in the European Union", *Management & Marketing. Challenges for the Knowledge Society*, Vol. 17, No. 2, pp. 139-155, DOI: 10.2478/mmcks-2022-0008.

Introduction

Environment and economy are indubitably related: on the one hand, economy relies on resources from the environment, and on the other hand, environment is shaped by the economy through its undesired outputs – emissions and waste. Production relies on the input of natural resources, while it also generates environmental pressure (Filimonova, et al. 2020). A decrease in the environmental quality not only results in a lower quality and/or

quantity of available resources but also affects the physical and mental health of the population, creating herewith a vicious cycle (OECD, 2016; Davidson et al. 2021).

Resource efficiency is often presented as a means of linking environmental and economic goals (Dima & Vasilache, 2016). Less material consumption reduces the environmental impact of material extraction, processing, use and waste management. In short, resource efficiency is about doing more with less (van Ewijk, 2018; Poliak et al., 2021).

Data recently presented by UN indicate for the last 20 years a rise by over 40% in the global domestic material consumption per capita – 2000: 8.7 m t, 2017: 12.2 m t (UN, 2021).

The world's increasing demand for resources such as energy, water and materials has been met by a new wave of resource efficiency policies around the world. Win-win regulations are considered as triggers for the sustainable development of the companies and the general economy in the green capitalism framework (Moraru, 2015). In Europe, some reference documents on resource efficiency policy are *The Roadmap to a Resource Efficient Europe (RREE)* (EC, 2011), the *EU Action Plan for the Circular Economy* (EC, 2015, Font Vivanco et al., 2018) and the *European Green Deal* (EC, 2019). As the *Roadmap* aims to "improve economic performance while reducing pressure on natural resources" (EC, 2011), the Green Deal aims at transforming the EU into "a fair and prosperous society, with a modern, *resource-efficient* and competitive economy where there are *no net emissions of greenhouse gases in 2050* and where *economic growth is decoupled from resource use*" (EC, 2019). The United Nations similarly defined resource efficiency as "more well-being with less use of materials [...] considering the ecological carrying capacity of the earth" (UNEP, 2010). These concise definitions describe a desired economic and ecologic state, but not the specific actions that need to be taken (van Ewijk, 2018) or the interaction between the set objectives. This paper aims at contributing to fill this gap. From a business administrator's perspective, these politics offer a wide range of opportunities but also imply new challenges. The private sector plays a critical role for the achievement of these goals, considering its impact on the environment.

Worldwide resource extraction and the processing of materials, fuels, and food account for about 50% of the greenhouse gas emissions and more than 90% of water stress and biodiversity loss. Despite the efforts made by the EU industries to lower their carbon footprint over the past decades, 20% of the EU's GHG emissions can be traced back to industry, which still relies to almost 90% on new materials extracted (EC, 2019). Lower resource intensity is associated with lower carbon footprint. This paper looks into the carbon and resource intensity of the EU Member States as presented in policy papers and as expressed by the indicators "resource efficiency" and "greenhouse gas emissions" measured relative to 1990 and into the relation between these indicators.

Literature review

Resource efficiency

T. R. Malthus is often credited with first drawing attention to the problem of resource scarcity and exponential population growth. His "An Essay on the Principle of Population" proposes that the availability of food increases linearly, while uncontrolled population growth tends to be exponential (Malthus, 1798). However, Malthus did not foresee the affluence of fossil fuels and rapid technological advances that made efficient food

production far more possible in the 20th century. The efficiency gains proved sufficient to keep pace with the population growth (van Ewijk, 2018).

The first major publication that formalised the potential impact of increased resource use was the Club of Rome's Limits to Growth report. The book presented the results of a computer simulation of exponential economic and population growth. The model showed that population growth, industrialisation and resource consumption reinforce each other and lead to a rapid depletion of natural resources. In the model, depletion increases the energy and financial costs of extraction and triggers population collapse (van Ewijk, 2018).

Thinking about resource efficiency results from a shift in environmental thinking called ecological modernisation. Dating back to the 1980s, this school of thought believes that business benefits from better environmental protection and resource conservation. This optimistic view broke radically with the past and ended the controversial relationship between many (but not all) environmentalists and the private sector. Resource efficiency promises a win-win opportunity to increase economic growth and reduce environmental pressure (Revell, 2005).

