

## THE IMPACT OF NATURAL GAS CONSUMPTION ON ENERGY SUSTAINABILITY AND THE SUSTAINABLE DEVELOPMENT OF THE AGRICULTURAL SECTOR

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### Abstract

*The analysis of natural gas consumption and its impact on energy sustainability and the sustainable development of the agricultural sector is an important topic, given the energy transition and challenges related to the security of resource supply. Natural gas is essential for energy production, industry and agriculture, and changes in its consumption directly influence production costs. This study aims to investigate the relationship between variations in gas consumption and sustainable agricultural growth, as well as to detect patterns in natural gas consumption within the European Union and analyze their effects on sustainability. The research's methodology is based on statistical analysis of data on natural gas consumption at the European level using a number of pertinent indicators, including the rates of domestic consumption growth and decline, the final consumption of energy generated from natural gas, the non-energy use of natural gas, and the availability of natural gas in European nations. The data was processed using comparative and correlative analytical tools to determine the effect of gas use on economic sustainability, which directly affects agriculture. The findings show that natural gas use has significantly decreased since 2019, accentuated in 2022, which generated increases in prices and energy costs for all categories of consumers, including agricultural farms. Also, the reduction in the amount of natural gas used in energy transformation processes indicates a decrease in dependence on energy generated from fossil fuels, but also the need for substantial investments to adopt viable alternatives, including in the case of agriculture. On the other hand, the decrease in non-energy consumption of natural gas has a direct impact on production, which has led to price increases, including agricultural inputs, and to economic pressures on businesses with limited financial resources, including agricultural farms. The study underlines the need for support policies, aimed at facilitating adaptation to the new energy conditions and ensuring a balanced transition towards sustainable and energy efficient production systems.*

**Key words:** natural gas, energy sustainability, sustainable development, transition

### INTRODUCTION

Since natural gas is inexpensive, efficient, and has a lower environmental impact than other fossil fuels like coal and oil, it is one of the most popular energy sources and plays a significant position in the global energy mix. Because they burn cleaner and emit less carbon dioxide, they are referred to as a "transition fuel" in the process of lowering greenhouse gas emissions. [8, 12].

In order to generate power, supply industrial infrastructure, and meet domestic energy needs, the energy sector employs natural gas. Because it can offset the unpredictability of

renewable energy sources like solar and wind, natural gas also plays a crucial role in maintaining the stability of the energy system, emphasizing the significance of striking a balance between present energy demands and long-term sustainability and emission reduction targets [1, 10]. This transition is essential to ensure sustainable economic development in a constantly changing global context [4, 9, 14].

Economically, natural gas is a more cost-effective and efficient alternative to other fossil energy sources, making it attractive to developing countries looking to expand their energy access. At the same time, international trade in natural gas, including pipelines and

liquefied natural gas, has become an essential component of the global economy, facilitating trade and reducing the dependence of some states on local resources [7, 15].

Changes in the amount of natural gas used in energy transformation processes indicate a reduction in gas dependence for the production of electricity and heat, which has led to a reconfiguration of the energy mix of European states.

Analyzing the rise and fall rates of natural gas consumption in Europe is motivated by the need to comprehend how these trends affect energy sustainability and the sustainable growth of the agricultural sector, given that agriculture is an energy-intensive industry. Energy efficiency regulations and the shift to renewable energy sources are intimately linked to domestic natural gas use, which also reflects the overall dynamics of the energy market [3, 11]. This relationship is essential to agriculture, as natural gas is used both as an energy source for farms and as a raw material in the production of inputs.

Thus, changes in the domestic consumption of natural gas influence the costs of agricultural production and the ability of farmers to maintain productivity at an optimal level [2, 16].

Analysis of the final consumption of energy produced by natural gas is relevant for agriculture because this indicator provides insight into how gases are used to generate electricity and heat. These forms of energy are used in agricultural processes, from irrigation and heating greenhouses, to transporting and processing agricultural products. With the use of natural gas for energy production declining, agriculture needs to find other ways to meet its energy needs without sacrificing crop yields.

The non-energy use of natural gas is another essential aspect, having direct implications on the availability of chemical fertilizers. The declines in natural gas use in this category show the challenges the agricultural sector can face, including increases in production costs and reductions in the amount of fertilizers available on the market. This phenomenon can affect both food security and the long-term sustainability of agricultural production.

The analysis of the amount of natural gas used in energy transformation processes is important for evaluating the degree of efficiency in the use of this fuel in agricultural production. A shift toward alternative energy sources like biogas, solar, or wind energy could be indicated by the decline in usage in this sector [13]. In agriculture, this translates into the need to adapt to new market conditions and increase investments in sustainable energy infrastructure.

