INSTITUTE FOR EUROPEAN ENERGY AND CLIMATE POLICY

Make Energy Efficiency Visible in the Energy Mix

Authors

Jean-Sébastien Broc, Shima Ebrahimigharehbaghi, Marco Peretto, Ivana Rogulj, Vlasis Oikonomou

Reviewer

Wolfgang Eichhammer, Mary Connors

IEECP would like to thank the European Climate Foundation and Knauf Insulation to make this study possible.

Published on 7 November 2023 by the Institute for European Energy and Climate Policy (IEECP), and funded by the European Climate Foundation and Knauf Insulation.

How to cite this report:
IEECP (2023). Make Energy Efficiency visible in the energy mix. Report of the Institute for European Energy & Climate Policy, prepared for the European Climate Foundation and Knauf Insulation.

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Institute for European Energy and Climate Policy Stichting - IEECP
Amsterdam Sloterdijk Teleport Towers, Kingsfordweg 151,
1043GR Amsterdam, The Netherlands
KvK: 64602214; VAT: NL0855739198

www.ieecp.org - info@ieecp.org

EXECUTIVE SUMMARY

For energy efficiency to be really considered as an energy resource on a level playing field with other energy resources, energy efficiency improvements need to be monitored. Then, energy efficiency data needs to be integrated together with energy data about other energy resources.

EU or national energy statistics most often start with showing the energy mix: what are the energy resources used (or produced) and their shares. The energy mix is used as a starting point to define the energy strategy. Our review of a selection of major publications on energy statistics shows that the way the energy mix is currently displayed, the contribution of energy efficiency to the energy balance is missed.

Examples of graphs showing the contribution of energy efficiency to the energy mix do exist. However, they are included in separate reports or online publications, dedicated to energy efficiency. The fact that energy efficiency is represented or discussed separately may contribute to a priority gap: out of sight, out of mind.

Reasons why energy efficiency data are kept separately include usual practices and conception of energy statistics (e.g. classical conception of energy flows), data issues (e.g. scope of official statistics, time lag in data availability), or the need for agreements on methodologies. However, any statistics require methodological choices, and thereby agreements. Available experience about methodologies to assess energy efficiency improvements shows that such agreement would be technically feasible. It requires political will to become a reality. Main methodological choices that likely require an agreement include (1) the choice of the method(s); (2) the choice of the base year or period; and (3) the disaggregation level and related indicators or indices for each (sub-)sector.

When comparing the main approaches to assess energy efficiency improvements, the top-down approach is more relevant to provide data for integration in the energy mix. Mainly because it is designed to capture the whole energy efficiency improvements, whereas the bottom-up approach is designed to capture policy-driven energy savings. Moreover, the top-down approach is already applicable in Europe, thanks to the ODYSSEE database. It is also closer to statistical practices.

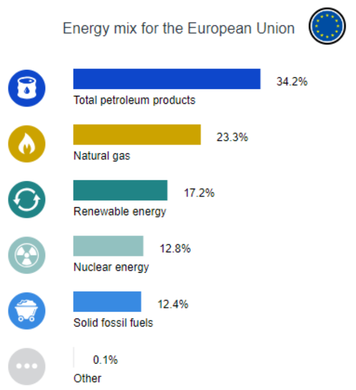
While including energy efficiency data in official statistics may be a long process, it is already possible to publish reports or online content that would complement or challenge official publications, which could stimulate changes. The similarities and differences in national publications on energy statistics show that there are some margins in what they can display. By integrating energy efficiency data in the main energy figures, the main objective is to ensure that energy efficiency is at the forefront of the general energy debate.

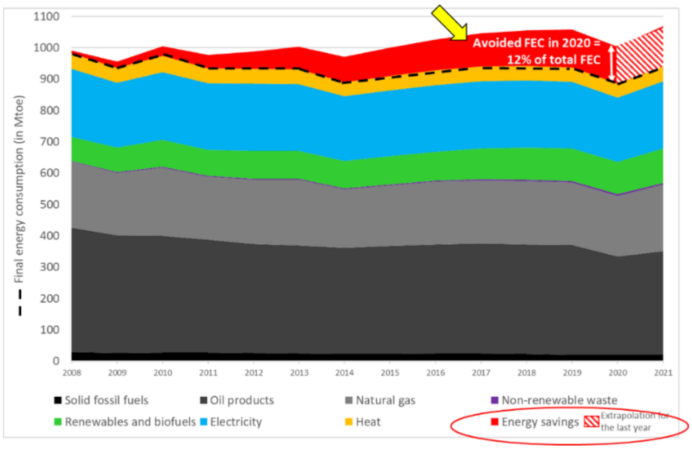
Further actions and research could also support the long-term process of getting energy efficiency data recognised as official statistics. Similarly, complementary actions could increase the visibility of energy efficiency, as listed below. Further developments could also be figures to display the contribution of energy efficiency to the flexibility of the electricity system. This is also part of the Energy Efficiency First principle, and getting energy efficiency recognised as an energy resource.

7 actions to make energy efficiency more visible in the overall energy picture

Action 1: Integrating energy efficiency in the energy mix

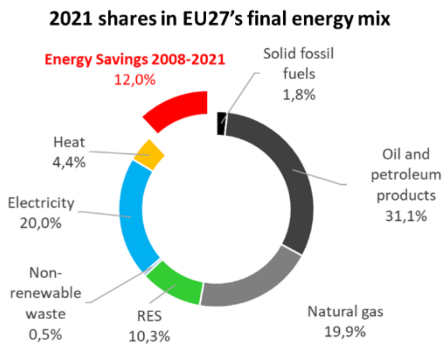
Adding next to the current figure about the energy supply mix, a graph showing the evolution of final energy consumption per energy carrier, including energy savings on the top. This would make an energy efficiency share visible in the final energy mix, as shown below.

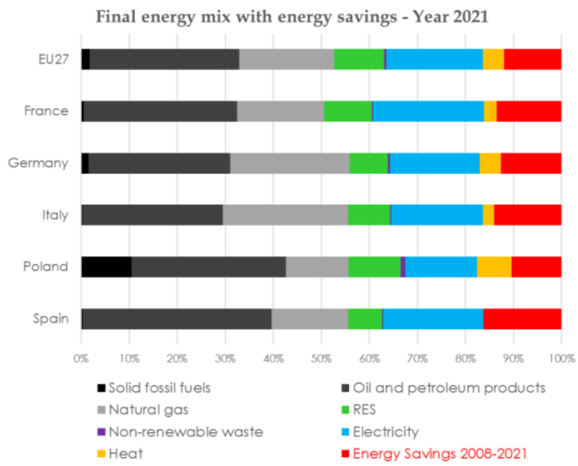




Action 2: Integrating the energy mix in the energy efficiency publications

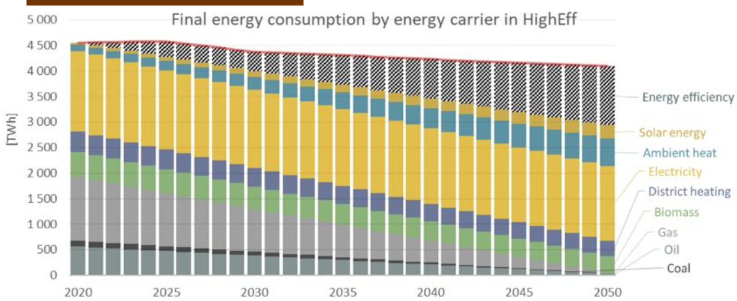
Adding in the main figures of energy efficiency publications, figures showing the energy efficiency share in the energy mix. The link between energy efficiency and the energy mix should be made in both ways. Energy efficiency publications could develop an 'energy savings balance' that could mirror the usual energy balance.

