The Energy Efficiency Issue in the European Union: Perspectives, Objectives and Challenges

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Abstract: *This paper discusses the energy issue in the European Union and the EU's progress on energy efficiency since the Energy Efficiency related Directive of 2012 (EED): (i) The energy consumption dynamics (primary and final energy consumption), (ii) Directives and other regulations adopted by the EU's institutions between 2012-2022, for energy consumption and efficiency targets established for the entire Union and for its member states, (iii) The National Energy and Climate Plans (NECPs) corresponding to the 2020 accomplishments and the 2030 projections, (iv) The same 2030 forecasts in the long-term context of climate neutrality to be ensured up to 2050. All these will be approached below in our argumentation. Effective energy consumption data are retrieved from Eurostat and the International Energy Agency (IEA). Optimism comes up for the 2030 perspective, since the 2020 specific performances were delivered, partly despite the recent COVID-19 pandemic related circumstances of 2020. A list of possible responses to some questions will conclude this paper: 'How receptive will the member states be in the future for transposing the EU's energy efficiency ambitions into their own strategies?' and 'Will the European policies be rigorous enough, and flexible to achieve the long-term objectives?'.*

Keywords: *energy efficiency, primary energy consumption, final energy consumption, energy targets, Green Deal.*

JEL classification: *Q40, Q43, Q48.*

Introduction

Reducing greenhouse gas emissions, increasing the security of energy supply, energy efficiency, energy consumption (primary and final), but also reducing dependence on fossil fuels, in general, and dependence on energy imports from Russia, in particular (i.e., in the form of sanctions imposed as a response to its military aggression on Ukraine) are EU's current aims. All of these are supposed to shape the long-term ***2050 target of climate neutrality***, its previous 2030 goal reaching in context a comparable strategic significance.

This paper focuses on the energy efficiency issue, as it is viewed in today's EU terms: the energy consumption should be lowered to its minimum through the EU member states' joint effort. The year 2050 has been chosen as deadline for attaining climate neutrality: zero carbon-dioxide and no other greenhouse gas emissions (GES). Since 2005, a similar target has been set for the EU's coordinated strategy to gradually reduce consumption, and measures to curtail energy consumption will also be taken during the 2020-2030 decade. Or, this is the arising point of our research questions asked as follows:

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- Given that the intermediary 2020 target for GES reduction has apparently been attained, which will be the appropriate scenario to achieve the next 2030 target? Plus, are the NECPs (of the member states) adequate and aligned with the EU's corresponding goals?
- Moreover, is the EU, together with its member states, prepared for attaining the final 2050 target, as described above? Will the existing methodology and tools be sufficient to ensure the success of the EU's energy policy? And what happens, if this strategy fails?
- We will provide, for this paper, an analysis and synthesis about these issues, with the purpose of clarifying on the subject in debate.

Literature review

Firstly, in our research, the specialist literature we consulted consists of the EU's rules and norms regarding the topic of energy and, especially, the issue of energy efficiency. It is necessary to enumerate the most significant documents in this domain: the *Energy Efficiency Directive (EED - 2012/27/EU)*, adopted in December 2012 (it included a range of measures to help the EU achieve its energy efficiency goals by 2020); *The Paris Agreement*, the first inter-state agreement regarding the climate changes concluded in Paris (COP21)/2015; *The Energy Union strategy (COM/2015/080)*, a strategic priority of the European Commission (EC) during the 2014-2019 time frame (when an Energy Union was envisaged to ensure a secure, sustainable, competitive energy supply, at an affordable price in the whole region); *Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action* (which has laid the legal foundations for the governance mechanism of the Energy Union in Europe and sustains so far its energy strategy up to 2030, in line with the provisions of 2015 Paris Agreement). The *National energy and climate plans (NECPs)* are included in the *Regulation on the governance of the Energy Union (EU)2018/1999* and they support climate action at national level, each member state of the EU having designed its own 10-year energy and climate plans for 2021-2030. The NECPs aim to mirror the actions taken by the EU member states to achieve the EU's objectives and targets for 2030 in the field of energy and climate. *A Clean Planet for all – (COM/2018/773 final)* describes the long-term strategic vision of the EU for a modern and climate neutral economy, while stressing the importance of energy efficiency in all decarbonization scenarios. *Directive (EU) 2018/2002*, amending *Directive 2012/27/EU* on energy efficiency, establishes guidelines up to 2030. The *Clean energy for all Europeans package*, adopted in 2019, updates the rules for reducing the energy consumption after the year 2020. *The European Green Deal (COM/2019/640 final)* is a set of policy initiatives to help achieve the EU's goal of climate neutrality by 2050. Actually, all greenhouse gas emissions might be curbed towards that historical moment. The *REPowerEU, COM/2022/230 final*, is a new plan for a fast reduction of the EU's dependence on the fossil fuels from the Russian Federation. Within this framework, the EU member states are supposed to show solidarity in creating a real and solid energy union.

Secondly, the EU institutions also conducted studies and other initiatives on the energy efficiency issue, that acquired an increasing importance and represents a key factor in the presumably full decarbonization of Europe's economic sector. *European*

Commission - Eurostat, Energy efficiency statistics (2022) do (i) relate to the EU's 2020 and 2030 energy efficiency objectives, (ii) evaluate the real energy consumption trends to be compared to these objectives, as previously formulated and (iii) describe the statistical methods used for measurements. The European Commission's study titled: *Trends and Policies in the EU based on the ODYSSEE and MURE Databases*, from 2015 is in-depth research which analyses the general trends on energy efficiency based on a package of 200 indicators, harmonized and comparable for EU28 during the 2000–2013-time frame. Trends identified refer to both the whole region (EU28) and individual member countries. About 2500 energy efficiency policies used by the 28 EU member countries in their National Energy Efficiency Action Plans (NEEAP) are analysed. Among other results, this study concludes that the 2008-2009 crisis affected both the energy efficiency trends and the projections for implementing policies on long term, even though, after 2010, trends registered recovering patters.

International Energy Agency (IEA, 2018) plays a key role in the development of energy indicators focused on energy consumption, its relation with human activity and energy efficiency. The studies conducted reveal, among other aspects, that there might be a potential of 40% gas emissions cut even in the absence of new technologies. The IEA also mentions that the world would look significantly different if between now and 2040 all countries were to implement their full energy efficiency potential.

And thirdly, the individual researchers' studies are to be mentioned:

Bertoldi P., Mosconi R (2020). The authors created an econometric model on the EU member countries, plus Norway, which indicates the usefulness of energy efficiency policies through energy consumption reduction at the European aggregate level. The same model prefers to replace some classical variables – e.g., economic growth, production levels, energy prices – by energy policy efficiency measuring indicators. The study concluded that energy policies had an impact on reducing energy consumption, estimating that the EU plus Norway would have consumed 12% more energy in 2013 in the absence of these policies.

Bertoldi, P., López-Lorente, J., Labanca, N., (2016). The authors analyse the trends of energy consumption in four main consumer economic sectors – i.e., residential, tertiary, transport and industries – in the EU, between 2000 and 2014 interval, with the aim of identifying energy efficiency's behaviours. But extending this interval to 1990-2014, the authors notice that 2014 has been the second lowest energy consumption period, after 1994. And, interestingly, in 2014 the EU's Energy Efficiency Directive's (EED - 2012/27/EU) target for 2020 in the energy consumption has actually been achieved, affirm the authors.

Thomas, S., & Rosenow, J. (2019). The authors conducted a study on the factors that could generate an increase in energy consumption instead of a decrease, based on the decomposition analysis, that makes it possible to identify the impact of factors that can be measured (economic growth, population growth and outdoor air temperature). Focused on primary (PEC) and final (FEC) energy consumptions, their study finds both a decrease during the 2005-2014 interval (the former by 12%; the latter by 11%) then an increase for the 2014-2016 interval (PEC with 2.3%; FEC with 4.2%). The year 2014 was identified with the lowest energy consumption year since the eighties and lower than the target for 2020. However, since 2016 both levels of consumption re-started increasing,

therefore the authors concluded that to meet the energy efficiency targets for 2020, FEC had to decrease by an average of 0.5% per year and PEC by 1.0% per year between 2016 and 2020.

Knoop, K., & Lechtenböhmer, S. (2017). This study presents an in-depth comparative analysis on the previously existing studies regarding the energy efficiency in the EU member countries, individually examined. On the one hand, they mentioned that studies on national potentials in such a sense are rare and difficult to be compared amongst, but current studies agree on the existence of significant technical and economic potential for final energy efficiency, although these vary substantially at national and sectoral levels.