The total amount of natural gas available in Europe influences their accessibility for agriculture, and fluctuations in this indicator can have implications on the energy security of farms. A reduction in gas availability may lead to higher prices and the need for support policies for farmers to offset the economic impact of higher energy input prices.

Analyzing indicators related to natural gas consumption allows a better understanding of the interdependence between energy policies and the sustainability of agricultural production [5, 17]. This highlights the need for an integrated strategy that includes energy efficiency measures, diversification of energy sources and policies to support farmers in the transition to a more sustainable agricultural model.

In this context, this study researched the relationship between variations in gas consumption and sustainable agricultural growth, the patterns in natural gas consumption within the European Union and their effects on sustainability.

## MATERIALS AND METHODS

The research is based on a quantitative and comparative analysis of the dynamics of natural gas consumption in Europe.

In order to identify the relevant trends and the effects they can have on agriculture, the methodology used combines the statistical analysis of the data available on Eurostat, with the correlative interpretation of the calculated indicators.

In the first stage, we selected the relevant indicators for this analysis, which included:

*The growth/decrease rates of domestic natural gas consumption in Europe*, used to

identify general trends in natural gas use at national and regional level;

*The rates of increase and decrease in the ultimate energy consumption generated by natural gas* give an indication of how natural gas affects the generation of heat and electricity, as well as in agriculture;

*The growth/decrease rates of final consumption – non-energy use of natural gas*, relevant for the analysis of the impact on essential agricultural inputs;

Understanding the efficiency of converting natural gas into usable energy and the possibility of switching to renewable sources requires knowing the *rates at which the amount of natural gas used in energy transformation processes is increasing or decreasing*;

*The growth/decrease rates of the total amount of natural gas available in Europe* reflecting changes in gas supply and their impact on the energy market, including agriculture.

The research methodology was based on the collection and analysis of data from official sources (Eurostat).

The indicators were calculated using statistical analysis methods, comparing annual values and evaluating trends for the period 2014-2023.

To validate the results, a comparative analysis was carried out between European countries, highlighting the differences in adaptation and the alternative strategies adopted according to the energy specifics of each country.

This methodological approach allows a detailed understanding of how the consumption of natural gas influences energy sustainability and agriculture, being the basis for the formulation of recommendations regarding the transition to renewable sources and the optimization of resource consumption in the agricultural sector.

## RESULTS AND DISCUSSIONS

Analyzing natural gas use and its effects on agricultural and energy sustainability becomes crucial for EU member states in light of the energy transition and global economic challenges. With a significant impact on industry, agriculture, and the generation of

thermal and electrical energy, natural gas is a vital part of the European energy mix.

Studying the growth and decline rates of natural gas consumption allows for a detailed assessment of long-term trends, providing essential data for the formulation of effective strategies to adapt to changes in the energy market. This research contributes to the identification of optimal solutions for ensuring a balanced energy transition, minimizing the economic impact on agriculture and promoting sustainable development at European level.

Using the gross calorific value (GCV, or gross calorific value) and terajoules (TJ), an analysis of the internal consumption of natural gas for the years 2014–2023 reveals variations in natural gas consumption in Europe, influenced by the energy crisis, price increases and the transition to alternative sources. In 2022-2023, most countries recorded significant decreases (EU -12.9%, Euro Zone -12.11%, Finland -47.81%, Lithuania -31.7%), due to the reduction of imports from Russia, the energy saving process and the increase in the share of renewable energy. Countries such as Germany (-12.72% in 2022) and France (-9.58%) were less affected due to diversified imports important adjustments, and Finland and Norway, had increases in 2023 (+14.48% and +14.36%). The extreme fluctuations of some countries like Albania +78.27% in 2019, -28.46% in 2020, Greece +30.36% in 2016, -19.18% in 2022 are due to the impact of infrastructure development, but also economic adjustments.

Ukraine and Moldova have seen steady declines due to economic difficulties as a result of the war. In order to stabilize the energy market, strategic measures are needed, such as the diversification of supply sources through LNG and hydrogen, the efficiency of industrial and household consumption, massive investments in renewable energy and the reduction of dependence on fossil gases, i.e. solutions that will contribute to Europe's energy security in the current geopolitical context (Table 1).