In summary, the roots of resource efficiency go back to Malthus and the concept represents an optimistic view of the relationship between environment and economy. In the European Union, resource efficiency thinking has been supported by concerns about the environment, stagnant growth and high unemployment. The implementation of the concept can build on previous successes in waste management. In addition, the focus is shifting from end-of-pipe solutions to improvements in resource utilisation, process and product design (van Ewijk, 2018).

"Win-win" logic

In order to understand the win-win logic, it is important to distinguish between short and long-term benefits of the resource-efficient circular economy. In the long term, the economy as a whole can only benefit from securing the natural resources on which it is critically dependent. In the short term, the business benefits of the circular economy come from savings in material input costs: the more resource efficient a company is, the less it has to pay for material inputs per unit of production. This increases productivity and competitiveness and reduces the risk of volatile commodity prices (Dima & Vasilache, 2016).

Increased resource efficiency does not always save costs in the short term. Individual companies can benefit from inefficiency, overexploitation (Mihalca et al., 2021) and pollution because they do not bear the environmental costs. It may be necessary to increase the cost of resource inputs to reduce their consumption. Such a price shift can make the economy as a whole more efficient by better sharing the environmental costs of raw material extraction and processing (Gavurova et al. 2018, 2019). The short-term losses of inefficient firms can be offset by the short-term gains of other industries, leading to aggregate economic growth (Simionescu et al. 2022).

Greater resource efficiency can benefit multiple companies at the same time. For example, farmers' sparing use of fertilisers can reduce their input costs and also reduce treatment costs for water companies. Most importantly, extending the lifecycle of materials allows for greater value creation. Reusing materials can be beneficial for the company that generates the waste (e.g., from revenue from selling the waste and avoiding landfill fees)

and for the company that uses the waste (when recycled, substitutes have lower costs, as new goods) (van Ewijk, 2017; Janovská et al. 2021).

A study commissioned by Defra (Hollins, 2017) estimates the potential cost savings for UK businesses at £5.7-7.2 billion from missing or low-cost opportunities related to energy efficiency, waste reduction and water savings. Due to a lack of data, the study only provides basic estimates for a limited number of sectors. It analyses more efficient use of energy, food, water and materials on a global scale and estimates private sector savings at US$2.9 trillion. It should be noted that raw material prices have since fallen, which implies a proportional reduction in savings.

Circular economy

In the current environmental and economic policy discourse, the term resource efficiency is often used synonymously with circular economy. The circular economy is a model for "sustainable growth through the creation of an industrial system that is regenerative by intention and design" (Ellen MacArthur Foundation, 2012). The EU's Circular Economy Action Plan defines it as a system "where the value of products, materials and resources is preserved in the economy for as long as possible and waste generation is minimised" "to achieve a sustainable, low-carbon, resource-efficient and competitive economy" (EC, 2015).

In the European Union, recent interest in resource efficiency and the circular economy is being fuelled by concerns about sluggish growth and high unemployment. Resource efficiency is seen as a means of generating growth through better environmental management, as shown for example in the Roadmap to a Resource Efficient Europe (EC, 2011). In China, which has had a Circular Economy Law since 2008, the logic is almost the opposite: The Chinese Circular Economy Law aims to achieve better environmental management despite rapid economic growth (Geng et al., 2017).

Resource efficiency and circular economy thinking build on the gradual implementation of the waste hierarchy in waste management. The waste hierarchy is a priority order for waste management, listing energy recovery, recycling, reuse and prevention as the best alternatives to landfill. It is often summarised as the 3Rs: Reduce, Reuse, Recycle. The hierarchy was introduced in response to the lack of landfill space and the environmental issues of landfilling hazardous waste. (EC, 2015; Skvarciany et al. 2021)

In the context of resource efficiency, the top priority of "waste prevention" in the waste hierarchy is particularly relevant. Prevention is often ignored as the waste sector has little control over how and how much waste is generated.

Resource efficiency within the EU

In the last decade, the sustainable use of natural resources has received increasing attention in European Union (EU) policies as a smart way to achieve environmental, climate, economic efficiency, and security of supply (Richterová et al. 2021). It also is a central element of the 2050 Vision for Europe as set out in several strategy papers of the European Union (2011, 2013, 2013a, 2015, 2016, 2019, 2021).