Pérez-Lombard, L., Ortiz, J., & Velázquez, D. (2012). This study discusses, analyses and revises some basic concepts and indicators related to energy and energy efficiency topics: efficiency, energy efficiency concept, energy efficiency indicators, specific energy consumption.

Methodology

Our paper begins with the collection of data, especially on gross available energy, primary and final energy consumptions, in the EU region (on aggregate) and in individual EU member states, based on official data sources, among which we can mention Eurostat (European Statistics Office), International Energy Agency (IEA) and European Environment Agency (EEA). The large 1990-2021 interval was approached for static, dynamic and comparative analyses. The reference years considered for this paper have been selected in accordance to the framework suggested by the above mentioned institutions: 1990 is a reference year allowing analyses on a significantly long term; 2005 is a reference year (that registered a peak in energy consumption) also helping the dynamic analysis; the average of the pre-pandemic interval 2017-2019 was used for a comparative analysis, unaffected by the effect of the pandemic and finally, a simple predictive analysis related to the future targets for the 2030s to assess the progress made to date and estimate the difference to achieve these targets. National Energy and Climate Plans (NECPs) – as drafts and final - were further reviewed at the individual EU member states' side of engagements in the energy efficiency objectives, against the objectives proposed by the European Commission (EC). The last data made available to our study – i.e., of Eurostat for 2021 – was used to be compared to that of NECPs to assess the effort required by each EU member state to reach its specific target. Last, but not least, alongside with statistical sources, European legislation directives, energy-related plans and communications have been analysed.

Developments and results

The EU Directive 2012/27/EU (Energy Efficiency Directive - EED)[2] identifies the notion of energy applicable to all forms of energy products, like fuels, heating, electricity, renewable energy sources, and all other possible energy types, as well defined by the EC

[2] European Commission 2012. *Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC* ('Official Journal of the European Union', L315/1 from 11 November 2012). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0027.

Regulation 1099/2008[3]. Primary Energy Consumption (PEC) is gross domestic energy consumption[4], of which non-energy uses are excluded. Final Energy Consumption (FEC) equals the energy that goes to transports, households, services, and agriculture, but stays off the energy flows received by the specific energy producing and transforming sectors (Reuter et al., 2017).

The primary energy consumption measures the total of domestic energy demand, while the final energy consumption limits to what the final users, as indicated above, do receive in the same terms. The difference between these two is made by the specific energy sector, together with natural losses caused by the complex process of transformation and distribution of the same energy matter.

Energy efficiency is defined by the same EED as the ratio between the performing services or goods (energy) output and the energy input. For the real energy efficiency, the same energy input is supposed to perform for higher results or the unchanged results are presumed to be given by lower energy inputs. For that, energy efficiency means costs saving/reduced costs, lower climate impacts (of greenhouse and pollution types), reduced demand for energy imports and higher availability of energy resources to the final consumers, eventually also at smaller prices. Moreover, energy wastes decrease, together with their related risk and inefficiency, when costs take off. Raising the energy efficiency is said to be immediate and the cheapest, although indirect, way of reducing the fossil fuels' consumption. The energy efficiency's indicators used in the EU are (Kolosok S. et al., 2021):

- Share of energy from renewable sources in total energy.
- Energy intensity and energy productivity.
- The ratio between final and primary energy consumption (FEC/PEC) – e.g., this is for higher energy efficiency, when final energy consumption rises and primary consumption lowers. The energy itself will appear below to be measured by million tonnes oil equivalent (Mtoe)[5].

Multiple	Name	Symbol
103	Kilotons of oil equivalent	Ktoe
106	Million tonnes of oil equivalent	Mtoe

Source: Eurostat (n.d.).

Our approach starts by studying trends and dynamics of primary and final energy consumptions in each member country and at EU aggregate level with the purpose of evaluating the progress made in implementing the energy efficiency objectives and targets, and identifying weak or strong tendencies and opportunities for improvement. We have built our argumentation based on reference years and/or periods and methodologies

[3] *The European Union Official Journal*, OJL 304, 14.11.2008, p. 1.

[4] Gross domestic energy consumption, according to Reuter et al., 2017, cumulates the following: primary energy products (including their reception), recycled and recovered products (i.e., other sources), imports, stocks variation, of which exports, bunker and direct use are deducted.

[5] Eurostat, *Energy efficiency statistics*, 2022. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_efficiency_statistics.

considered relevant by the EU-connected statistical institutions (Eurostat, EEA) and international ones (IEA). We share the assumption that a wide array of measurements can contribute to a better image on energy consumption evolution: (i) the long period evolution 1990 – 2021 cannot show more than just a slight decrease in energy consumption as it was accompanied by a dynamic view; (ii) a dynamic evolution along the same period 1990 – 2021 emphasizes large fluctuations for each year as compared to the previous one (alternative increasing with lowering energy consumption level; (iii) further on, the year 2005 was considered as a base year for a better dynamic comparison, because it is also used by the EU institutions as a fundamental year for greenhouse gas emissions legislations and for renewable energy targets. It also corresponds to a peak in energy consumption in the EU (EEA, 2019). Also, compared to 2005 the reduction of energy consumption can be more easily observed by paper graphs; (iv) the large drop in primary and final energy consumption in 2020 correlates to the pandemic restrictions. But this drop was favourable for 2020 targets achievement by almost all countries; (v) 2017-2019 average interval was used for a comparative analysis of energy consumption, unaffected by COVID-19 pandemic, (vi) last, the most important analysis was compiled with the purpose to compare (i) each country's level of energy consumption within EU's targets for 2020 and (ii) each member state's assessment from individual NECPs including the 2030 objectives proposed by EU.

International Energy Agency (IEA)[6] and Eurostat: contributions to the energy efficiency calculation

The IEA provides an overview of the calculation methods and of energy efficiency analysis. Its *Energy Efficiency Insight Brief* reports contain analyses and recommendations for policies and programmes related to energy efficiency and address to a wide range of topics as such -- e.g., rules and standards of minimum energy efficiency for buildings (i.e., building codes), transportation and industry –, plus their connections with governments and other authorities' efforts directed to, at least, achieving energy efficiency and reducing greenhouse gas emissions. Moreover, IEA provides data and information on the current state of energy efficiency, on related practices recommended and case studies from all over the world. Last, but not least, a variety of indicators to calculate the energy efficiency come to be defined in context (IEA, 2017):

- *Energy intensity* - measures the energy used on the unit of (final) economic activity, e.g., of GDP, of industry output. This is used especially for detecting the energy efficiency changes through given intervals.
- *Energy productivity* - indicates the opposite, i.e., GDP afferent to the unit of energy used. This is applied for assessing the energy quantity used by each country to produce its own final goods and services.
- *Energy savings potential* - estimates how much energy efficiency could result through specific measures. The concrete advantage of this indicator relies in its direct relationship with individual economic sectors – e.g., private consumption in buildings, industry – and the entire economy.
- *Per capita energy consumption* - shows the total amount of consumed energy

[6] International Energy Agency (IEA) is a global intergovernmental organization that works to promote sustainable energy policies and improve energy security.

divided by country's population. This contributes to the understanding of the individuals' access to the energy produced and can be used for comparisons between different countries.

Part of these above-mentioned indicators can be met in the Eurostat statistics – e.g., energy intensity, the country's and/or individual sector's and/or individual's (i.e., per capita) energy consumption. Eurostat uses the energy-related indicators that are compatible among the EU member states to monitor the situation and trends of the levels of energy used. Plus, the indicators proved to be relevant for the energy policies' evaluation, as used in the EU area. In addition, another pair of indicators are applied in the EU as reduction targets: the ones targeting energy consumption and greenhouse gases.