Table 1. Growth/decrease rates of domestic natural gas consumption in European countries (TJ)

Country	2014/ 2015	2016/ 2015	2017/ 2016	2018/ 2017	2019/ 2018	2020/ 2019	2021/ 2020	2022/ 2021	2023/ 2022
GEO (Labels)									
European Union - 27 countries (from 2020)	4.45	5.86	5.65	-1.83	3.20	-2.42	4.07	-12.90	-7.31
Euro area – 20 countries (from 2023)	4.81	5.94	5.78	-2.19	3.88	-3.43	3.89	-12.11	-7.91
Albania	10.22	27.77	7.05	-13.68	78.27	-28.46	7.43	-13.85	3.79
Austria	6.82	4.84	7.37	-5.32	4.43	-4.67	5.63	-10.88	-14.45
Belgium	10.32	2.01	2.20	3.21	1.35	-0.56	0.46	-15.00	-5.70
Bosnia and Herzegovina	16.86	4.09	8.15	-0.34	-5.56	-8.78	20.51	-2.53	-9.81
Bulgaria	9.83	3.54	2.82	-5.43	-6.52	3.00	12.95	-18.15	-6.58
Croatia	3.09	4.26	14.87	-8.06	4.96	4.96	-3.80	-12.20	7.31
Czechia	4.86	8.23	2.63	-5.30	4.97	1.66	7.16	-18.66	-13.11
Denmark	2.35	2.61	-2.77	-0.98	-2.97	-10.94	-2.32	-18.10	-1.28
Estonia	-10.35	9.68	-5.21	2.34	-7.74	-7.99	13.83	-25.07	-12.32
Finland	-10.86	-7.90	-6.05	12.38	-2.07	-0.74	0.69	-47.81	14.48
France	7.51	9.30	0.57	-4.24	2.03	-6.83	6.50	-9.58	-11.19
Georgia	10.16	-5.99	5.33	-0.47	13.30	0.36	3.66	19.70	0.14
Germany	2.81	7.94	7.12	-2.37	2.81	-1.35	4.16	-12.72	-4.19
Greece	7.75	30.36	20.46	-2.06	9.04	9.78	10.55	-19.18	-9.78
Hungary	7.28	7.18	6.46	-3.14	2.31	3.54	6.05	-14.69	-10.90
Ireland	0.72	12.97	1.55	4.06	1.62	0.13	-4.30	2.12	-7.14
Italy	9.06	5.02	5.99	-3.28	2.44	-4.30	7.19	-10.03	-10.19
Latvia	1.55	1.36	-10.81	17.73	-5.62	-17.50	5.93	-28.24	-0.83
Liechtenstein	**	**	**	**	**	-3.59	11.54	-15.99	-7.40
Lithuania	0.14	-10.93	4.34	-7.58	4.99	5.76	-4.84	-31.70	-2.33
Luxembourg	-8.68	-7.73	-2.15	-1.41	-0.21	-8.88	7.63	-21.41	-6.26
Malta	**	**	**	21.18	4.53	3.93	0.27	1.15	4.45
Moldova	-3.98	2.66	-0.12	8.83	-7.60	1.91	14.33	-28.75	-18.51
Montenegro									
Netherlands	-1.69	4.92	3.75	-1.32	4.37	-1.74	-4.04	-22.12	-5.04
North Macedonia	0.73	57.23	28.61	-7.77	16.90	14.47	26.96	-32.63	26.51
Norway	8.23	-10.14	-10.56	10.62	-9.61	-8.80	10.38	-20.35	14.36
Poland	2.77	6.23	5.54	4.40	0.64	5.42	6.57	-17.45	4.75
Portugal	16.63	6.71	25.27	-7.26	5.20	-1.87	-4.42	-3.12	-20.70
Romania	-4.62	1.19	6.51	2.42	-6.81	4.53	2.70	-16.05	-6.12
Serbia	8.79	8.06	11.94	0.69	-6.50	-0.19	20.36	-3.31	-2.65
Slovakia	2.84	0.41	6.20	-1.44	0.22	0.05	11.32	-16.68	-4.80
Slovenia	6.12	6.13	4.76	-1.89	1.50	-0.01	5.39	-11.82	-3.53
Spain	3.91	2.01	9.25	-0.56	14.09	-9.61	5.33	-3.66	-10.94
Sweden	-8.87	13.08	12.39	8.81	-5.80	32.92	-17.15	-36.38	13.40
Türkiye	-2.04	-2.85	15.60	-7.27	-9.69	7.21	23.68	-14.56	-1.34
Ukraine	-22.02	-1.85	-4.09	4.48	-8.85	1.97	-2.65	**	**
United Kingdom	3.35	11.82	-2.50	1.26	-1.75	**	**	**	**

Source: own processing [6].