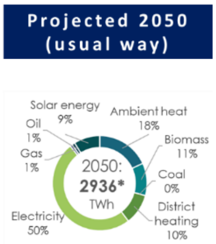


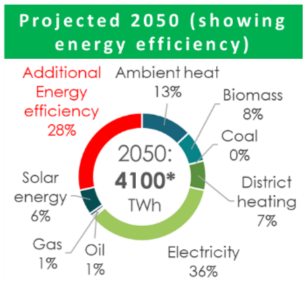


Action 3: Making energy efficiency visible in forward-looking scenarios

Adding the share related to additional energy savings or energy efficiency improvements in the graphs showing the results of the scenarios, as illustrated below with the ENEFIRST scenario exploring the results of higher energy efficiency ambition in buildings.







Action 4: Allocate means to data collection in line with data needs	Ensuring that enough means are allocated to collect, process and analyse the data needed to monitor trends in energy efficiency improvements and results from energy efficiency policies, having in mind the differences among countries. While digitalisation provides ways to develop data collection and processing, the increasing needs related to the energy and climate policy framework require sufficient means.
Action 5: Establish a European working group on energy efficiency data	Providing a forum where national and European experts could exchange regularly about methodologies, in view of preparing more formal discussions to agree on methodological choices for the publications of energy efficiency data in a consistent manner across countries.
Action 6: Improving the visibility of the results of energy efficiency policies	Ensuring that results from energy efficiency policies are published on a regular basis and can be easily found and accessed. This could be complemented with monitoring and publishing the achievements related to major objectives such as the renovation of the building stock (in line with the Governance Regulation of the Energy Union and Climate Action). This is essential to inform policymaking, as well as to provide visibility to market players and transparency to citizens.
Action 7: Highlighting the topical impacts of energy efficiency	Complementing the energy efficiency data available on a regular basis with ad-hoc studies providing evidence and key figures about the multiple impacts of energy efficiency, selecting the impacts in focus according to what is in the top of the policy priorities or in the news. Illustrating other impacts from energy efficiency improvements shows how strategic they can be for multiple objectives and contexts. This can increase the visibility of energy efficiency beyond the energy efficiency community.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ... 3

TABLE OF CONTENTS ... 6

Introduction ... 10

Why does it matter? ... 10

How energy efficiency is represented (or not) in major publications on energy statistics ... 11

Objectives ... 11

Methodology ... 11

Findings ... 14

Energy efficiency is not included in the headline figures of the energy balances, energy statistics or other similar reports. ... 14

Energy efficiency is often included in a dedicated section or chapter (in general publications on energy statistics), or presented in separate reports. ... 14

The most advanced graphs showing the quantitative contribution of energy efficiency to the energy balance are based on decomposition analysis ... 15

The way to publish, represent and visualize the data has evolved significantly in recent years. ... 18

International standards or methodologies on energy statistics do not impede public authorities to select the data to highlight and the way to display them. ... 21

Therefore, the main barrier is not the limitation about what could be presented / published, but rather what data can be used ... 21

Representing the energy efficiency contribution to the energy mix from a bottom-up approach has only been found in US publications (or in forward-looking scenarios). ... 22

Approaches and examples to make energy efficiency visible ... 25

Top-down approach ... 25

From energy intensities to decomposition analysis ... 25

Advantages and limitations of the different methods ... 26

Integrating energy efficiency in the energy mix from top-down results ... 28

Methodological discussions ... 32

Bottom-up approach ... 33

Diversity of methods ... 33

Challenges to aggregate results ... 34

Comparing top-down and bottom-up savings ... 35

Forward-looking scenarios ... 37

Other ways to show the contribution of energy efficiency ... 40

Summary of key issues discussed at the expert workshop ... 42

About the use of decomposition analysis 42
About data availability, related needs and developments 43
About the way to make data available 44
About agreements on methodological choices and conventions 45
About challenges and opportunities for further developments and integration of energy efficiency data in energy statistics 45
Conclusions 49
Integrating energy efficiency in the mix is possible, but not yet done 49
The top-down approach is already applicable and in line with statistical practices 51
Promoting energy statistics including energy efficiency can already be done 51
Political will and agreements are needed for a more systematic and official integration 52
Other actions can support this process 52
Other developments could help increase the visibility of energy efficiency 53
Perspectives: 7 actions to make energy efficiency more visible in the overall energy picture 54
Action 1: Integrating energy efficiency in the energy mix 54
Action 2: Integrating the energy mix in the energy efficiency publications 55
Action 3: Making energy efficiency visible in forward-looking scenarios 56
Action 4: Allocate means to data collection in line with data needs 56
Action 5: Establish a European working group on energy efficiency data 57
Action 6: Improving the visibility of the results of energy efficiency policies 57
Action 7: Highlighting the topical impacts of energy efficiency 58
References 59
Acknowledgements 61
Annex: Energy efficiency share in the energy mix of the five Member States with the largest energy consumption 62

TABLE OF FIGURES

Figure 1. IEA waterfall graph showing the decomposition of final energy consumption in IEA countries.... 15
Figure 2. ODYSSEE waterfall graph showing the decomposition of final energy consumption in the EU27.... 16
Figure 3. ODYSSEE bar chart showing the drivers of final energy consumption variation at EU level between 2014 and 2019.... 16
Figure 4. ODYSSEE stacked area chart showing cumulative energy savings from energy efficiency improvements over 2000-2019 in the EU (in Mtoe), with shares of energy savings per sector compared to shares of final energy consumption per sector.... 16
Figure 5. IEA stacked-area chart showing estimated savings of final energy use in IEA countries, 2000-2020 (in EJ).... 17
Figure 6. IEA stacked area chart showing avoided energy use from energy efficiency in 11 IEA member countries.... 17
Figure 7. How energy efficiency is introduced on the IEA website.... 18
Figure 8. EU28 primary energy consumption by fuel and energy savings over 1990-2016ings (in Mtoe), including energy savings.... 18
Figure 9. EU's energy mix (left) and Member States' share of energy products in total energy available (right), all for year 2021.... 19
Figure 10. ODYSSEE Decomposition tool.... 20
Figure 11. Example of Sankey diagram showing the energy balance of the OECD countries.... 20
Figure 12. Eurostat's portal to interactive energy visualisation tools.... 20
Figure 13. France's primary energy production per energy source in 2021.... 21
Figure 14. US electricity generation and savings from energy efficiency (left), and share of US electricity generation by resource (right), both for year 2015.... 23
Figure 15. share of California's electricity generation by resource (including energy efficiency) in 2012.... 23
Figure 16. Pie charts without and with the energy efficiency contribution in the energy mix for year 2021, for EU27.... 29
Figure 17. Final energy consumption (in Mtoe) in EU27 over 2008-2021, including energy savings (last area on top).... 30
Figure 18. Adapted stacked-area chart, including extrapolation about energy savings in the last year, to match with the timing of data of the other energy data.... 31
Figure 19. Stacked-bar chart showing the final energy mix including energy savings, for EU27, France, Germany, Italy, Poland and Spain.... 32
Figure 20. Comparing top-down and bottom-up energy savings in 2019, from energy efficiency improvements achieved over 2014-2019.... 36
Figure 21. Modelled developments in final energy consumption for EU27 in the HighEff scenario of the ENEFIRST project, showing energy efficiency improvements from higher ambition for building renovations, compared to the LowEff scenario.... 38
Figure 22. Pie charts showing the energy mix in buildings in the ENEFIRST scenarios with higher efficiency ambition.... 39
Figure 23. Avoided volume and value of imports in 2014 from efficiency investments in IEA countries since 1990.... 40
Figure 24. Number of power plant equivalents avoided by energy efficiency in the US since 1990, and potential through 2030.... 40