In 2011, the European Commission published a "Roadmap to a Resource Efficient Europe" by 2050; a key component of the "Resource efficient Europe – a flagship initiative within the Europe 2020 strategy" (EC, 2011), in its turn part of the Europe 2020 strategy. The overarching goal of this roadmap is to lay the foundations for the EU economy to grow by 2050 "in ways that respect resource scarcity and the planet's limits, contributing to a

global economic transformation". The economy is supposed to become "competitive and inclusive, offering a high standard of living with a significantly lower environmental footprint" with "all resources are managed sustainably" (EC, 2011).

The vision contains important qualitative and quantitative characteristics that such an economy should have in 2050. These characteristics were derived by first identifying significant "sustainability visions" that have been developed in recent years and then analysing them against a common analytical framework that focuses on two assessment pillars – "nature" and "wellbeing and quality of life". The vision was then refined in a process of consultation with stakeholders (EC, 2011).

The Europe 2020 strategy focuses on 3 priorities: smart, sustainable and inclusive growth translated into five goals covering the topics of employment, investments, environment, education and poverty. The environment is covered through the 20/20/20 targets: increasing the share of renewables in the final energy consumption to 20%, increasing energy efficiency by 20% and reducing GHG emissions by at least 20% compared to 1990, where possible by 30%.

The Roadmap to a Resource Efficient Europe offers a framework for the coherent design and implementation of future actions, covering structural and technological aspects as well as milestones up to 2020. This roadmap is part of A Resource-Efficient Europe - a flagship initiative within the Europe 2020 strategy. The roadmap aims to "increase resource productivity and decouple economic growth from resource use and its environmental impact" (EC, 2011).

More recently, the European Commission and the United Nations Environment Programme, the United Nations Industrial Development Organization teamed up to form the *Global Alliance on Circular Economy and Resource Efficiency (GACERE)* (EC, 2021).

Resource efficiency indicators

Resource efficiency is an essential part of Europe's economic future, as well as for its environmental and social well-being. Therefore, a scoreboard was published in 2015 to assess the implementation of the roadmap in EU countries. The scoreboard was developed using a three-tiered approach combining 32 different indicators:

1. A general headline indicator of "resource productivity";
2. A second level "dashboard" with supplemental macro indicators for materials, land, water and carbon;
3. A third level of theme specific indicators to evaluate the progress towards key thematic objectives, actions and milestones set out in the roadmap (EC, 2016).

Resource productivity

Resource productivity can be measured as the ratio between economic output and resource input of a process. At the country level, resource productivity (RP) is typically measured by dividing gross domestic product (GDP) by domestic material consumption (DMC):

$$RP=GDP/DMC \quad (1)$$

There is some evidence of the comparative performance across countries and the direction of change over time, but it offers little insight into well-being or the state of the environment. Resource productivity is the headline indicator in the European Union

Resource Efficiency Scoreboard (EC, 2016). Resource efficiency can be understood as a means of preserving natural capital while enabling the creation of other forms of capital.

While the gross domestic product is the most commonly used indicator to analyse the size of an economy, the domestic material consumption measures the material input to the economy. DMC includes all domestic material resources, plus the imported material resources, minus the exported ones, combining several different material types with their weight as a common unit of account. Flachenecker et al. (2018, 2018, 2019) looked into the definition, limitations and evolution of this indicator often used to monitor the progress towards the UN SDGs (UN, 2020).

Carbon intensity of economies

When looking at the carbon intensity, we look at GHG Missions. Greenhouse gas emissions are emissions of gases that cause the greenhouse effect, reported in units of potency equivalent to that of a kilogram, tonne, or gigatonne of carbon dioxide (IRP, 2020). The GHG in the EU amounted to 4.234 million tonnes CO_2 equivalent in 2018 (including indirect CO_2 emissions). According to the European Environmental Agency, 2018, total GHG emissions were 25.2 below 1990 levels (EC, 2020).

The GHG indicator (expressed in CO_2 equivalents) shows the greenhouse gas emissions of the main source categories: energy, industrial processes and construction, agriculture, and waste. LULUCF (land-use, land-use change and forestry) are historically excluded from the EU's headline indicator. Greenhouse gases are also released from natural sources, but the burning of fossil fuels, agricultural activities, waste generation and industrial processes have historically increased their concentrations well beyond historical levels.

The subsequently analysed indicator is based on man-made gas emissions, and to lower the overall level, the European Commission is relying on two instruments: the Emission Trading Scheme (ETS) and the Effort Sharing Decisions (ESD) (EC, 2020).