Table 2 analyzes the final energy consumption, i.e. the actual use of natural gas by consumers (industry, residential sector, transport, etc.). Final energy consumption in European countries has been influenced by economic factors, global crises and energy policies.

Table 2. Growth/decrease rates of final energy consumption produced by natural gas in European countries (TJ)

Country	2014/ 2015	2016/ 2015	2017/ 2016	2018/ 2017	2019/ 2018	2020/ 2019	2021/ 2020	2022/ 2021	2023/ 2022
European Union – 27 countries (from 2020)	3.66	4.05	0.78	-0.06	-1.30	-2.45	10.14	-14.15	-6.68
Euro area – 20 countries (from 2023)	3.84	4.08	0.43	0.14	-1.34	-3.03	9.97	-14.16	-6.60
Albania	-6.39	20.82	15.88	-1.71	-0.4	1.83	19.36	-18.76	9.78
Austria	6.05	3.26	-0.78	-0.84	-3.31	-4.37	7.65	-19.12	-8.15
Belgium	7.24	4.11	1.58	0.7	-0.6	-4.14	11.83	-18.08	-2.39
Bosnia and Herzegovina	0.22	-1.33	8.82	-9.62	8.29	-14.05	6.96	-6.28	-9.03
Bulgaria	10.26	0.07	4.01	-3.77	-11.91	1.34	13.31	-15.65	-8.43
Croatia	4.16	5.46	4.93	-0.5	1.73	0.5	5.73	-9.89	-3.08
Czechia	4.52	5.17	4.65	-6.57	0.41	-0.56	6.66	-14.28	-10.81
Denmark	3.94	1.54	4.47	-1.65	-1.63	-0.02	5.76	-19.05	-1.1
Estonia	-0.63	13.49	-6.63	7.39	-2.63	1.07	6.23	-32.35	-9.79
Finland	0.46	3.2	7.42	-3.69	-3.15	-5.37	11.29	-9.34	-8.04
France	2.61	4.9	-2.66	-1.25	-2.49	-6.25	8.99	-14.51	-8.43
Georgia	1.75	6.42	2.56	13.39	-3.4	3.97	21.22	-25.49	-18.85
Germany	3.95	6.32	0.68	0.81	-1.56	-0.57	9.77	-13	-6.52
Greece	16.09	8.12	-19.18	-4.14	10.47	22.46	7.23	0.42	-9.14
Hungary	4.81	5.12	-1.51	-0.02	-0.01	-9.46	7.65	-21.24	-4.04
Ireland	6	4.44	1.53	7.74	0.57	-0.7	-0.6	-7.13	-8.04
Italy	6.73	0.77	2.06	-0.86	-1.74	-3.74	15.02	-13.7	-6.66
Liechtenstein	7.52	-18.98	6.98	-5.63	2.21	-0.87	-2.68	-16.01	-18.88
Lithuania	-3.1	1.49	2.1	5.02	-6.06	-0.21	8.88	-15.37	-6.66
Luxembourg	-0.59	6.23	3.37	4.76	-2.15	-0.22	11.18	-9.59	-2.28
Malta	5.82	4.66	3.06	-2.44	-1.59	3.8	6.93	-14.61	-13.12
Moldova	18.63	3.08	9.68	-0.65	-5.46	-10.57	25.96	-1.16	-11.61
Montenegro	3.59	2.81	-1.95	4.4	-0.9	**	**	**	**
Poland	4.15	3.66	1.23	-2.74	2.72	-1.97	5.47	-11.71	-11.39
Portugal	1.7	8.67	-0.61	0.73	0.55	-1.13	17.03	-10.34	-2.47
Romania	4.33	1.29	6.44	3.19	0.66	-6.74	10.59	-9.38	-3.02
Serbia	7.16	0.15	8.9	-0.96	8.96	3.85	12.74	13.75	-0.34
Slovakia	7.7	7.25	1.99	-2.09	-0.98	-2.15	6.49	-9.99	-5.78
Slovenia	-3.05	-1.8	6.08	3.22	-2.25	3.92	12.04	-17.88	-7.04
Spain	-4.6	3.41	1.3	4.33	1.61	-3.53	6.16	-14.78	-2.85
Sweden	-8.15	-2.22	10.27	-5.43	12.94	-0.94	9.76	-19.77	-11.01
Türkiye	63.21	-10.05	24.56	-40.96	-12.2	-0.02	0	-8.94	92.16
Ukraine	10.1	6.27	19.31	10.04	-11.82	-7.58	29.09	3.76	-6.09

Source: own processing [6].