Figure 25. Pie charts without and with the energy efficiency contribution in the energy mix for year 2021, for Germany, France, Italy, Spain and Poland. 64
Figure 26. Final energy consumption (in Mtoe) in Germany over 2008-2021, including energy savings (last area on top). 64
Figure 27. Final energy consumption (in Mtoe) in France over 2008-2021, including energy savings (last area on top). 65
Figure 28. Final energy consumption (in Mtoe) in Italy over 2008-2021, including energy savings (last area on top).......... 65
Figure 29. Final energy consumption (in Mtoe) in Spain over 2008-2021, including energy savings (last area on top).......... 66
Figure 30. Final energy consumption (in Mtoe) in Poland over 2008-2021, including energy savings (last area on top). 66

TABLE OF TABLES

Table 1. Overview of the publications reviewed (international organisations). 12
Table 2. Overview of the publications reviewed (countries). 13

INTRODUCTION

EU or national energy statistics most often start with showing the **energy mix**: **what energy resources are used (or produced) and their shares**. The energy mix is used as a starting point to define the energy strategy. In the way it is currently done, **the contribution of energy efficiency to the energy balance is missed**.

The Commission's energy statistics regulation was revised early 2022 to support the implementation of the EU Green Deal. This shows the importance of energy statistics. It announced developments in the availability of more detailed data of final energy consumption (e.g. about services or rail) but did not change the way energy efficiency is reported.

The current energy crisis illustrates **how the bias in representing the energy mix can materialize in major policy issues**. First, because if the European countries had tapped all the cost-effective energy efficiency potentials available for years, they would not have been so dependent from the Russian gas, and the withdrawal from this addiction would have been easier. Second, because in the main policy efforts following the REPowerEU communication, the actual top priority was first on diversifying the gas supply (e.g. by increasing the LNG imports and organising joint purchasing). The importance of saving energy to reduce fossil fuel imports was acknowledged in the communication but was not given the same political impetus or coordination between Member States.

Energy efficiency has gained recognition in words. It is briefly reminded as essential in most communications about energy strategies. And the Energy Efficiency First principle has been promoted as one of the overarching principles of the Energy Union, especially as part of the Governance Regulation of the Energy Union and Climate Action. But one may question whether the **priority gap observed between words and actions** could be because energy efficiency would not yet be considered reliable enough or big enough. The way the energy mix is represented raises similar issues:

- Would the priority gap be due to a lack of visibility of the energy efficiency contribution in the main energy statistics?
- Could the integration of energy efficiency in the energy mix help to get energy efficiency recognised as a major energy resource deserving more policy attention?

The present study aims to **review how energy efficiency is represented (or not) in the energy mix**, at national and EU level, and to **explore alternative ways to make the energy efficiency contribution more visible**.

Why does it matter?

For **energy efficiency to be really considered as an energy resource**, on a level playing field with other energy resources, energy efficiency improvements and energy savings need to be monitored. The main approaches (top-down and bottom-up) used to monitor and assess them are discussed in the second part of the report.

Then, the energy efficiency or energy savings data need to be integrated **together with the energy data about other energy resources**. A review of energy publications shows in the in the first part of the report that this has not been done so far, while examples can be found in publications dedicated to energy efficiency. After presenting the main assessment methods, the second part makes suggestions about how energy efficiency or energy savings data could be integrated in typical figures used to represent the final energy mix. The third part summarizes further discussions from an expert workshop organised in September 2023.

HOW ENERGY EFFICIENCY IS REPRESENTED (OR NOT) IN MAJOR PUBLICATIONS ON ENERGY STATISTICS

Objectives

The first step of the study had the following specific objectives:

- To **review the way energy efficiency is considered and represented** in the main publications on energy statistics/figures of major European and international organisations producing energy statistics or related reports (**Eurostat, European Environmental Agency – EEA, International Energy Agency – IEA**) and a selection of five EU Member States (**France, Germany, Italy, Poland and Spain**)
- To identify regular energy efficiency reports of the same organisations or countries, and **other publications where the contribution of energy efficiency would be made visible/tangible**

We thus investigated to what extent energy efficiency is currently visible (or not) in these main publications on energy statistics or energy balances. This first step also aimed at identifying the main approaches currently used to show the contribution of energy efficiency as an energy resource.

Methodology

A first screening done before this study[1] suggested that energy efficiency is missing in most of the key figures about energy mix or energy balance, as published by international organisations or national authorities (or their delegated statistics' bodies).

We therefore formulated the assumptions that:

- (**assumption 1**) the main publications on energy statistics, energy mix or balances are most often not including energy efficiency (or energy savings) in their main figures or data;
- (**assumption 2**) statistics or data about energy efficiency are mostly included in separate (and dedicated) publications or chapters (so not integrated in the overall picture of the energy mix or balance).

We then selected major publications on energy statistics and looked for regular reports on energy efficiency to test these assumptions.

This review was not meant to be exhaustive. The focus was on sources assumed to be well-known, commonly used by policy makers and experts, and thereby having an influence on the agenda setting and the policy discussions on energy.

[1] See presentation done at the Energy Efficiency Day 2022.

The three selected international organisations (Eurostat, EEA and IEA) were identified as the main sources for benchmarking and cross-country datasets on energy, for European countries. The ODYSSEE-MURE project was also selected as a well-known source on energy efficiency indicators (cf. ODYSSEE database), commonly used by the Member States and European experts.

France, Germany, Italy, Poland and Spain were selected as country examples, because they are the largest EU Member States (in population) and represent the largest shares of final energy consumption.

The review was done in February and March 2023.

The **criteria to select the publications** about energy statistics in general included:

- Visibility / exposure: focus on publications identified as flagship publications about energy statistics (either at international or national level)
- Frequency of publication: focus on publications that are published/updated regularly (usually annually)

The criteria to select the second group of publications, focused on energy efficiency, included:

- Frequency of publication: focus on publications that are published/updated regularly (usually annually)
- Originality of the figures: focus on publications that provide examples of figures that could be used to explore ways to represent the contribution of energy efficiency to the energy mix or energy balance

Table 1. Overview of the publications reviewed (international organisations).