The ETS covers around 45% of all EU greenhouse gas emissions. ETS is the EU's central instrument for reducing greenhouse gas emissions from large-scale installations in the energy and industrial sectors and in aviation. In 2020, emissions from these sectors should be reduced by 21% compared to 2005.

The ESD covers around 55% of all EU greenhouse gas emissions. The ESD sets national annual binding targets for emissions that are not covered by the EU Emissions Trading Scheme. These sectors include, for example, housing, agriculture, waste and transport (excluding aviation). As part of the "effort sharing decision", the EU countries have adopted binding annual targets for reducing emissions in these sectors by 2020 (compared to 2005). National emission targets for 2020 ranged from a 20% reduction by 2020 for the most ambitious Member States (Denmark, Luxembourg) to a 20% increase for the country with the highest need for development (Bulgaria) (Wach et al., 2021).

Empirical study – relation between resource efficiency and greenhouse gas emissions

Several reports by IRP (2019, 2020) and the OECD (2019) indicate that there are potential synergies between resource efficiency and greenhouse gas emission reductions, emerging mainly due to overlapping extraction and processing of large quantities of resources with

the requirement of large amounts of energy. Policies related to material usage still largely focus on waste management rather than reduction in greenhouse gas emissions. Since emissions from the production of materials increased from 5 Gt of CO_2 - equivalent in 1995 to 11 Gt in 2015, with their share of global emissions rising from 15 per cent to 23 per cent (IRP, 2020), we decided to further look into the relation between resource efficiency and GHG.

As discussed in the previous chapters, resource productivity is the leading indicator that measures resource efficiency. However, this indicator is not very comprehensive, as it is based only on GDP and DMC. Some of the 2015 EU Resource Efficiency Dashboard's macro indicators like GHG/capita, energy productivity or share of e-res in the final energy consumption, suggest that resource productivity is connected to the carbon intensity of the economy. Thus, resource efficiency and the 2020 climate and energy targets are related. We decided to analyse the degree of correlation between the 2020 indicators and resource productivity in the countries of the European Union, as available at Eurostat and presented in Table 1. The following chapter presents the results of this analysis and some projected values based on existing data.

Table 1. GHG emissions and Resource Productivity

Year	***GHG emissions, EU-27 average base year 1990=100***	***RP, EU-27 average***
2000	92.50	1.187
2001	93.42	1.2388
2002	93.10	1.2718
2003	94.84	1.294
2004	95.06	1.2922
2005	94.62	1.3362
2006	94.60	1.3803
2007	93.95	1.4108
2008	92.03	1.4841
2009	85.44	1.6127
2010	87.31	1.7227
2011	85.05	1.6844
2012	83.43	1.8349
2013	81.74	1.9071
2014	79.01	1.9259
2015	80.15	2.0011
2016	80.26	2.0591
2017	80.97	2.0755
2018	79.26	2.1084

Source: Eurostat.

Methodology

The study is based on the hypothesis that there is a strong correlation between the resource productivity of the European countries T2020_rl100 and their GHG emissions, using the main indicator for climate change T2020_30. Therefore, an econometric model has been created, to test this hypothesis: significance of intercept/regression constant, significance of variable/regression coefficient and validity of the model. The linear simple regression model is considered, as follows:

$$y = \alpha + \beta x + \varepsilon \ (2)$$

where:
x – independent variable;
y – dependent variable;
α – non-random/structural component/intercept;
β – regression coefficient/slope;
ε – error term/disturbance.

After the automatic generation of the ANOVA table in Excel, the hypothesis is tested.

H0: α = 0
H1: α ≠ 0
Null hypothesis of y intercept (3)

If 0 is in the [Lower 95%; Upper 95%] interval, H1 must be rejected and H0 accepted.

H0: β = 0 (β is not significantly different from 0)
H1: β ≠ 0 ((β is significantly different from 0)
Null hypothesis of the regression coefficient (4)

If the p-value of the variable is less than 0.05 (the confidence interval is 95%), H0 must be rejected and H1 accepted. This means that a relationship between the 2 indicators and the model is significant.

The last test relates to the validity of the model. So if the significance F from the ANOVA table is less than the risk (5%) then H0 must be rejected and H1 accepted.