In the period 2014-2019, a moderate increase in final energy consumption is observed, with annual rates between 3% and 4% in the EU-27 and the Eurozone, driven by economic growth and industrial development. The COVID-19 pandemic of 2020 caused financial hardships and a decrease in transportation and industry, which in turn led to a drop in consumption (-2.45% in the EU-27 and -3.03% in the Eurozone). Due to the recovery of economic activity and the demand for energy, the return in 2021 was +10.14% in the EU-27 and +9.97% in the Eurozone. Rising energy prices, the energy crisis caused by the conflict in Ukraine, and EU-mandated energy

efficiency standards all played a part in the reduction in consumption in 2022. (-14.15% in the EU-27 and -14.16% in the Eurozone). Consumption declined by -6.68% in the EU-27 in 2023, confirming the trend of energy demand adjustment. The countries with the largest fluctuations were Estonia (-32.35% in 2022), affected by the decline in industrial activity, and Türkiye (+92.16% in 2023), where the increase in consumption was due to changes in energy supply Germany, France and Italy recorded moderate decreases, as a result of their ability to manage the energy crisis more effectively.

Table 3. Growth/decrease rates of final consumption - non-energy uses of natural gas in European countries (TJ)

Country	2014/ 2015	2016/ 2015	2017/ 2016	2018/ 2017	2019/ 2018	2020/ 2019	2021/ 2020	2022/ 2021
European Union - 27 countries (from 2020)	-4.26	10.49	-2.32	7.93	-3.06	-1.36	-4.39	-1.61
Euro area - 20 countries (from 2023)	-1.78	9.70	-0.52	9.14	-6.76	-0.15	-6.90	0.90
Austria	-13.72	17.87	-11.16	4.71	-6.05	6.98	0.51	-1.68
Belgium	14.63	15.52	-0.94	14.43	12.42	-11.39	-0.39	2.08
Bosnia and Herzegovina	6.07	12.38	-10.5	0.58	-5.11	-12.65	-17.12	8.28
Bulgaria	23.59	-3.47	-25.21	-27.81	-0.98	7.62	6.56	-7.59
Croatia	-1.02	7.93	-13.5	-6.64	-4.62	-33.13	-36.22	114.06
Czechia	1.48	-11.51	0.44	-11.12	-2.09	-13.56	-15.37	-14.7
Finland	34.48	12.52	17.11	31.77	7.05	4.63	12	-7.82
France	5.34	0.1	-5.1	-5.01	-10.53	2.14	-8.62	-2.37
Germany	-6.16	-1.56	16.47	14.66	-17.01	1.3	-15.93	1.67
Greece	-0.1	177.85	19.29	231.44	-12.36	-18.81	-28.85	453.5
Italy	12.39	0.45	-6.02	-5.59	1.61	1.61	3.26	-16.81
Liechtenstein	7.66	256.91	1.25	261.36	10.62	-4.43	5.72	4.1
Luxembourg	7.82	18.4	-13.84	2.02	-5.54	-12.8	-17.63	-1.1
Malta	-10.22	14.31	-12.49	0.04	10.75	-2.53	7.95	41.09
Montenegro	-3	-3	-3	-5.91	**	**	**	**
Poland	-3.61	-2.86	-16.46	-18.85	-4.64	-2.75	-7.26	4.26
Portugal	2.83	3.37	-8.26	-5.17	9.66	-4.6	4.61	-20.04
Serbia	5.17	12.47	10.95	24.79	0.31	-8.66	-8.38	-3.83
Slovakia	12.5	-0.89	5.17	4.24	-6	9.81	3.22	-16.66
Slovenia	-59.47	24.35	7.57	33.77	18.18	-12.69	3.18	-20.38
Spain	-10.02	-1.79	6.09	4.19	-4.61	34.58	28.38	6.02
Sweden	-10.29	11.31	18.6	32.01	-7.47	182.5	161.39	-12.98
Ukraine	38	2.48	-34.05	-32.42	10.87	-29.09	-21.38	**

Source: own processing [6]

In the long term, these fluctuations in energy consumption will have effects on the European economy, industry and energy policies. The decreases in natural gas consumption are due to investments in renewable sources and energy efficiency measures to reduce dependence on gas imports. High energy costs and imposed austerity measures can have a social impact, changing consumer behavior, even generating economic tensions. These changes are the result of the transition to more efficient energy consumption, but also of the major challenges that the European economy was facing.