Eurostat	European Environmental Agency
Main publications on energy statistics ▪ Energy statistics – an overview (2022) ▪ Energy data – 2020 edition ▪ Shedding light on energy in the EU 2022 ▪ Energy dashboard visualization tool ▪ EU energy in figures – 2022 edition (Commission's publication)	*Main publications on energy statistics* ▪ Trends and projections in Europe 2022
Main publication on energy efficiency ▪ Energy efficiency statistics – statistics explained	*Main publication on energy efficiency* ▪ EEA webpage on energy efficiency
International Energy Agency	**ODYSSEE-MURE project**
Main publications on energy statistics ▪ Key World Energy Statistics ▪ World Energy Outlook	
Main publications on energy efficiency ▪ Energy Efficiency Indicators Data Collection ▪ Energy efficiency 2022 ▪ Energy Efficiency – Energy system overview ▪ The Value of Urgent Action on Energy Efficiency	*Main publications on energy efficiency* ▪ Recent trends in energy efficiency in the EU (2021) ▪ ODYSSEE tools (Decomposition; and Energy Saving)

Table 2. Overview of the publications reviewed (countries).

France	Italy
Main publications on energy statistics ▪ France's energy balance and snapshot ▪ Key Energy Figures (2022)	*Main publications on energy statistics* ▪ National energy situation in 2021 ▪ Italy's energy mix ▪ National Energy and Climate Plan
Main publication on energy efficiency ▪ Energy efficiency in France 2000-2016	*Main publication on energy efficiency* ▪ National Energy Efficiency Action Plan ▪ ENEA's annual report on energy efficiency (2022) ▪ Ministry of Economic Development's annual report on energy efficiency
Germany	**Spain**
Main publications on energy statistics ▪ Energy in numbers ▪ Energy flow diagram of the Federal Republic of Germany 2020 ▪ Energy Consumption in Germany in 2020	*Main publications on energy statistics* ▪ Spain's Energy balance ▪ Spain's Energy Book ▪ National Energy and Climate Plan
Main publications on energy efficiency ▪ Selected efficiency indicators for Germany's energy balance (1990-2021)	*Main publications on energy efficiency* ▪ Summary report on energy efficiency indicators 2020
Poland	
Main publications on energy statistics ▪ Energy statistics in 2020 and 2021 ▪ Energy 2021 ▪ Energy policy of Poland until 2040 ▪ National Energy and Climate Plan	*Main publications on energy efficiency* ▪ Energy Efficiency trends and policies in Poland

The review of these publications looked at:

- Their contents / structure, and if energy efficiency is included (or not)
- How information on energy efficiency is included / presented
- The main data sources used (about energy efficiency data)
- The main figures (type of figure, what they show and whether they can have a link with energy efficiency)

This was complemented with a targeted literature search. The literature provides methodologies or guidelines about energy statistics, energy balances or energy efficiency indicators (e.g. IEA 2014 and 2023; ISO 50049:2020; ODYSSEE-MURE 2020a and 2020b; UN 2018). However, we could not find any paper or report dealing with the integration or visualisation of energy efficiency in energy statistics. We found few papers about the use of energy balances as a tool for energy planning or to support policy making. But these papers do not look at the contribution of energy efficiency to the energy mix or energy balance. Nevertheless, we found **a few US reports representing the contribution of energy efficiency in the electricity mix** (e.g. Molina et al. 2016).

Findings

Energy efficiency is not included in the headline figures of the energy balances, energy statistics or other similar reports.

The headline figures showing the energy mix (e.g. primary energy supply per energy source; final energy consumption per energy source) do not include energy efficiency among the various energy sources (oil, coal, natural gas, nuclear, renewables).

Figures related to energy efficiency are sometimes included after the figures about the energy mix (e.g. in Eurostat's energy statistics overview and Spain's energy balance), showing the trends in energy intensity (either primary or final energy consumption divided by the GDP). However, the explanations or analysis next to these figures clarify that various factors may explain the changes in energy intensity, reminding that (macro) energy intensity is a poor proxy of energy efficiency. This might explain why some publications on energy statistics have even removed figures on energy intensity (e.g. case of France's energy balance that included figures on energy intensity until 2017 on 2015 data, then not anymore).

Some publications also present the trends in final energy consumption as an energy efficiency indicator (e.g. Eurostat's EU Energy in figures), because the Article 3 (now Article 4) of the Energy Efficiency Directive (formerly 2012/27(EU), now (EU) 2023/1791) defines the EU headline energy efficiency targets in terms of primary and final energy consumption levels not to exceed by a target year (2020 then 2030). However, like for figures on energy intensity, the explanations or analysis remind the various factors that may influence primary and final energy consumption.

Therefore, even in the few cases where energy efficiency is mentioned close to the headline energy figures, it is with qualitative comments only. **The quantitative contribution of energy efficiency to the energy mix is missing in the main pictures of the energy balance**.

Energy efficiency is often included in a dedicated section or chapter (in general publications on energy statistics), or presented in separate reports.

When a section or chapter is dedicated to energy efficiency in the general publications on energy statistics (e.g. IEA Key World Energy Statistics, Eurostat's EU Energy in figures, France's Key figures on energy), it is usually included in the last sections or chapters. Moreover, such dedicated section or chapter on energy efficiency is most often included in the extended publication on energy statistics (as the ones listed above). Whereas information on energy efficiency is very limited (if included at all) in the energy balance itself (see above).

This may be because the first sections or chapters of these publications are the usual steps of the energy balance: energy production and supply > energy transformation, transmission and distribution > final energy consumption.

Dedicated reports or publications on energy efficiency data (sometimes together with information on energy efficiency policies) were found in all organisations and countries reviewed, with various degrees of details and scope. **Energy efficiency data is therefore available, but separate**.

Some of these publications are annual reports (e.g. Italy, Spain), whereas others are not regularly updated (e.g. France). At national level, these publications on energy efficiency might be produced by the national energy agencies (e.g. ENEA in Italy, IDAE in Spain) or by the statistical office or division in charge of the energy statistics (e.g. in France and Poland). In Germany, it is published by AGEB (Working Group on Energy Balances, gathering associations of the German energy industry and energy research institutes) that produces Germany's energy balance.

The most advanced graphs showing the quantitative contribution of energy efficiency to the energy balance are based on decomposition analysis.

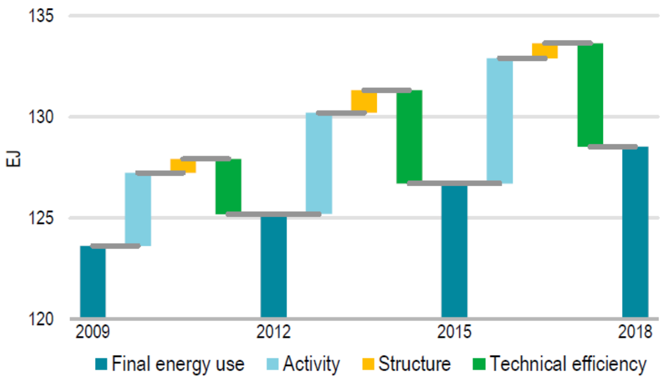
The limitations of using energy intensity as a proxy to monitor energy efficiency trends can be overcome by using more detailed analysis, looking at how different factors influence energy consumption. The most common methodology used to assess energy efficiency improvements at macro level is the decomposition analysis (see box on the right and the second part of this report).