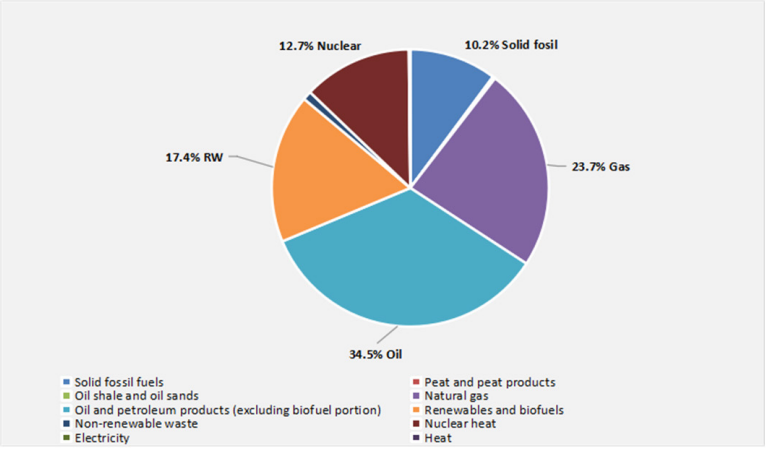
Gross available energy in the EU

The total energy available at the level of each country or in the Union as total, the individual country's or the Union's own production plus net imports (import-export), with energy from recyclable products and stock losses/changes (Eurostat, 2022a) can be calculated by the following formula:

Gross available energy (GAE) = Primary energy production + Recovered and recycled products + Imports - Exports + Change in stock

At the end of 2020, the total of EU's energy was composed by own production amounting to 42% and imports reaching 58%. The last actually dropped by two percentage points (pp.) in 2020, as related to its previous 2019 quantity, due to the COVID-19 crisis – i.e., to import networks' related crisis, to which the drop in demand (caused by temporary stop of some economic activities) are to be added. The items that form the EU's *energy mix* (IEA, 2020) - i.e., *gross available energy* (GAE) – are: oil and its derivatives (the same with petroleum products - 34.5%), natural gas (23.7%), renewable sources (17.4%), solid fossil fuels (10.2%) and other sources 14.2% (*Figure 1*).

Figure 1. EU - Share of gross available energy by fuels (%), in 2020

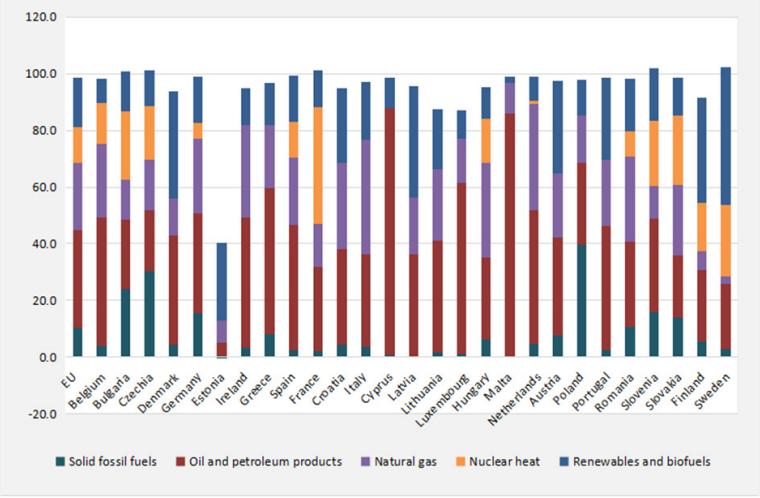


Source: The author, based on Eurostat, Complete energy balances [nrg_bal_c], 2022.

Significant differences regarding this structure are to be found among individual EU member countries – e.g., *solid fossil fuels* are dominant in Poland (39.6%) and the Czech Republic (30.3%); the same for *oil and derivatives* in Cyprus (87.1%), Luxembourg (60.4%) and Malta (86.0%). To be equally remarked that the last three countries, coincidently or not, use the previous solid fuels at the lowest weights of the EU region: Malta 0.0%, Cyprus 0.5%, and Luxembourg 1.0%.

For the case where *natural gas* is dominant in the country energy mix, Italy (40.5%), the Netherlands (37.5%) and Ireland (32.4%) are to be mentioned within the EU area. Actually, only Cyprus is the country case with no gas produced or imported in the whole region. As for *nuclear energy*, this is for 41% in France and for 23-25% in national energy mixes of countries like Sweden, Slovenia, Slovakia, and Bulgaria. *Renewable energy* marks high percentages in the available energy of Sweden (48.6%), Latvia (39.6%), Finland and Denmark (37.1% for each of the last two). Austria is the country whose own production and imports of renewable cumulate 32.6% in the total energy mix (*Figure 2*).

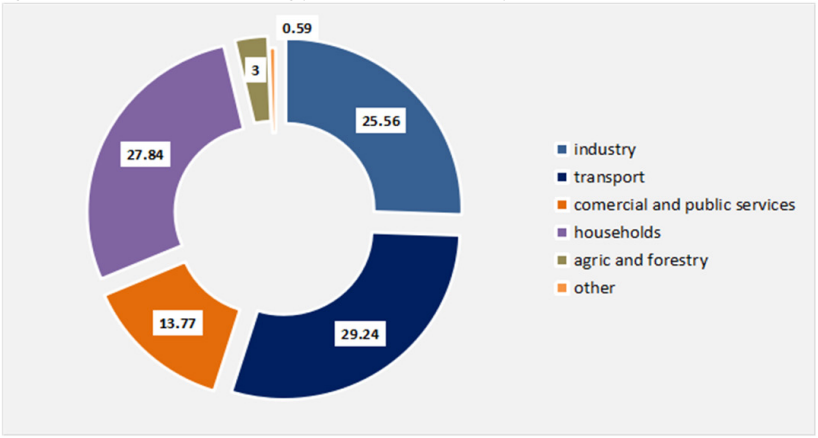
Figure 2. EU countries-Gross available energy, by fuel (%), in 2020



Source: The author, based on Eurostat, complete energy balances [nrg_bal_c], 2022.

On the other hand, about 2/3 of the EU's total available energy goes to final consumers, e.g., industry, transports, trade, agriculture, and households. The rest – i.e., 1/3 that isn't *final consumption* – represents losses of specific production and distribution networks, to which energy specific effects of sustaining both energy or non-energy production procedures are to be added. As for this *final consumption (FEC)*, the Eurostat indicates its breaking down into three main destinations of similar weights in 2021 - transports (29.24%), households (27.24%) and industry (25.56%) – plus public trade and services (14%) and agriculture (3%) (*Figure 3*).

Figure 3. EU – Final energy consumption by sectors in 2021 (% of total)

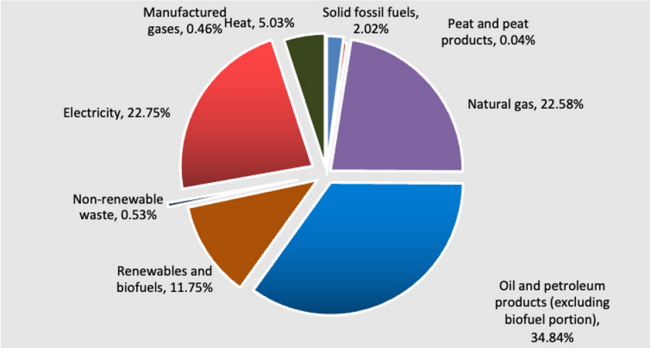


Source: The author, based on Eurostat, final energy consumption by sector [TEN00124__custom_4427721], 2022.

In the EU directive of 2021, *oil and derivatives* – i.e., the same with *petroleum products*, that are oil used for heating, petrol, and diesel – make the top energy source by 34.84% of the total final energy consumption, followed by *electricity*, with 22.75%, and immediately after by *natural* and *processed gas*, with 22.58%, according to Eurostat. Then, there are *renewable sources*, breaking down into: (i) the ones not for electricity, but just for heating spaces and/or water (e.g., wood, thermal solar energy, geothermal or biogas, all cumulating 11.75%), and (ii) the ones turning into electricity, (e.g., hydroelectric, wind or photovoltaic solar energy[7]).

Finally, *solid fossil fuels* – i.e., coal and a few others – mark as low as 2.02% of final energy consumption in the EU (*Figure 4*).