The data on the rates of increase/decrease in final consumption for the non-energy use of natural gas, i.e. their use for purposes that do not involve the direct production of energy, are missing for some European countries, due to their non-publication (Table 3).

However, it emphasizes how natural gas use has varied over the examined period, impacted by world events, energy policy, and economic considerations. In the EU-27, consumption increased by 10.49% in 2016 and 7.93% in 2018. Starting with 2019, the decreases were 3.06%, 1.36%, 4.39% and 1.61%. The Eurozone had a similar evolution, with increases in 2016 (+9.70%) and 2018 (+9.14%), and decreases in 2019 (-6.76%) and 2020 (-0.15%). This dynamic reflects the impact of the energy transition, the pandemic and the instability of the gas market. Some countries recorded high growth, such as Belgium (+15.52% in 2016), Finland (+31.77% in 2018) and Slovenia (+33.77% in 2018), driven by increased industrial demand. In 2021, some states saw a recovery in consumption, with high values in Sweden (+161.39%) and Croatia (+114.06%), due to the post-pandemic economic recovery.

In contrast, Germany recorded decreases (-17.01% in 2019, -15.93% in 2021), along with the Czech Republic (-15.37% in 2021), Poland (-7.26% in 2021) and Italy (-16.81% in 2021), driven by reduced industrial activity and stricter energy efficiency measures.

There are also extreme cases, such as Greece, where consumption increased exponentially (+177.85% in 2016, +231.44% in 2018,

+453.50% in 2021) or Liechtenstein (+256.91% in 2016, +261.36% in 2018) as a result of the development of the gas infrastructure (Table 4).

In the long run, these fluctuations have significant economic and political implications. The European Union has stepped up its efforts to reduce dependence on fossil fuels, which explains the steady declines in many states. The evolution of gas consumption indicates a general trend of energy efficiency and transition to renewable sources, but in certain regions natural gas remains an essential strategic resource. However, it should be highlighted that these decreases in consumption directly influenced all industrial production sectors, including those related to agricultural inputs that turned into higher costs that influenced the entire production and marketing chain.

Economic variables, energy policy, and world events all influence the evolution of natural gas usage in Europe's energy transition processes.. At the level of the European Union (EU-27), consumption increased between 2014 and 2017 (+8.15% in 2015, +13.48% in 2016, +10.31% in 2017). Starting with 2018 and until 2023 this consumption started to decrease after (-5.66% in 2018) and (-11.07% in 2023). In the Eurozone, the trends were similar, with a sharp increase between 2015 and 2017 (+7.95%, +14.10%, +11.08%) and a gradual decrease from 2018 (-6.83%) to 2023 (-12.96%).

These declines are correlated with the energy transition towards renewable sources, energy efficiency policies and reducing dependence on fossil fuels. Certain countries registered increases: France (+45.47% in 2015, +45.31% in 2016), Romania (+30.49% in 2015, +36.94% in 2017) and Spain (+42.12% in 2018), as a result of the intensification of the use of natural gas for the production of electricity, but also the increase in industrial demand.

Germany, one of the largest gas consumers in Europe, recorded an increase of 23.56% in 2016 and 5.19% in 2017), followed by decreases of 5.53% in 2019, 11.95% in 2022, as a result of the transition to energy alternatives.

Table 4. Growth/decrease rates of the amount of natural gas used in energy transformation processes (TJ)