H0: The model is not valid.
H1: The model is valid.
Validity of the model (5)

If H1 was accepted, this means that GHG emissions (x) is related to resource productivity (y) and the analysis can proceed (Kunst, 2011, pp. 24, 30, 34, 50). The next step is to determine whether there is a negative or a positive relation between the two indicators. We calculated this using the COVARIANCE.P function. If the covariance is less than 0, there is a negative association between them. (e.g., if x increases, y decreases). The next step is to see if this association is strong or weak. This can be calculated using Pearson's coefficient and the CORREL function. The closer the value is to 0, the weaker the relation is. However, when it tends to ±1, the relation is strong and the indicators affect strongly each other. All data used were retrieved from the Eurostat database. We also created forecast values for the EU-27 and for the member states using the function FORECAST.ETS (Microsoft, 2014). We also looked whether countries have managed to meet the 2020 minimum climate change requirements.

Results

Our model analyses the relation between resource productivity and greenhouse gas emissions as an average in the EU-27 from 2000 to 2018 (T2020_30). It should be noted that greenhouse gas emissions are measured relative to 1990, which is considered the base year, which is 100.

The analysis results in the function:

$$y = 5.94 - 0.049x. \quad (6)$$

After generating the data analysis, it is noticed that 0 is not in the range defined by the constant for Lower 95% and Upper 95%. Therefore, hypothesis H1 is accepted. In addition, the p-value is less than 0.05, which leads to the rejection of the H0 hypothesis. The covariance has a value of **-1.853** and the Pearson coefficient is equal to **-0.958.** Therefore, the two indicators are strongly negatively correlated.

Table 2. Summary output of GHG Emissions and Resource Productivity model

Regression Statistics	
Multiple R	0.958830
R Square	0.919356
Adjusted R Square	0.914612
Standard Error	0.094660
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.736555	1.736555	193.802430	0.000000
Residual	17	0.152327	0.008960		
Total	18	1.888882			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5.949306	0.311564	19.094941	0.000000	5.291962	6.606649
GHG emissions average EU-27 base year 1990=100	-0.049324	0.003543	-13.921294	0.000000	-0.056799	-0.041849

Parameter values		
a= 5.94	**Y= a+bx=> Y= 5.94-0.049x**	
b= -0.049		

Significance of the intercept	**Lower 95%**	**Upper 95%**
H0: a=0	**5.291962**	**6.606649**
H1: a<=>0	**0 is not in the interval**	
	H1 accepted	

Significance of the slope	**p-Value**
H0: b=0	**α=0.05**
H1: b<=>0	**p-value<α**

	H0 rejected => the model is valid

Validity of the model		**α=0.05**	
H0: the model is not valid		**sig. F**	**H0 rejected**
H1: the model is valid		**α>sig.F**	

Kov(x.y)	-1.853015	Negative covariance
R(Pearson)	-0.958830	Strong correlation

Source: Authors' own research based on Eurostat Data.