Figure 4. EU - Final energy consumption, by fuels (%), in 2021

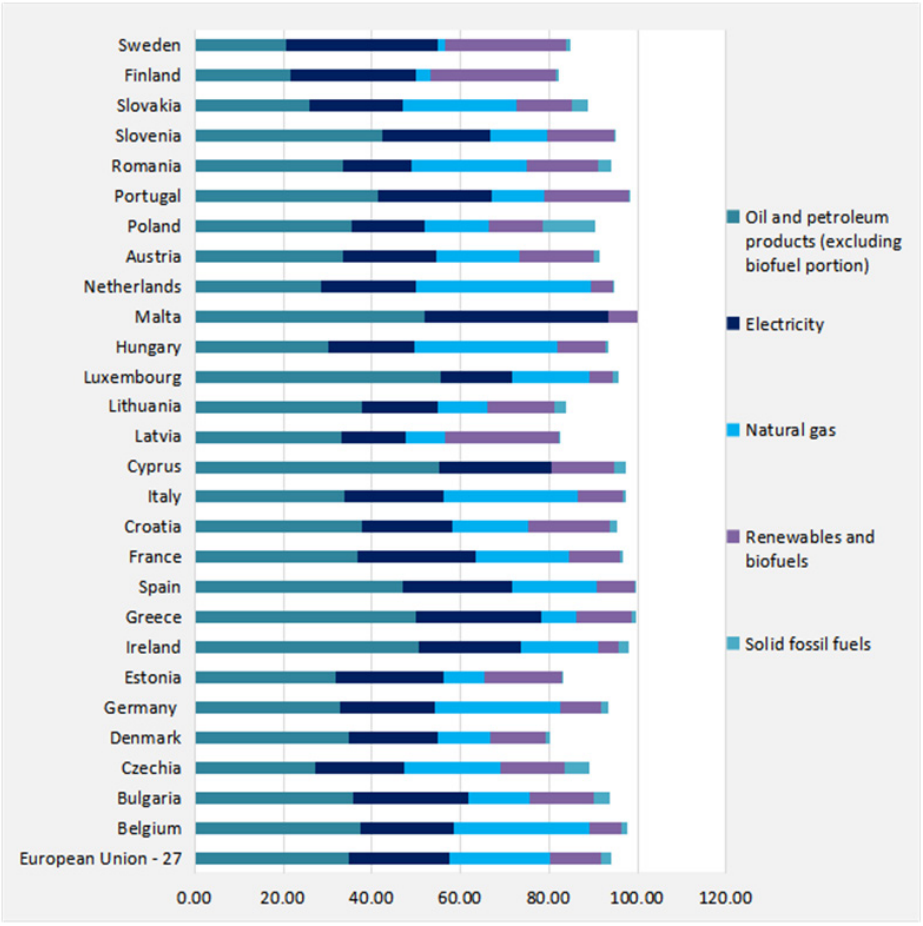


Source: Retrieved from Eurostat - Simplified energy balances [NRG_BAL_S__custom_4831422], 2022.

[7] Solar panels can be divided into two categories: (i) photovoltaic solar panels, which convert the light energy from the sun's rays directly into electricity; (ii) thermal solar panels (solar collector) that capture solar energy and transform it into thermal energy.

The above percentages regarding the energy sources' mix vary between the whole EU region and its individual member countries (*Figure 5*). *Oil and derivatives* represent 50% of final energy of Ireland (50.44%), Malta (51,9%), Cyprus (55.18%) and Luxembourg (55.62%). *Electricity* sums for 30% of the final energy consumption of Malta (41.62%) and Sweden (34.3%), while *gas* also accounts for 30% of the final energy consumption of Netherlands (39.57%), Hungary (32.32%), Belgium (30.59%) and Italy (30.39%). *Renewable energy* sources and *biofuels* make up 25% of the final energy consumption of Sweden (27.47%), Finland (28.52%) and Latvia (25.65%). Fossil fuels represent less than 5% of the final energy consumption of all the EU member countries, except for Poland (11.71%).

Figure 5. EU member countries - Final energy consumption, by fuels (%), in 2021

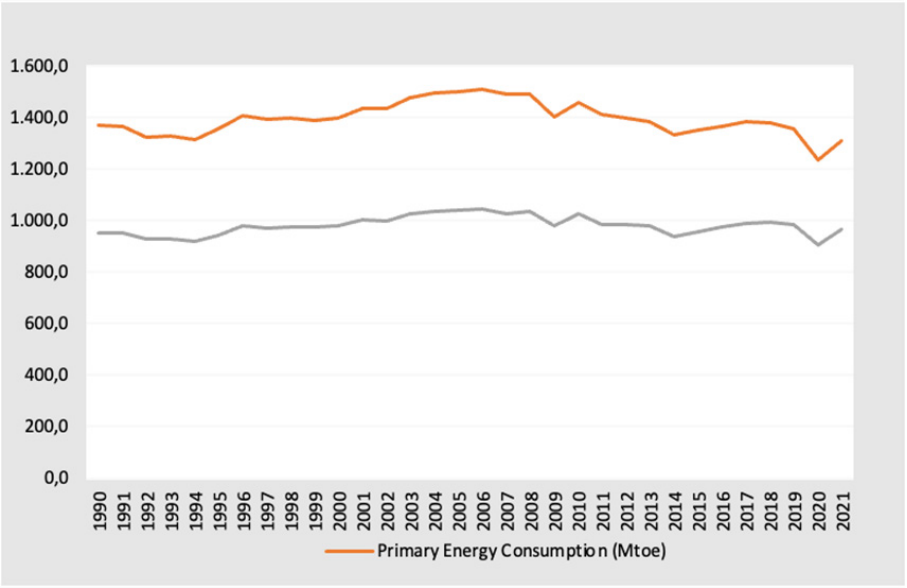


Source: Retrieved from Eurostat - Simplified energy balances [NRG_BAL_S__custom_4831422], 2022.

Ways to analyse the evolution of energy consumption in the EU according to Eurostat

According to the data retrieved from Eurostat, the energy consumption in the EU region registered a slightly decreasing trend during the 1990–2021 time, and especially in the past years. This can be explained by a complex factors' combination, one accounting for the European Commission's energy efficiency targets, and the other for the recent COVID-19 pandemic's effects (*Figure 6*).

Figure 6. Primary and final energy consumption (in Mtoe), between 1991-2021, in the EU

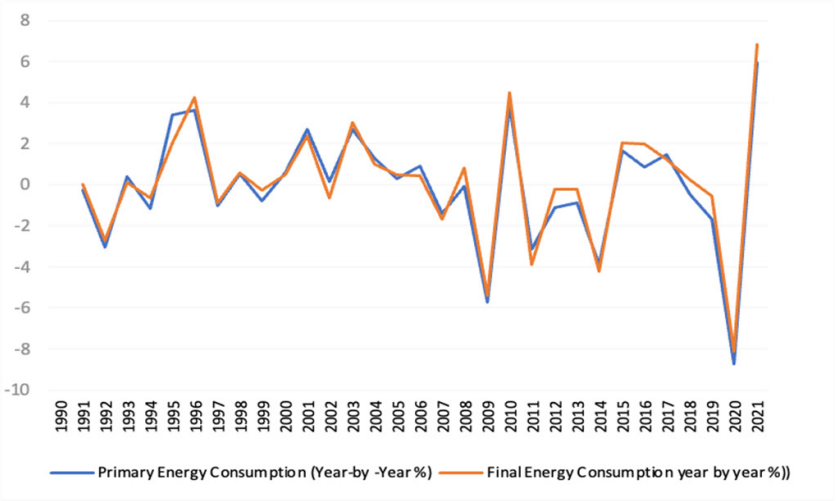


Source: Retrieved from Eurostat - Simplified energy balances [NRG_BAL_S__custom_4831422], 2022.

There are also shorter time intervals during which the same energy consumption increased, as seen in *Figure 6*. The economic and/or the population's growth and energy price changes might compete for, plus the effective climate change might equally be considered (e.g., too hot during summer and severe cold during winter, especially for buildings' adequate equipment). See, below, the approaches used for calculating and understanding this phenomenon:

A) Year-by-year comparison. This approach (*Figure 7*) is for comparing both final and primary energy consumptions to their previous ones (in years). Specific consumption trends might result, together with specific policy measures on the consumption reduction and management of energy resources. This method proves relevant to trends identifying, the same for impacts and fluctuations of the energy consumption and the alternative policy strategies, i.e., on longer terms.

Figure 7. EU 27 - Primary and final energy consumption by year (%)



Source: extracted from Eurostat - Simplified energy balances [NRG_BAL_S__custom_4831422], 2022

Regarding the weaknesses, this method might prove less capable to analyse and discern in terms of trends, when fluctuations registered on the short term are too large, and in terms of influencing factors, when there are too many to account for – e.g., economic changes, climate and weather causes, prices, including those of energy, availability of efficient energy specific technologies.

Despite such shortcomings - and back to *Figure 7* -, the EU area reveals both its general energy consumption reduction trend and the COVID-19 pandemic's even stronger consequences in the same direction - i.e., lower demand for energy caused by the decreasing of the economic activity, especially in industry and transports, and with brutal supply chain disruptions or staffing issues, as specific impacts. Sharing the same assertion, government measures against the pandemic stroke the (same) energy consumption, during the COVID-19 lockdowns.