Country	2014/ 2015	2016/ 2015	2017/ 2016	2018/ 2017	2019/ 2018	2020/ 2019	2021/ 2020	2022/ 2021	2023/ 2022
Euro area – 20 countries (from 2023)	7.95	14.10	11.08	-6.83	13.16	-2.65	-2.89	-3.19	-12.96
European Union - 27 countries (from 2020)	8.15	13.48	10.31	-5.66	11.73	-1.90	-2.17	-5.15	-11.07
Albania	3.39	0.20	5.53	0.69	1.13	5.62	23.21	1.19	3.37
Austria	-12.13	11.36	7.58	-3.14	18.65	0.53	-20.55	-14.77	-3.15
Belgium	13.22	-1.01	-0.34	5.21	2.50	5.65	-16.87	-0.77	-19.95
Bosnia and Herzegovina	12.42	7.00	4.05	-0.13	-5.61	-5.58	8.22	-6.57	-3.99
Bulgaria	3.70	8.13	2.88	-4.41	2.26	1.38	16.29	-18.63	-5.59
Croatia	6.43	16.51	39.21	-17.79	4.10	19.63	-6.25	8.63	11.16
Czechia	8.05	25.14	-3.22	-0.53	21.63	10.60	10.16	-31.75	-11.01
Denmark	-1.88	10.49	-13.77	0.04	-9.91	-29.79	5.99	-36.95	13.26
Estonia	-20.70	-8.27	10.86	-11.91	-15.93	-23.40	22.91	-1.54	-17.16
Finland	4.05	-4.84	1.87	-3.02	23.36	13.34	14.92	-33.20	3.35
France	45.47	45.31	11.58	-20.80	24.42	-8.50	-3.54	19.51	-23.56
Georgia	13.72	-19.60	1.63	-5.41	38.07	-9.22	-19.39	51.85	1.35
Germany	0.89	23.56	5.19	-5.53	6.56	4.87	1.93	-11.95	1.03
Greece	2.79	69.59	27.71	-5.58	11.97	5.98	16.69	-15.41	-15.96
Hungary	-37.10	-52.86	-7.13	-12.95	-2.11	-3.23	7.09	-23.18	-26.54
Ireland	-4.23	23.43	3.04	1.32	2.54	1.75	-9.02	9.90	-6.56
Italy	14.20	11.66	10.99	-7.32	8.78	-4.77	-1.02	-4.06	-15.40
Liechtenstein	4.67	37.22	-56.22	37.99	-26.51	-66.97	220.60	-45.22	40.04
Lithuania	5.04	1.52	-16.38	24.32	-6.04	-24.82	4.41	-36.27	2.65
Luxembourg	-13.18	-26.48	-20.22	-10.43	-15.84	54.05	-1.27	-50.98	-1.00
Malta	11.60	9.09	11.55	-4.82	9.23	3.89	3.94	-9.73	-13.43
Moldova	-7.65	1.12	-2.85	5.92	-9.75	0.77	5.76	-34.88	-17.51
Netherlands	**	**	**	26.22	4.52	4.10	-0.15	1.59	4.45
North Macedonia	3.68	72.04	32.28	-9.38	21.12	17.43	28.47	-35.18	29.71
Norway	-1.03	1.02	-2.73	3.04	-8.59	-24.73	-57.78	75.43	15.47
Poland	25.19	9.67	24.12	-10.90	5.50	-9.24	6.57	-7.73	-24.71
Portugal	16.06	9.80	13.30	18.12	8.71	11.09	-3.30	-23.83	34.04
Romania	30.49	12.26	36.94	-13.67	8.47	-0.09	-11.77	0.29	-32.37
Serbia	-13.87	-10.01	17.51	-17.31	-32.35	18.76	50.18	-30.73	-7.11
Slovakia	-2.14	2.45	21.24	-1.21	13.85	9.56	1.14	-15.76	13.57
Slovenia	10.73	-0.21	8.44	2.14	-15.95	4.61	-1.70	-6.70	0.50
Spain	18.67	-2.11	22.79	-9.57	42.12	-16.43	2.77	24.28	-24.43
Sweden	-10.54	-6.51	-12.10	19.83	-9.60	0.95	-3.18	-65.49	43.64
Türkiye	-15.94	-2.23	-5.41	10.37	-6.11	11.06	**	**	**
United Kingdom	-0.81	35.67	-4.18	-3.63	-1.50	**	**	**	**

Source: own processing [6].

The general trends indicate an increase in the consumption of natural gas until 2017, followed by a period of stagnation and decrease starting in 2018, against the background of the energy transition and the

increase in the use of renewable sources. Starting from 2020, a decrease is observed in many European states, due to the instability of the gas market. In the long term, this evolution indicates a decreasing dependence



on natural gas in energy production, but with strategy.  
variations depending on the adopted energy

Table 5. Growth/decrease rates of the total amount of natural gas available in European countries (TJ)