Decomposition analysis starts from macro data about energy consumption (e.g. at country level or per sector) and uses statistical methods to explain changes in energy consumption over time according to a given set of factors (e.g. activity, structure, efficiency).

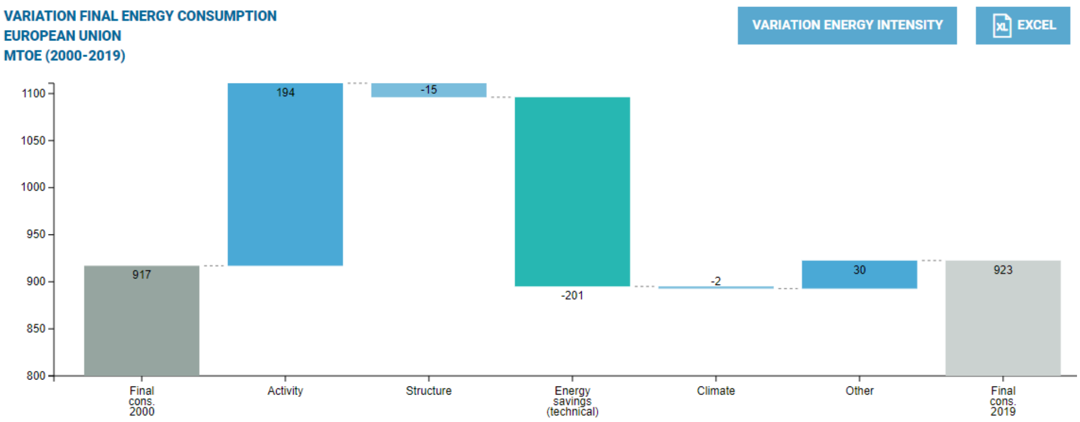
The results from a decomposition analysis can be used to show in graphs what share of the changes in energy consumption can be attributed to energy efficiency improvements or energy savings.

These graphs have been developed notably by the ODYSSEE-MURE project and the IEA, as illustrated below.

The first group of graphs are waterfall graphs or bar charts showing the decomposition of the change in final energy consumption between two years according to main types of factors influencing final energy consumption. Typical factors include activity (e.g. economic and population growth), structure (e.g. GDP shares of services and industry respectively), climate, and technical efficiency or savings (that captures energy efficiency improvements or savings).

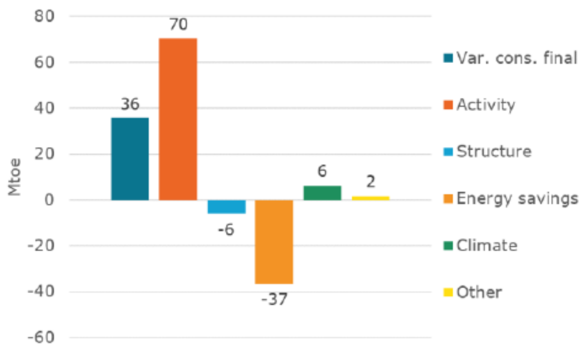


(source: IEA 2020 ; note: this figure is not included in the IEA's Key World Energy Statistics 2021, but a similar graph is included in IEA's Energy Efficiency Indicators Data Explorer)
Figure 1. IEA waterfall graph showing the decomposition of final energy consumption in IEA countries.



(source: [ODYSSEE Decomposition Tool]())

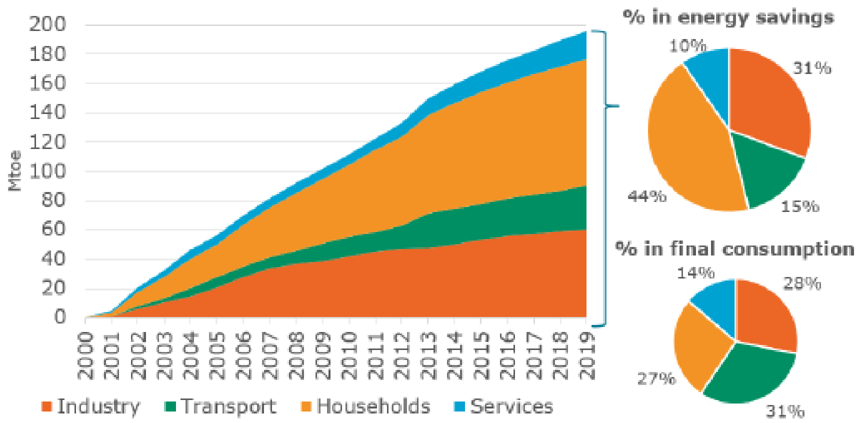
Figure 2. ODYSSEE waterfall graph showing the decomposition of final energy consumption in the EU27.



(source: Lapillonne et al. 2021)

Figure 3. ODYSSEE bar chart showing the drivers of final energy consumption variation at EU level between 2014 and 2019.

The second group of graphs shows with stacked-area charts how energy savings from energy efficiency improvements cumulate over time.

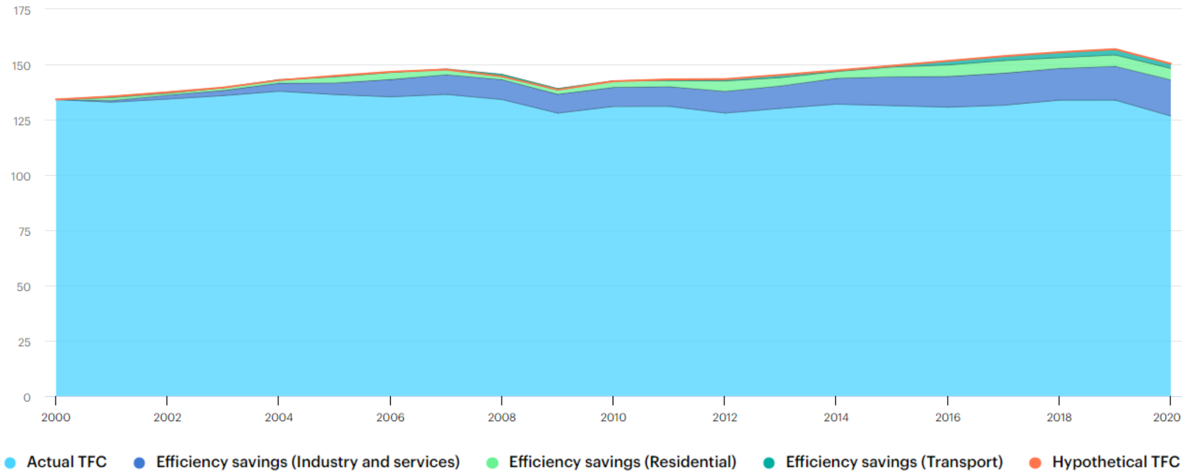


(source: Lapillonne et al. 2021)

Figure 4. ODYSSEE stacked area chart showing cumulative energy savings from energy efficiency improvements over 2000-2019 in the EU (in Mtoe), with shares of energy savings per sector compared to shares of final energy consumption per sector.

Lapillonne et al. clarify that the energy savings shown here in Figure 4 represent the sum of the additional annual energy savings by sector (year-to-year changes cumulated from 2000 to 2019) and was equivalent to 21% of final energy consumption in 2019: "*in other words, without these savings, the final energy consumption would have been 21% higher in 2019*".