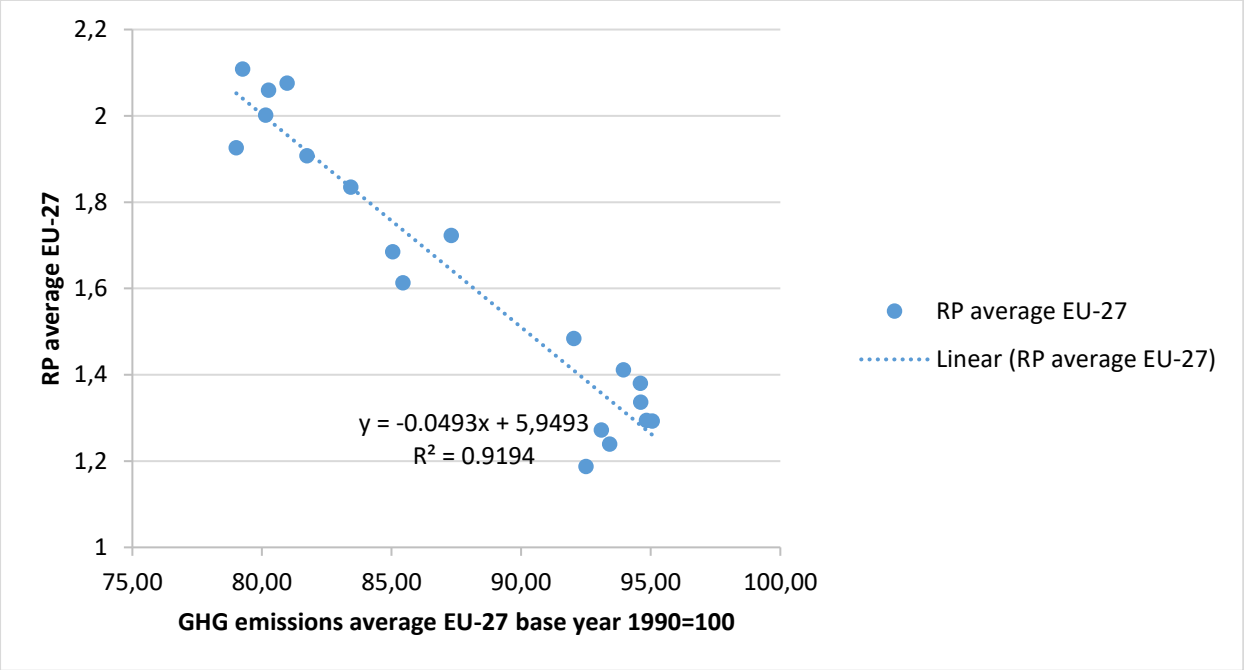


Figure 1. Relation between GHG emissions and resource productivity as an average in the EU-27 from 2000 to 2018

Source: Authors' own research based on Eurostat Data.

The chart above shows that most of the values are close to or even on the trend line. However, there are some exceptions. These values correspond to the years 2000-2003 when the European Union started to publish concrete guidelines on greenhouse gas emissions. The coefficient of determination above 0.9 lets us conclude that a very high proportion of the variance in the response variable can be explained by the linear model.

In the second part of the analysis for this indicator, the variance for the EU-27 average value was calculated using the VAR.P function. All EU countries' values from 1990 to 2018 were taken into account. The value resulted is 38.472. This means the data is heterogeneous, as the value exceeds 30%. Considering that it is somehow close to that percentage, we can assume that the data are homogeneous, but not complete. Therefore, the confidence limit can be slightly larger, but not by much. This is easy to see in Figure 2.

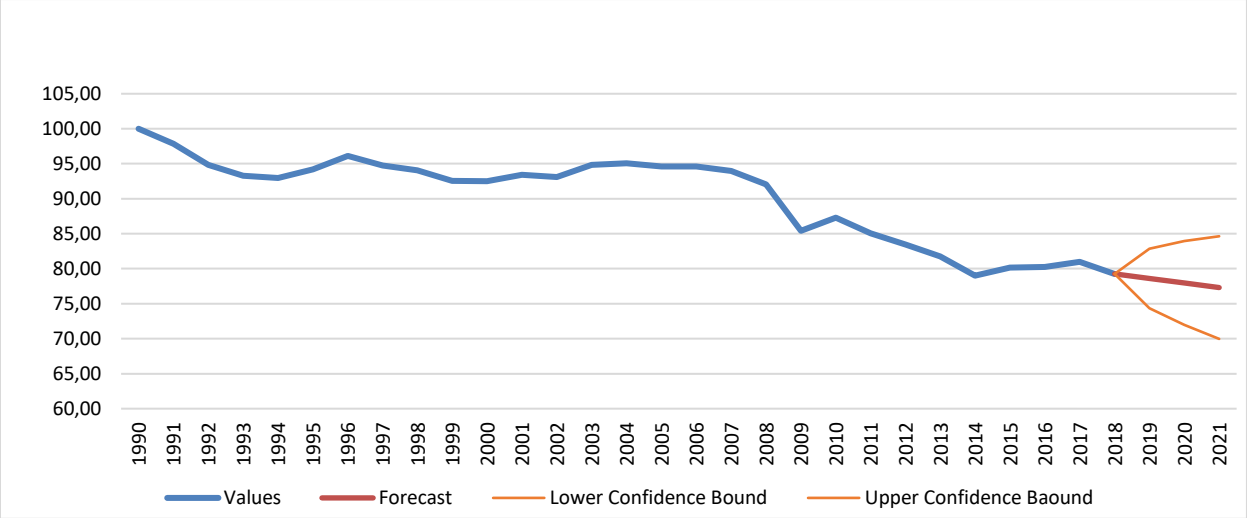


Figure 2. Projected values for the years 2019, 2020 and 2021 for the average GHG emissions of the EU - 27 countries

Source: Authors' own research based on Eurostat Data.