County	2014/ 2015	2016/ 2015	2017/ 2016	2018/ 2017	2019/ 2018	2020/ 2019	2021/ 2020	2022/ 2021	2023/ 2022
European Union - 27 countries (from 2020)	0.54	-3.01	8.31	6.85	1.37	-3.58	-8.01	-35.70	17.33
Euro area – 20 countries (from 2023)	1.77	-3.70	6.22	12.59	-0.10	-2.13	-9.36	-41.39	17.45
Albania	-9.92	53.81	0.00	0.00	105.05	-32.06	8.81	-14.69	-12.38
Austria	-29.36	-6.87	4.80	18.14	0.25	-14.26	13.76	-22.54	-2.49
Belgium	12.07	-7.07	15.31	55.76	30.11	-5.23	-22.64	-35.44	30.84
Bulgaria	83.99	-27.07	10.22	40.38	-2.42	-1.63	9.83	-61.91	7.56
Croatia	-2.77	-10.95	9.41	3.67	3.66	-3.35	-2.68	-10.71	22.88
Czechia	0.30	-16.00	19.75	-7.91	11.96	-15.82	-1.28	15.28	-0.04
Denmark	4.60	-8.92	3.81	-7.82	-5.84	-32.01	13.03	-1.46	-10.16
Estonia	-18.40	421.28	-82.86	253.32	-14.01	-35.56	127.75	-85.26	-37.43
Finland	-20.35	-29.06	-7.10	8.41	13.65	-12.38	-17.93	-75.51	163.90
France	4.10	-9.64	-1.94	20.14	5.80	-5.26	-1.45	-31.59	-2.24
Germany	5.41	-10.49	9.32	13.29	-5.92	21.48	-21.43	-46.85	8.36
Greece	-14.22	17.83	360.15	31.55	20.25	133.32	-13.09	-81.67	189.47
Hungary	-14.13	59.12	23.14	-4.91	1.54	2.76	2.23	-10.17	-1.22
Italy	-6.00	5.14	20.26	11.74	-3.17	-4.88	-20.87	-22.19	4.98
Latvia	-17.72	-25.63	-13.38	18.24	9.63	-13.51	6.82	-28.83	55.69
Lithuania	430.15	-15.05	-29.88	0.70	261.16	35.98	-43.50	-45.96	-34.00
Moldova	**	**	**	-66.67	0.00	200.00	163.33	-68.99	161.22
Netherlands	-1.27	-12.29	1.96	10.20	-3.63	-1.95	-9.41	-42.33	-1.69
Norway	3.37	-1.60	2.27	-6.05	1.09	-3.31	-6.12	-5.01	-2.27
Poland	4.43	-12.06	36.44	-14.72	20.80	3.07	-8.38	-24.01	28.58
Portugal	-9.76	-30.66	20.75	-10.21	-0.30	-7.99	4.22	-33.86	32.87
Romania	-25.09	30.89	-18.68	-9.35	-13.97	-31.58	-19.38	9.43	20.85
Serbia	14.25	-13.70	12.15	-2.77	6.65	7.84	6.18	-10.25	-19.95
Slovakia	-32.92	24.82	-10.20	3.15	-7.90	-23.26	-7.02	12.12	-4.35
Slovenia	0.00	-83.69	62.05	3.95	7.82	-17.49	-23.08	11.43	-35.89
Spain	16.59	9.08	1.05	5.86	-5.13	-16.81	11.54	-51.62	45.37
Sweden	-78.29	45.64	204.23	82.75	-16.69	-4.66	195.76	-22.58	50.20
Türkiye	37.28	-0.53	15.09	-15.77	14.82	-15.25	16.01	-21.46	-2.96
Ukraine	-5.13	-1.66	7.82	-1.30	-25.08	-0.88	**	**	**
United Kingdom	11.41	-1.45	0.48	1.57	6.09	**	**	**	**

Source: own processing [6]

Although the data on the total quantities of natural gas available in the countries of Europe have not been published for quite a large number of countries, it can be seen that at the EU-27 level there was an increase of 8.31% in 2016 and 6.85% in 2017 (Table 5). Although in the following period there were stagnations and sharper decreases in 2022 a severe contraction was observed (-35.70%). The Eurozone followed a similar pattern, but some countries experienced extreme fluctuations (Estonia, Lithuania or Greece). Countries such as Germany and France faced the strong effects of the energy crisis, while

Sweden had high volatility in gas consumption. Volatility in this sector remains high, reflecting a difficult transition to more sustainable energy sources and a reconfiguration of the gas market in Europe.

## CONCLUSIONS

Natural gas is utilized in the framework of energy sustainability to produce heat and power, and it is crucial for the effectiveness of agricultural and industrial systems. Reducing natural gas consumption in energy production processes has led to a decrease in

greenhouse gas emissions, but has also imposed significant challenges for industries dependent on this fuel, including agriculture. This study provides essential information for policy makers, energy companies and investors, helping to identify trends in gas consumption and anticipate future developments.

In the context of the energy transition, data shows that many states have begun to reduce dependence on natural gas, accelerating investments in renewables and energy efficiency.

As Europe accelerates its energy transition, the agricultural sector must adapt to new market conditions by investing in more efficient technologies and diversifying energy sources. Support policies for farmers and energy efficiency measures will play a key role in ensuring sustainable agricultural production, while reducing dependence on natural gas and contributing to carbon reduction targets.

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