B) Consumption: current situation and its values in relation to the one of a basic year

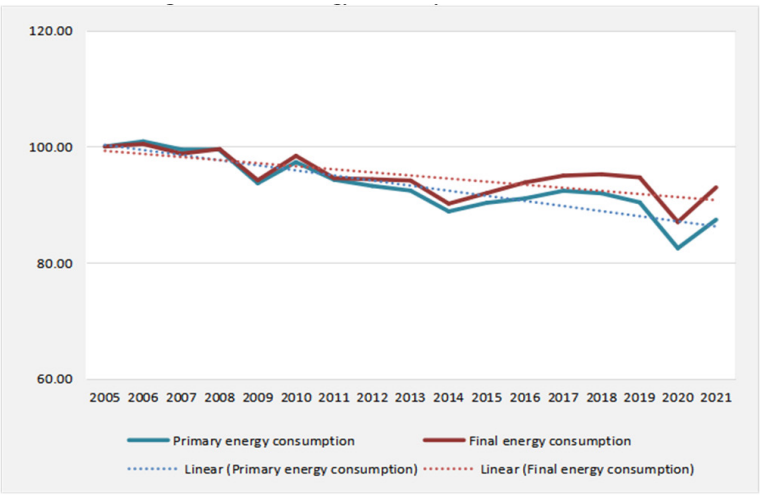
In this other approach, both the final and primary energy consumptions first consider a basic year for some specific reasons, then the following and previous years' consumptions might relate to the basic consumption. This is the practice finding relevant energy consumption (final and primary) modifications, as related to the year 2005 on the EU (EEA, 2019)[8]. Actually, 2005 was chosen by Eurostat as a base year since an energy consumption peak was registered in the EU area, but also as the first step into the analysis of greenhouse effect gas (GHG) in its Emissions Certificate Trading System of

[8] The European Environment Agency (EEA) is an agency of the European Union that delivers knowledge and data to support Europe's environment and climate goals.

the European Union (EU-ETS) – i.e., given the Effort Sharing Decisions (ESD)[9] in such a sense.

Relating to a base year, for evaluation, helps the energy consumption and gas emission reducing progresses measuring during a period or another in the analysis performed. Therefore, as related to 2005 (2005=100), primary energy consumption in the EU area was 12.6% lower in 2021, even 17.5% lower in the previous 2020, as well as continuously reducing along the whole 2005-2020 interval. And not too much different for the final energy consumption: 7.5% lower in 2021, as compared to 2005 (2005=100), while 13% lower in the previous 2020 than in 2005, on the basis of a similarly continuous cost reducing practice during the 2005–2020 time (*Figure 8*).

Figure 8. EU-27 Energy Efficiency - Index (2005=100)



Source: Data extracted from Eurostat, Energy efficiency [NRG_IND_EFF__custom_4407905], 2022.

C) Current consumption related to the average of the pre-pandemic years

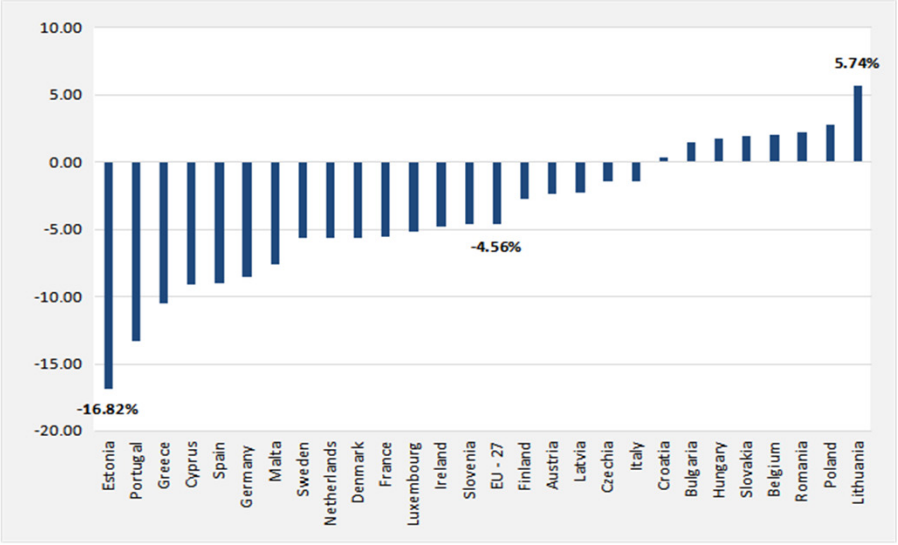
For this case, we can consider the example of comparing data between 2021 and the pre-pandemic time frame of 2017-2019 for the last's energy consumption average numbers. This approach prefers a years' interval reference, instead of just one year reference, in order to detect consumption deviations, accordingly for each distinct year. It is in this context that, since admitting the 2017-2019 interval as pre-pandemic, 2020 is found to be less relevant, for its proper energy consumption numbers (too low), as compared to all the following years, and so this year might rightly be eliminated from all bases of comparison.

Referring to 2021, by directly comparing it against the pre-pandemic 2017-2019 interval, the primary energy consumption in the EU area has been 4.56% lower – i.e., as compared to that years' interval's average, as seen in Figure 9. Nineteen EU member countries registered such decreases between a threshold of (-)1.39% and a ceiling of

[9] ETS and ESD are the EU's instruments for managing GHG emissions.

(-)16.82%. The highest such reductions in the area came up in Estonia (-16.82%), Portugal (-13.25%) and Greece (-10.49%). On the other hand, the EU member countries reducing the same primary energy consumption by lower percentages than this average were Finland (-2.74%), Austria (-2.33%), Latvia (-2.26%), Czech Republic (-1.45%) and Italy (-1.39%). The rest eight EU member states actually rose their energy consumption in a percentages' interval between (+)0.36% (Croatia) and (+)5.74% (Lithuania). Romania here belongs with its (+)2.23% corresponding percentage before the pre-pandemic interval. That is to say, eight EU member countries out of 27 stay off the EU's target of energy efficiency raising towards 2030 through primary energy consumption reducing – i.e., corresponding efforts should be higher towards this goal.

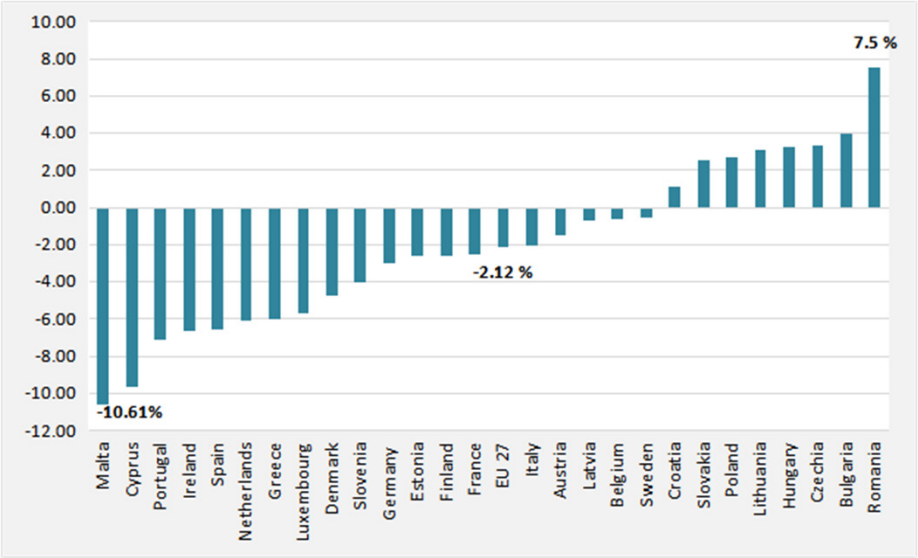
Figure 9. EU Primary energy consumption, 2021 versus 2017-2019 average (%)



Source: Data extracted from Eurostat, Energy efficiency [NRG_IND_EFF__custom_4407905], 2023.