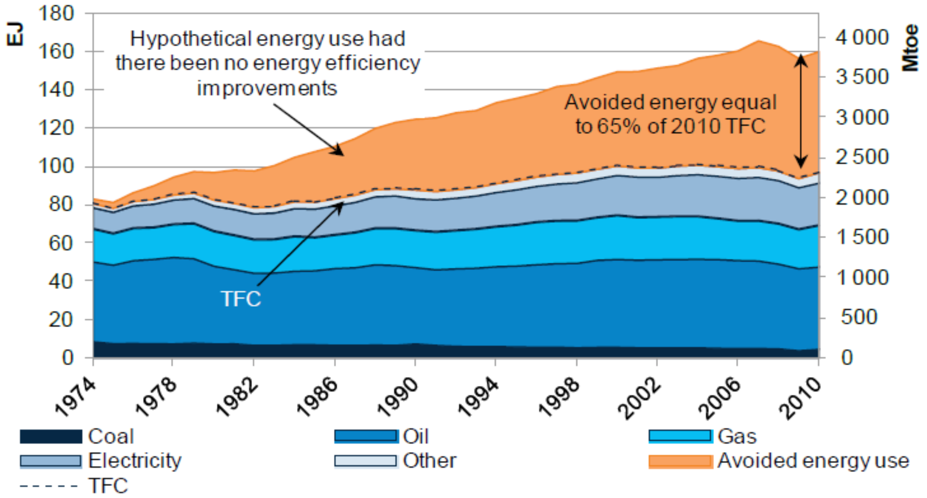
A similar approach, but with a different method (see discussions about top-down approach below), is also used by the IEA. Figure 5 below represents the energy savings on top of the final energy consumption, showing what the total final energy consumption would have been in the absence of energy savings from energy efficiency improvements ("efficiency savings").



(source: IEA's [Energy Efficiency Indicators Data Explorer]() ; TFC: Total Final energy Consumption)
Figure 5. IEA stacked-area chart showing estimated savings of final energy use in IEA countries, 2000-2020 (in EJ).

In both approaches (waterfall graphs or stacked-area charts), the contribution of energy efficiency is compared to the total final energy consumption shown as a block (or reminding its distribution per end-use sector). However, the energy efficiency contribution or energy savings are not put next to the contribution of the other energy sources forming the final energy mix.

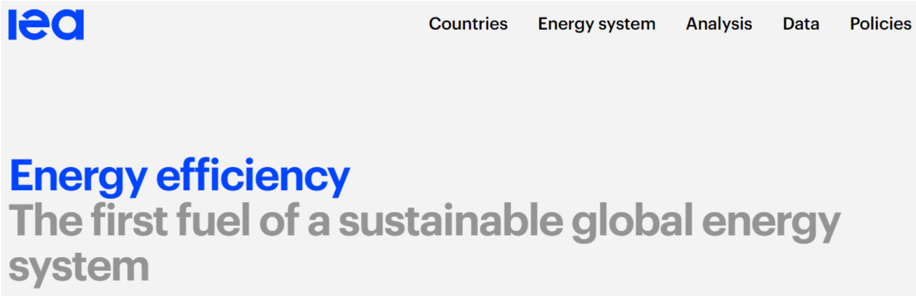
An option to show more explicitly the energy efficiency contribution compared to other energy carriers is to use the same type of graphs, but representing the final energy consumption with areas per energy source, as done in the first IEA's Energy Efficiency report (IEA 2013):



(source: IEA 2013; TFC: Total Final energy Consumption)
Figure 6. IEA stacked area chart showing avoided energy use from energy efficiency in 11 IEA member countries.

This graph supported the IEA communication about energy efficiency "from hidden to first fuel". It is not based on decomposition analysis, but on comparing a scenario with "frozen" efficiency with the actual final energy consumption. The scenario of "frozen" efficiency assumes that the energy intensity in each country would have remained the same as in the reference year (1974).

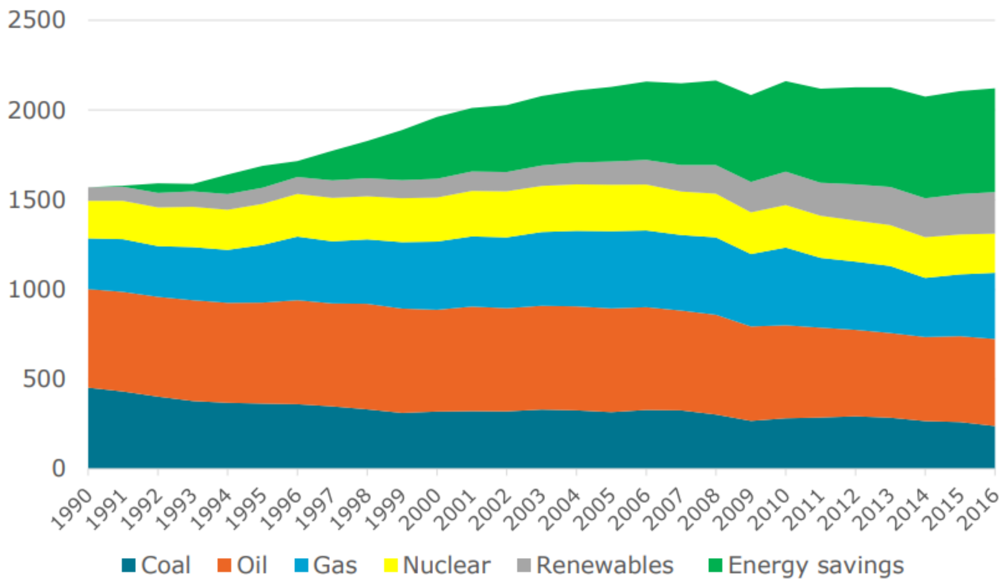
The main message from IEA's first Energy Efficiency report and the corresponding figure (shown above) had a major impact on the communication about energy efficiency. This can be seen for example in the way energy efficiency is still presented on the IEA website ten years later (see Figure 7 below).



Source: screenshot (September 2023) of https://www.iea.org/topics/energy-efficiency
Figure 7. How energy efficiency is introduced on the IEA website.

This also likely contributed to the emergence of the Energy Efficiency First principle in the political discussions.

A similar graph was prepared by the ODYSSEE-MURE project about the primary energy consumption in Europe, also resulting in highlighting energy efficiency as the first fuel.



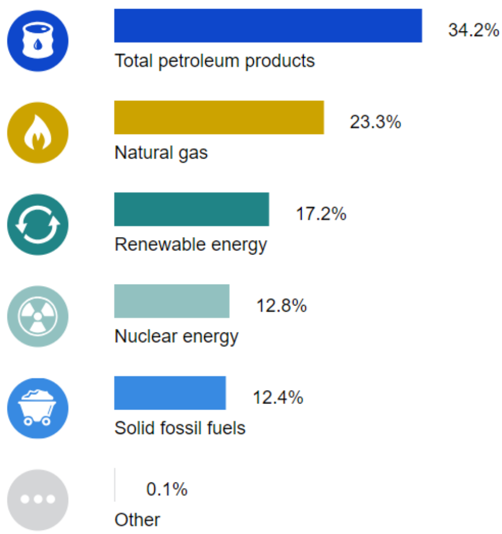
(source: Lapillonne and Sudries, 2019)
Figure 8. EU28 primary energy consumption by fuel and energy savings over 1990-2016ings (in Mtoe), including energy savings.