Some values with a decreasing tendency were obtained from the calculations for the EU average (see Figure 3). Also, the confidence interval is about 4 percent higher than the mean. For the year 2020, the interval is [71.97; 83.94]. If the target was to reduce gas emissions by 20% compared to 1990, this was not achieved in the worst case, but could have been achieved by the end of 2021, as a slight growth trend can be seen at the upper end of the interval. However, for this analysis we will consider the mean of the forecast, which is 77.96 for the year 2020. As this value is below 80%, on average the European Member States have met the target for 2020. Looking out to 2030 and 2050, however, new challenges must be overcome.

Table 3. GHG emissions forecast

TIME	2019	2020	2021	Target 2020
European Union 27	78.61	77.96	77.30	80
Belgium	81.75	80.82	79.90	80
Bulgaria	56.55	55.68	54.82	80
Czech Republic	63.93	63.05	62.18	80
Denmark	70.39	70.22	70.05	80
Germany	69.73	68.84	67.95	80
Eastland	49.28	48.59	47.89	80
Ireland	113.81	114.02	114.22	80
Greece	90.58	90.32	90.06	80
Spain	120.36	120.98	121.59	80
France	81.60	80.08	78.57	80
Croatia	75.34	75.46	75.57	80
Italy	83.84	83.27	82.71	80
Cyprus	163.04	164.69	166.34	80
Latvia	44.90	43.86	42.81	80
Leetonia	41.53	40.49	39.44	80
Luxemburg	94.25	94.34	94.42	80
Hungary	66.86	65.90	64.94	80

TIME	2019	2020	2021	Target 2020
Malta	96.05	95.96	95.87	80
Netherlands	88.09	87.45	86.80	80
Austria	102.80	102.95	103.09	80
Poland	87.47	87.51	87.56	80
Portugal	119.15	119.39	119.64	80
Romania	45.30	43.88	42.46	80
Slovenia	99.78	99.79	99.81	80
Slovakia	58.08	57.11	56.13	80
Finland	80.19	78.98	77.76	80
Sweden	74.14	73.01	71.87	80

Source: Authors' own research based on Eurostat Data.

Looking at the data for all European Member States (see Figure 3.), we can see that Romania has a very low percentage compared to the other Member States, namely 43.88 for the year 2020. It seems like Romania reached the European target a long time ago, in 1991-1992 to be precise. As shown in another study, the explanation for these figures is the significant drop in energy demand and industrial activity after the communist revolution (Dachin & Clodnitchi, 2020).

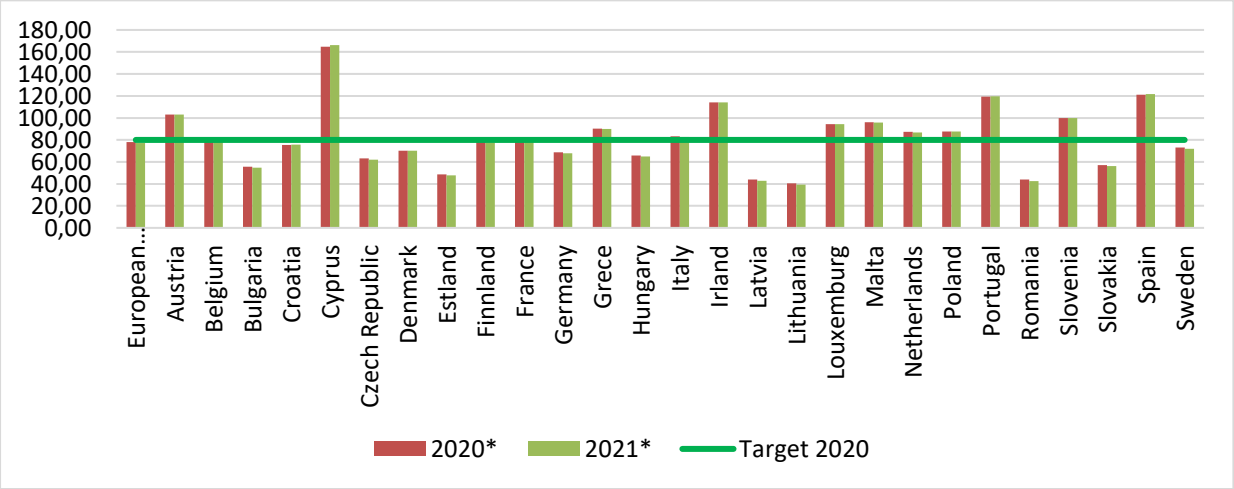


Figure 3. GHG emissions target for 2020 and 2021 compared to projected values for the EU-27

Source: Authors' own research based on Eurostat Data.