The EU's *final* energy consumption in 2021 was analysed and, in turn, compared to the pre-pandemic 2017-2019 interval consumption average, the result was (-)2.12%, as seen in *Figure 10*. It was observed that nineteen EU member states achieved a final energy consumption reducing, as related to the same pre-pandemic considered interval between (-)10.61% and (-)0.53%. And the highest energy consumption reductions were registered by: Malta (-10.61%), Cyprus (-9.63%) and Portugal (-7.08%), of course, as compared to the pre-pandemic chosen period. These are followed by a group of EU member countries performing energy consumption reductions at the same, but below the region's average of (-)2.12%: Austria (-1.49%), Latvia (-0.73%), Belgium (-0.66%) and Sweden (-0.53%). The other eight EU members, similarly to the above situation of primary energy consumption, met with increases in consumption – i.e., between the minimum of (+)1.11% (Croatia) and the maximum of (+)7.5% (Romania).

Figure 10. EU: Final energy consumption in 2021, as compared to 2017-2019 average (%)



Source: Data extracted from Eurostat, Energy efficiency [NRG_IND_EFF__custom_4407905], 2023.

D) The EU: current primary and final energy consumptions, face to corresponding targets of 2030

The concept considered in this case is the ***distance to the target*** **of energy consumption reduction** and this expresses in million tonnes (of) oil equivalent (Mtoe) -- i.e., the same as the energy consumption itself. The EU specific targets, in their turn, are defined by the European Environment Agency (EEA 2019). This distance is the difference between the energy consumption – i.e., final or primary, and this in *absolute* numbers – in/of the current year and the corresponding one of 2030, as targeted. But the same *distance* might also be expressed as relative, i.e., in percentages of the respective target. The *distance to the target* is presumed to be able to evaluate progresses related to the targets previously drawn for energy consumption reduction in the EU area. In such a context, either opportunities specific to accomplished targets might be identified, or current performing is assessed, together with identifying possible additional measures.

The EU energy consumption *targets*, in their turn, originate in a combination of top-down and bottom-up approaches and then transformed into plans of action for individual member states (i.e., 'top-down' - type strategy). Some flexibility is allowed to member countries in their action as such, but they are supposed to report on progresses performed to the Union, as regularly.

Targets are indicative - they aim to guide the EU member states' efforts towards a sustainable energy system built and to the greenhouse effect from gas emissions reduced down to its elimination. While so, since indicative, the primary energy consumption targets make no commitment for the EU members, the final ones becoming mandatory,

as the 2030 specific targets (EURACTIV, 2022).

The primary consumption targets for 2020 and 2030 were 1483 Mtoe and 1273 Mtoe, respectively (EED). With the United Kingdom leaving the EU, these targets have been revised to 1312 Mtoe and 1128 Mtoe for 2020 and 2030, therefore we have opted to consider these data for the paper. Furthermore, the COVID-19 crisis affected the EU economy – i.e., the Eurostat data show the primary consumption in the EU dropped to 1,236 Mtoe, which is 5.8% lower than the 2020 specific EU target. As for what happened in 2020 in the EU member countries, with their *primary* energy consumption, targets were accomplished, sometimes even surpassed, by 24 of these and the other three (Belgium, Bulgaria and Poland) performed similarly, as seen in *Table 1*. The European Commission's report COM (2022/641 final) named '*2022 report on the achievement of the 2020 energy efficiency target*'[10]. We found out that the *final* energy consumption is nearly the same: there were 21 EU member states accomplishing and/or exceeding their specific targets of consumption reduction for 2020. And, finally, the European Environment Agency (EEA, 2021) released its '*Trends and Projections in Europe 2021*' paper, in which most EU member states appear to have filled their energy efficiency targets in 2020.

However, one should recall the same above-mentioned EC's COM (2022/641 final), in which six EU member countries are shown to have failed on their individual targets, despite high efforts being employed – i.e., Austria, Belgium, Bulgaria, Germany, Lithuania and Sweden[11]. Other countries remained far from corresponding targets, possibly due to serious problems of their energy efficiency policies – e.g. by 90.6% for Bulgaria; by 81% for Lithuania.

Table 1 indicates the results on energy efficiency degree performed by the EU member countries, as computed on data offered by the EC in COM (2022) 641 final through two formulae as such:

$$PEC_{2020}\ (\%) = PEC_{target\_2020}/PEC_{2020} * 100 \quad (1),$$

In which PEC_{2020} (%) is the specific primary energy consumption degree performed in 2020, PEC_{target_2020} the corresponding consumption targeted in absolute numbers, i.e., million tonnes oil equivalent (Mtoe) and PEC_{2000} represents the corresponding effective consumption (in the same system, Mtoe).

And then:

$$FEC_{2020}\ (\%) = FEC_{target\_2020}/FEC_{2020} * 100 \quad (2),$$

In which, FEC2020 (%) is the specific primary energy consumption degree performed in 2020, FECtarget_2020 the corresponding consumption targeted in absolute numbers, i.e., million tonnes oil equivalent (Mtoe) and FEC2000 represents the corresponding effective consumption (expressed in Mtoe).

[10] European Commission, COM (2022) 641 final, *2022 report on the achievement of the 2020 energy efficiency targets*, available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022DC0641.

[11] Sweden has opted for an energy intensity target in which the assumed levels of growth in both gross domestic product (GDP) and energy consumption impact the target level. This energy intensity target has not been included in this assessment, to allow for comparison with other member states.

Table 1. The degree of fulfilment of specific energy consumption targets proposed for 2020 by the EU to each member state

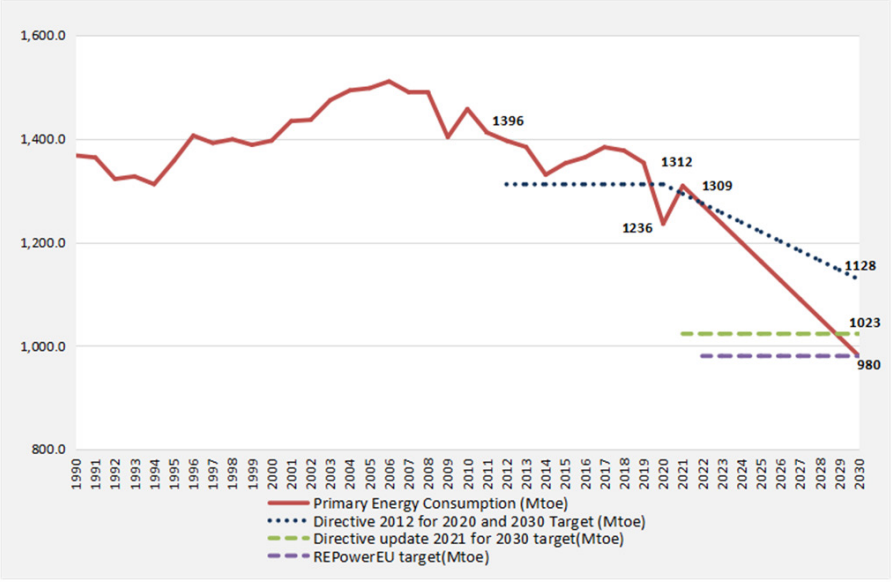
EU member	PEC2020 (%)	FEC2020 (%)
Belgium	99.6	97.6
Bulgaria	98.1	90.6
Czech Republic	118.2	103.4
Denmark	114.3	115.4
Germany	105.4	96.4
Estonia	127.5	105.4
Ireland	103.5	104.7
Greece	128.4	127.3
Spain	117.5	117
France	108.6	106
Croatia	137.9	107.6
Italy	119.4	120.7
Cyprus	101.6	121.8
Latvia	126	115.9
Lithuania	104.4	81.0
Luxembourg	113.9	111.2
Hungary	111.4	101.1
Malta	111.1	116.4
Netherlands	103.9	114.7
Austria	106.1	96.2
Poland	99.5	100.6
Portugal	115.1	115.8
Romania	139.1	128.9
Slovenia	115.8	116.6
Slovakia	108	100.2
Finland	120	114.5
Sweden	104.1	97.8

Source: European Commission, COM (2022) 641 final, 2022.

The EU objectives for 2030

The European Commission (EC) presented in 2022 a plan for reducing the EU's dependence on imports of fossil fuels from Russia to sanction the current military aggression against Ukraine – i.e., REPowerEU[12] (COM/2022/230 final). This initiative came to be considered a renewed basis for remaking the old reference scenario of EU's energy efficiency, i.e., this proposal targeting the energy efficiency with the aim of increasing it at 13%, instead of 9%, in the old planning version. Or, this would equal 980 Mtoe as *primary* energy consumption in the EU in 2030. See also our calculations, resulting in 13% less for primary consumption energy up to 2030 – i.e., from 1,128 Mtoe in 2012, as proposed by EED at that time, down to 980 Mtoe in the new *REpowerEU Plan* (*Figure 11*).