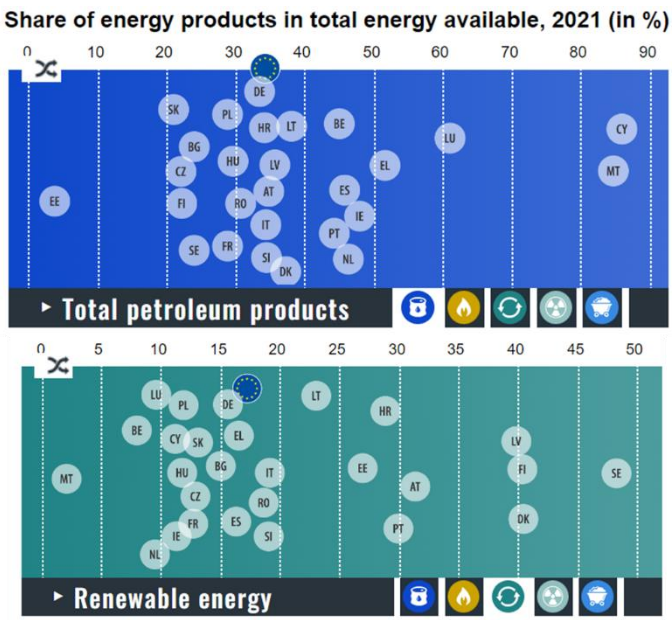
The way to publish, represent and visualize the data has evolved significantly in recent years.

Reports on energy balances were first published in the last 1970's / early 1980's, with mostly tables including values and a limited number of graphs. This was indeed the main way to share data, and providing values was more important (and easy to do) than facilitating their visualization. With the development of Information and Communication Technologies, the publications progressively included more graphs and less tables: visualizing the data became more important, as making the data available could be done separately (e.g. with datasets in standard format such as csv format), and various tools have made it easier to produce more types of graphs.

Nevertheless, until just a few years ago, the reports on energy statistics were still mainly including classical types of graphs (like stacked-area charts, basic pie charts, etc.). This has evolved recently, particularly in the last five years, with the growing development of infographics and using various ways to represent the data to make them more appealing for non-experts (see examples from Eurostat in Figure 9 below).

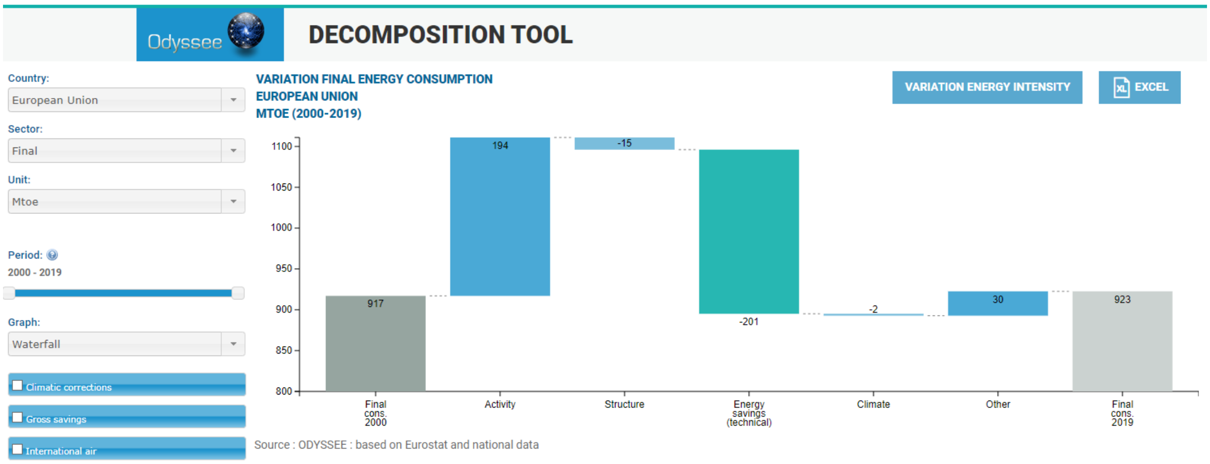
More sophisticated graphs like Sankey diagrams also became more common (see IEA's example in Figure 11 below).





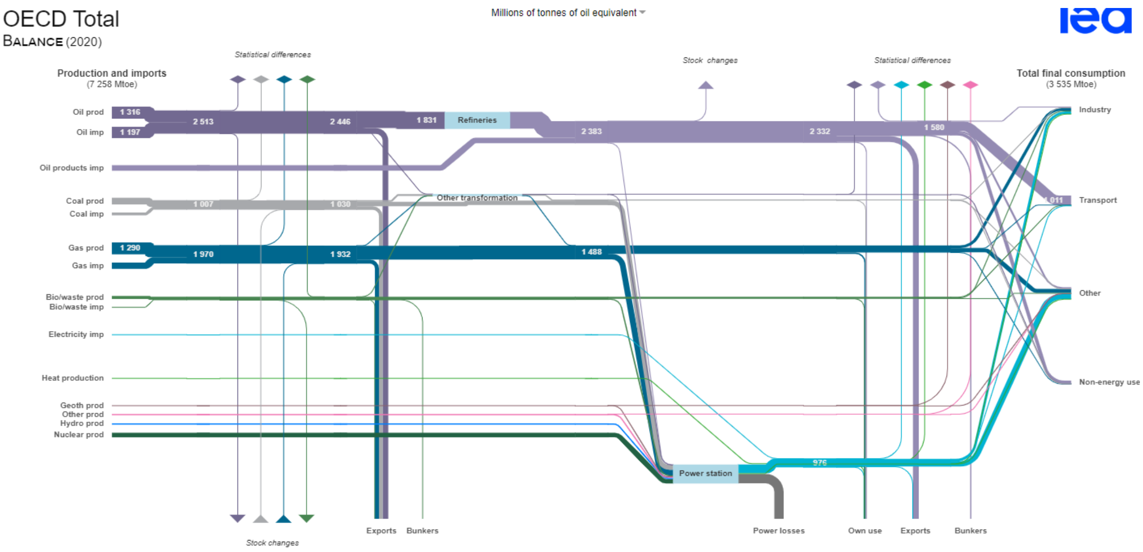
Source: Eurostat's Shedding light on energy in the EU (2023 interactive publication)
Figure 9. EU's energy mix (left) and Member States' share of energy products in total energy available (right), all for year 2021.

Another major change in the way to present and make the data available is that publications are now primarily meant for online versions. These are no longer simple webpages with texts and static graphs or downloadable versions of the reports (e.g. pdf). The more recent online publications include dynamic ways of presenting the data, where users can select indicators, time periods, sectors, etc. See for example below screenshots of the ODYSSEE tools, the interactive IEA Sankey diagrams or the new Eurostat portal on energy data.