According to the Union of Concerned Scientists (2022), Germany is the country with the highest GHG emissions in the EU in 2020. Per capita, Germany occupies the same place, followed by France and Poland. However, there are countries that look worse according to Figure 3, such as Cyprus, Portugal, Spain and Ireland. In Cyprus, the amount of emissions increased by 80% between 1990 and 2008 compared to 1990. The increase is mainly caused by the increase in emissions from road traffic. However, emissions from other sectors such as agriculture or energy consumption remained stable. Furthermore, between 2009 and 2012, Cyprus managed to reduce all its emissions except from the agricultural sector (Donat et al., 2014).

Recent estimations cited by the European Commission show that the EU's net emissions in 2020 were 34% lower than in 1990. These are based on national projections regarding the implementation of the climate and energy policies and measures. Looking at the Climate Change Performance Index (2022), there was a global decline in GHG emissions by 5,4% in 2020. Therefore, it is possible that, in reality, GHG emissions at EU level to have decreased significantly and more countries reached their 2020 target. As with GHG emissions, the COVID-19 pandemic has had a significant impact. However, these changes are most likely temporary. The International Energy Agency estimated, for the period of January–July 2021, that CO_2 emissions would rise by 4.8% (IEA, 2021). In this way, emissions will probably return to their original levels or even rise above them. For a 1.5°C decrease at world level, it would have been necessary for emissions to fall at their 2020 rate (CCPI, 2022).

Limitations and discussion

This research builds upon the existing literature. The novelty of our approach is the examination of the relation between resource efficiency and GHG-emissions through a regression model. Looking at the results of our research, it can be said that the actions aiming to reduce Green House Gas Emissions are strongly connected to an increase in Resource Productivity. Furthermore, we have shown that some EU countries were not supposed to reach their targets set for 2020, but they reached them, probably due to the reduction triggered by the COVID pandemic, which are considered reversible.

The main limitations of the study are given by the sample of variables chosen and its simplicity. The use of EXCEL instead of other statistical software also limits the analysis options, not allowing us to investigate the autocorrelation and multicollinearity of the regression equation. The forecast analysis is also not accurate, because it is not taking into account the differences triggered by the pandemic situation. However, it contributes to the scientific literature through the regression model that has not been previously examined and the topical overview of the overall situation in these turbulent times.

Future Research

In view of future goals associated with the current study, the research can be extended by introducing different uncorrelated variables such as the recycling rate, municipal waste generation or indicators from the other segments of the scoreboard such as material, water or land. Another potential approach would be an analysis of different regions (e.g., the Nordic region, the Baltic countries, the Visegrad countries, the Benelux countries or EFTA countries, etc.). In the light of the CORONA pandemic, the energy inflation and the war in Ukraine, an update of data would be of great interest.

Conclusions

Despite all efforts of the EU or the United Nations, it has turned out that resource efficiency has only increased by one percent worldwide in the last 30 years.

The paper examines the EU's medium-term potential to use resources more efficiently. We have shown that resource productivity is strongly related to our carbon footprint. The negative correlation between the resource productivity of countries and their GHG emissions is very strong. With the help of the forecast, we found that only 2/3 of the

targets relating to GHG emissions would have been achieved by 2020. It is probable that the coronavirus pandemic has lowered the values of GHG emissions, but what can we expect for the coming years when everything returns to "normal"? Especially in the light of the war in Ukraine and the energy price inflation, policymakers must develop new ways to tackle the balance of sustainable development.

The European Commission presents optimistic figures related to the progress towards decarbonisation, so far. Nevertheless, if the current trend continues, we will have a net emission reduction of 41% by 2030 (EC, 2022). Considering that the European Commission introduced in 2021 the 'Fit for 55' climate package, to achieve the 55% net reduction target by 2030, further analysis on the topic is needed. Only by acting according to our best knowledge and conscience, we can meet climate neutrality by 2050.

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