Figure 11. EU27 - Primary energy consumption (PEC) and updated targets for 2030 (Mtoe)



Source: The author, calculation based on Eurostat data; targets for primary energy consumption in years 2012, 2021, 2022.

A reduction of 329 Mtoe *primary energy* consumption in the EU for nine years onwards, which is the 2022-2030 interval, needs a series of policies and measures taken by each EU member state. A simple and indicative way to calculate the reduction in primary energy consumption for each year is dividing the figure corresponding to the total reduction objective at the EU level (329 Mtoe), by the number of years in the respective period (nine years). This leads to an annual reduction of 36.5 Mtoe on this

[12] European Commission, COM/2022/230 final - *Communication from the Commission to the European Parliament*, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, REPowerEU Plan, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2022:230:FIN.

time frame. The subsequent calculation is:

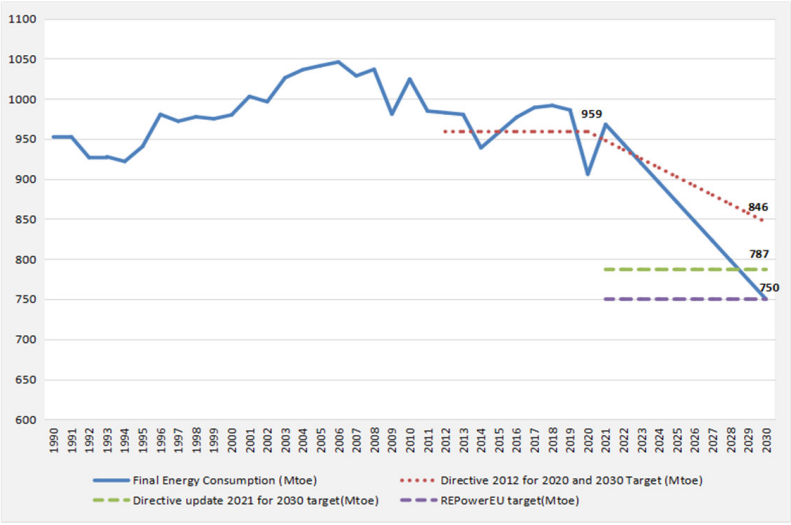
$$PEC_n = PEC_{n-1} - (329\ Mtoe / 9\ years),$$

In which *n* is each of the years in the 2022-2030 interval, PECn is the *primary* energy consumption in the year *n* and PEC_{n-1} is the same in the year previous to the year *n*. An equality that makes the image of a linear reducing of the energy consumption year by year at constant annual rate, which results, as previously explained, into 36,5 Mtoe – i.e., on the EU region aggregate.

In addition, one should recall the previous EED related EC directive's data on the *final* energy consumption at 959 Mtoe for 2020 and 846 Mtoe for 2030, respectively. This specific 2020 target has been accomplished, due to the COVID-19 pandemic. To this end, 905 Mtoe final energy consumption has been registered, as compared to the 959 Mtoe targeted consumption for that year. In 2021, the final energy consumption rose back above the previous 2020 targeted level. The Commission proposed in 2021 to review the Energy Efficiency Directive (COM/2021/558), then corrected the previously established 846 Mtoe level targets for the 2030 final energy consumption to 787 Mtoe level (EED). Following this, another energy consumption reduction was proposed in 2022, amounting to 750 Mtoe for 2030, through the REPowerEU plan. Firstly, it has been noticed a deliberate and continuous energy efficiency target's adjustment, followed by an increasingly brutal change that may lack realistic and feasible perspectives – i.e., see *Figure 12*.

Our findings assess the recent REPowerEU proposal on 2030's final energy consumption level at (-) 11.3 % reduction - i.e., from 846 Mtoe in 2012, as proposed by EED at that time, down to 750 Mtoe in the new REPowerEU Plan.

Figure 12. EU 27 - FEC (Final energy consumption) and updated targets for 2030 (Mtoe)



Source: The author, calculation based on Eurostat data: targets for primary energy consumption in the years 2012, 2021, 2022.

Building on the above basic calculations on the primary energy consumption targeted in 2022 for 2030 – i.e., on a nine years' time frame for both the absolute number and the forecasted reduction it ought to be the same for the *final* energy consumption (about 217 Mtoe), as targeted for 2030, if we divide the number by the nine years and imagining policies implemented by the EU individual member states the result is 24.21 Mtoe per year for an aggregate number per EU region. See also the following calculation formula:

$$FEC_n = FEC_{n-1} - (217.91\ Mtoe / 9\ years),$$

In which – i.e., the same as above, for the primary energy consumption -- *n* is each of the years in the 2022-2030 interval, FEC_n is the *final* energy consumption in the year *n* and FEC_{n-1} is the same in the year previous to the year *n*. An equality that makes the image of a linear reducing of the final energy consumption year by year at an also constant annual rate – i.e., of course, on the EU region aggregate.

Recalling the individual EU member countries' involvement, this means both alignment to the Union's policies and adapting their National Integrated Plans for Energy and Climate (NECPs) on 10 years – i.e. 2021-2030 – a document which leaves room for the individual EU member states local realities (EU)2018/1999)[13]. In 2018, the European Commission (EC) received the NECPs /drafts from the EU member states, the following step being that of releasing the updated versions (COM/2019/285)[14] in 2019 with EC's specific recommendations. Member states received, analysed and revised the documents with the purpose of reaching the new NECPs versions by the end of 2019. In September 2020, a final evaluation of NECPs, published by the EC (COM/2020/564 final)[15], was followed by individual evaluations for each member state. Since then, the member states are supposed to report on their progress to the EC every two years.

According to the revised and final NECPs versions, nineteen EU member states aimed to reduce their *final* energy consumptions by 2030, between (-)24.3% (Luxembourg) and (-)0.42% (Slovenia), as seen in *Table 2*. The rest of eight EU member countries have already accomplished their 2030 targets of energy consumption in 2021 – i.e., Bulgaria, Denmark, Estonia, Greece, Cyprus, Malta, Romania and Finland.

Similarly, observing the other part of the energy consumptions, the *primary* one, according to the same EC document (COM/2020/564 final) for the 2030 targeting and then comparing these data to the factual ones of Eurostat for 2021 (i.e., their last issued data was at the time of this paper), the results were that eighteen EU member states aimed to reduce consumption by percentages varying between (-)23.3% (Netherlands) and (-)0.48% (Croatia). The rest of the nine EU member states were in the position of having

[13] European Parliament Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (Text with EEA relevance), available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG.

[14] European Commission, COM/2019/285 - Draft NECPs together with specific recommendations in June 2019, available at: https://energy.ec.europa.eu/topics/energy-strategy/national-energy-and-climate-plans-necps_en#draft-necps.

[15] European Commission, COM/2020/564 final. EU-wide assessment of National Energy and Climate Plans Driving forward the green transition and promoting economic recovery through integrated energy and climate planning.

already fulfilled the 2030 specific target, as similarly to the above description on the final energy consumption concomitant story, -i.e., Czech Republic, Denmark, Estonia, Greece, Cyprus, Malta, Portugal, Slovenia, and Finland.

Table 2. EU member countries individual assessments Plans (NECPs) for 2030

Primary energy consumption (Mtoe)				Final energy consumption (Mtoe)		
Country	Latest available data (2021) *	Target of 2030 **	Diff.*** 2030-2021(%)	Latest available data (2021) *	Target 2030**	Diff.*** 2030 - 2021 (%)
Belgium	48.76	42.7	-12.43	35.86	35.2	-1.84
Bulgaria	18.58	17.5	-5.81	10.28	10.3	0.19
Czech Rep.	39.61	41.43	4.59	26.21	23.65	-9.77
Denmark	16.23	18.3	12.75	13.80	15.8	14.49
Germany	266.98	216	-19.10	209.74	185	-11.80
Estonia	4.45	5.4	21.35	2.83	2.9	2.47
Ireland	13.86	13.7	-1.15	11.40	11.2	-1.75
Greece	20.33	20.55	1.08	15.21	16.51	8.55
Spain	112.14	98.5	-12.16	80.33	73.6	-8.38
France	224.38	202.2	-9.89	143.19	120.9	-15.57
Croatia	8.27	8.23	-0.48	6.97	6.85	-1.72
Italy	145.31	125.1	-13.91	113.27	103.8	-8.36
Cyprus	2.31	2.4	3.90	1.69	2	18.34
Latvia	4.47	4.1	-8.28	4.06	3.6	-11.33
Lithuania	6.63	5.5	-17.04	5.66	4.5	-20.49
Luxembourg	4.19	not provided	-	4.06	3.06	-24.63
Hungary	24.93	30.7	5.77	19.15	18.7	-2.35
Malta	0.77	1.1	42.86	0.59	0.8	35.59
Netherland	60.76	46.6	-23.30	46.90	43.9	-6.40
Austria	31.55	28.7	-9.03	27.82	24	-13.73
Poland	103.95	91.3	-12.17	75.15	67.1	-10.71
Portugal	19.53	21.5	10.09	15.66	14.9	-4.85
Romania	33.09	32.3	-2.39	25.37	25.7	1.30
Slovenia	6.33	6.4	1.11	4.72	4.7	-0.42
Slovakia	16.29	15.7	-3.62	11.42	10.3	-9.81
Finland	31.47	34.8	10.58	24.86	24.9	0.16
Sweden	43.83	40.2	-8.28	31.70	29.7	-6.31

Source: The author, calculation based on data retrieved from Eurostat and NECPs Plans.

**Data from this column show the values for 2021 (Eurostat) and are expressed in million tonnes oil equivalent (Mtoe) / Energy efficiency [NRG_IND_EFF__custom_4407905].*

*** Data from this column belong to the 2030 energy consumptions targeted, as extracted from the EU member states' NECPs, and is figured in Mtoe: https://energy.ec.europa.eu/individual-assessments_en*

**** Numbers in this column result from our calculations.*

Table 2 indicates results corresponding to the EU member states' NECPs that cumulate a total *primary* energy consumption of 1,171 Mtoe and a total *final* energy consumption of 883 Mtoe, as proposed for 2030 in the whole EU multi-country region – i.e., more precisely, in columns 2 and 5 of *Table 2*. Or, the very problem of these results is that they appear lower than the corresponding ones of the EC's REPowerEU Plan – i.e., 980 Mtoe (PEC) and 750 Mtoe (FEC) – for which the EC could qualify the member states' ambitions in such a respect as: 'low' and 'very low', 'modest' and, finally, 'sufficient' in just few country cases.

The solutions to achieve the 2030 targets as shown in several EC documents

In order to talk about a distinct *set of EC's specific documents* pointing out to the same 2030 energy consumption targets REPowerEU is one of these plans and has been already mentioned above. This was published on 18 May 2022, at the same time with the *Energy Savings* initiative. Corresponding, a document series that might be called *Orientations* (of the EC) on the updates of the same 2021-2030 NECPs' content include:

- *Communication of the European Commission to the European Parliament*, European Council, European Social and Economic Committee and Committee of Region of 18 May 2022 of the *REPowerEU Plan* – i.e., COM (2022) 230 final.
- *Communication of the European Commission to the European Parliament, European Council*, European Social and Economic Committee and Committee of Region of 18 May 2022 of the *Energy Savings* – i.e., COM (2022) 240 final[16].
- *Communication of the European Commission regarding the orientations addressed to EU member states to adapt their NECPs for 2021-2030* (from 29.12.2022).

The EC sees this list as being necessary for achieving the 2030 above targets of energy consumptions.

Two years after the first NECPs' (final and revised) report, the EC proceeds to its Communication (2022/C495/02)[17] for re-updating their provisions according to the latest geopolitical changes. This is also for approaching REPowerEU objectives by referring to NECPs. This Communication was issued in December 2022; in June 2023 new proposals from the member states are expected to be attached for a final *NECPs' updating* in June 2024. New orientations belonging to this Communication (2022/C495/02), for renewed and clarified targets, are included for sectors able to implement the energy consumption reduction initiatives. The updated NECPs are supposed to have (re)viewed all sectors of the energy demand – e.g., buildings, industry and transports – from the viewpoint of energy consumption.

The example of public buildings might be self-explanatory – e.g., total surface to

[16] European Commission, COM/2022/240 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions EU 'Save Energy', 2022, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2022:240:FIN.

[17] European Commission, 2022/C495/02, Commission Notice on the Guidance to Member States for the update of the 2021-2030 national energy and climate plans, 2022, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022XC1229(02).

be renovated and annual energy savings will be, according to the *renovation wave* (COM (2020)662 final)[18], expected for higher buildings' energetic performances, doubling the renovation rates and the gradual decarbonization of the real estate stocks, this latest in connection with long term national strategies, as well. Important for the *NECPs updated* is also the *REPowerEU - Plan for energy savings* tandem – i.e., both launched in May 2022, the previous with its cut of the dependence from Russian fossil fuels and gas, as imported energy sources, the latter including also changes aimed at the *individual behaviour on energy consumption*, previously to all decisions coming from the authorities to be implemented – e.g., measures taken, directives, orientations, communications.

Insisting on this last point, the *energy consumers' behaviour* accounts for being affected by the energy prices already higher – i.e., market driven behaviour. But this is not enough, in the Commission's view – i.e., consumers that feel wealthy might prefer keeping their consumption preferences untouched, while the others who are vulnerable might be really affected by the same circumstances. In this given situation, the Commission (EC), together with the IEA, just launched a common campaign called *Playing my part* (IEA and EC, 2022) for individuals' and companies', whose responsibilities are increased face to the energy consumption – i.e., a campaign of information and encouragement.

Finally, COM (2022) 240 provides, about *financing the measures plan for energy savings, energy efficiency and buildings' renovation* included, their special chapter to be filled in the National Recovery and Resilience Plans (NRRP) of the EU member states and their address to diverse funds – e.g., European Regional Development Fund (ERDF), Cohesion Fund and the Just Transition Fund, specific programmes – e.g., 'Europe-Horizon', LIFE – and private investors.

Conclusions and perspectives

The EC has issued and taken *numerous measures that are well harmonized* and benefit from sufficient funding at least on short and medium term for energy efficiency and climate specific objectives. However, it is up to the member states, within their NECPs, to navigate the changing circumstances and achieving their targets.

Firstly, we can observe a slightly decreasing trend of energy consumption in the EU area on aggregate, during the long 1990-2021 interval, out of which the 2005-2021 shorter interval sees a continuous decreasing. Then, in 2021 – i.e., following the global pandemic – the energy consumption suggested the same decreasing pattern on the EU as an aggregate, while there recorded some different behaviours among member countries, as compared to the pre-pandemic 2017-2019 interval (see in *Figures 9* and *10*).

Secondly, recalling our research questions the analyses conducted point out to the following conclusions:

(i) An obvious progress of each member country, at least in terms of reaching the targets for 2020;

(ii) Judging by the degree of low ambition within which the countries were assessed according to the proposals for 2030, a change in this will be analysed only after

[18] European Commission, COM (2020) 662 final, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A renovation wave for Europe - greening our buildings, creating jobs, improving lives*, 2022, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0662.

a new review of NECPs (in the proposal stage by 30 June 2023 and in the final stage by 30 June 2024). At this moment, we can affirm that only some of the countries are in the satisfactory situation of having reached the targets for 2030 (*Table 2*), but the question arises whether they will manage to maintain this downward trend and whether the rest of countries will align. This can be considered a limit of this research and also a point for future directions.

(iii) The targets for 2030 (and 2050 climate neutrality) seem to be very ambitious and brutal. A few countries already made some progress, some did not. This effort can only be a joint one: with guidance and financial help from the EU and with the member states' cooperation.

(iv) Falling to reach the EU's 2050 targets could lead to a prolonged negative climatic effect which could be caused by:

- Different and divergent EU member states' interests and priorities related to fossil fuels, scarce natural resources and available technological capabilities.
- New technologies missing – e.g., for capturing and stocking: carbon, nuclear energy, green hydrogen, off shore wind power, advanced solar energy – and complex and costly procurements.
- Unemployment that occurs in traditional industries as a consequence of the sudden transition to the new energy sources (together with social and economic effects).
- Giving up traditional energy sources might bring in risks of national security and/or imports dependency.
- Last, but not least, political changes inside the EU might create instability, delay and impede the long-term strategy.

Finally, a few future directions for research could be considered: (i) the main obstacles and challenges (economic, social, political etc.) in implementing energy policies both at the EU level and in the member states; (ii) implications and recommendations for energy policy and the necessary rules to be followed in the EU and member states with the aim of achieving energy efficiency, especially on its long-term goals; (iii) the energy efficiency financial and investment impacts' evaluation.

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