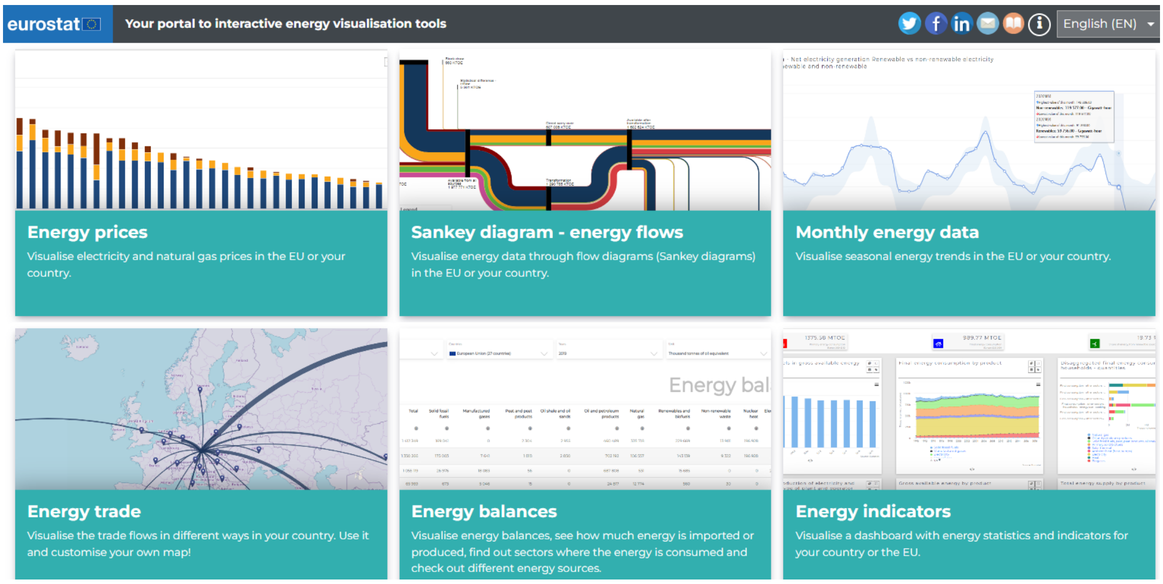
Source: https://www.indicators.odyssee-mure.eu/decomposition.html

Figure 10. ODYSSEE Decomposition tool.



Source: https://www.iea.org/data-and-statistics/data-tools/energy-sankey

Figure 11. Example of Sankey diagram showing the energy balance of the OECD countries.



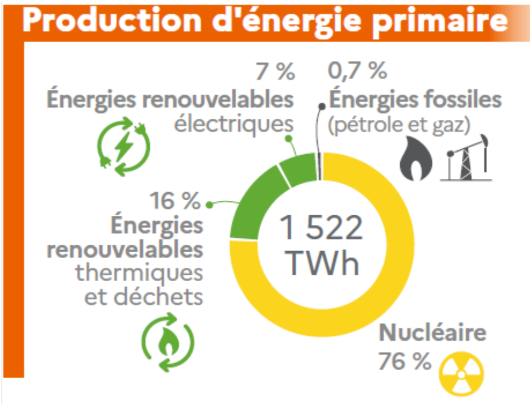
Source: https://ec.europa.eu/eurostat/cache/infographs/energy_portal/enviz.html?language=EN

Figure 12. Eurostat's portal to interactive energy visualisation tools.

International standards or methodologies on energy statistics do not impede public authorities to select the data to highlight and the way to display them.

Energy statistics are mostly produced according to the international methodology agreed upon in the International Recommendations for Energy Statistics of the United Nations Statistical Commission (UN 2018). For EU Member States, this is transcribed in the Eurostat methodology for energy balances. These methodologies ensure harmonized datasets allowing cross-country comparisons.

However, the different institutions publishing energy statistics and balances can make their own choices in the way they present the data, not only about the type of chart used, but also the type of indicators and the figures they want to highlight. This can be seen for example in the way France's main infographics on energy highlight the role of nuclear in the energy mix.



France's energy balance published by France's Ministry of Energy Transition, highlights in its summary a rate of energy independence of about 55% in 2021. When considering that the primary energy would be the nuclear fuel (imported in the case of France), then France's rate of energy independence would be about 13% in 2021. This important methodological choice is explained in the report of the energy balance.

Source: [France's energy balance in 2021]() (Ministry of Energy Transition)
Figure 13. France's primary energy production per energy source in 2021.

While using the same datasets, the methodological choices and way to display data might thus change very significantly the main messages conveyed.

Therefore, the main barrier is not the limitation about what could be presented / published, but rather what data can be used.

One restriction that statistical offices or units in charge of the energy balance may have is that their methodology usually requires to use '**official data**' only, i.e. data approved by the national statistical office(s) and complying with the statistical standards.

This may explain why the main publications on energy statistics, which are under this restriction, can only include aggregated figures on energy intensities. As the production of more disaggregated energy efficiency indicators may imply the use of complementary data sources, not necessarily validated by the national statistical office (see also discussions from the expert workshop below).

This is also why publications dedicated to energy efficiency, that would not fall under the restriction to 'official data', can more easily include more detailed data on energy efficiency. Likewise, the use of decomposition analysis usually requires disaggregated data, and thereby the use of complementary data sources.

The development of data collection with harmonized guidelines, the experience available from projects such as ODYSSEE-MURE (Bosseboeuf et al. 1997 and 2015) and initiatives such as the ones led by the IEA and ADEME to increase countries' capacities about energy efficiency statistics[2], provide the ground for these complementary data sources to become progressively 'official data'. Moreover, meeting energy transition's challenges implies getting more detailed data about the demand-side of energy, which supports this trend.

Another data issue pointed out in the discussions at the expert workshop is the **time lag** in the availability of energy efficiency data (data for year n-2 available by the end of year n) compared to energy data (data for year n-1 available by the end of year n). Energy savings data from the monitoring of energy efficiency policies (bottom-up approach) could then be an alternative, as they can be available with short delays and could be consolidated within the 1-year delay used for energy data. This is for example the case for energy savings from Energy Efficiency Obligation Schemes in Europe, or utility energy efficiency programmes in the US (see below). However, these data are not comprehensive: they do not cover all energy efficiency improvements, just the ones from actions supported by the schemes or programmes.

Representing the energy efficiency contribution to the energy mix from a bottom-up approach has only been found in US publications (or in forward-looking scenarios).

The bottom-up approach aggregates energy savings data from the monitoring of energy efficiency policies and programmes to obtain their overall result for a given area (e.g. country).

ACEEE (American Council for an Energy Efficient Economy) quantified the size of the energy efficiency resource in the electric power sector at Federal level (for the US), using a bottom-up approach. Molina et al. 2016 compiled electricity savings from 1990 to 2015 by examining documented sources available on energy efficiency policies and programmes implemented in the US. They used mainly three sources:

- the ACEEE's State Energy Efficiency Scorecards, that gather electricity savings data at state-level from utility energy efficiency programmes;
- state-level estimates of energy savings from appliance efficiency standards from the Appliance Standards Awareness Project (based on Lowenberger et al. 2012);
- state-level estimates of energy savings from building energy codes from the Pacific Northwest National Laboratory (PNNL) (Livingston et al. 2014).

The starting year of the data compilation is 1990, as the ACEEE experts estimated that available energy savings datasets started to be consistent around that time[3]. The state-level estimates collected from the three sources mentioned above were summed to obtain the national total. Finally, a factor was applied to take into account the avoided electricity losses in transmission and distribution[4], so that the result can be compared with amounts of generated electricity.

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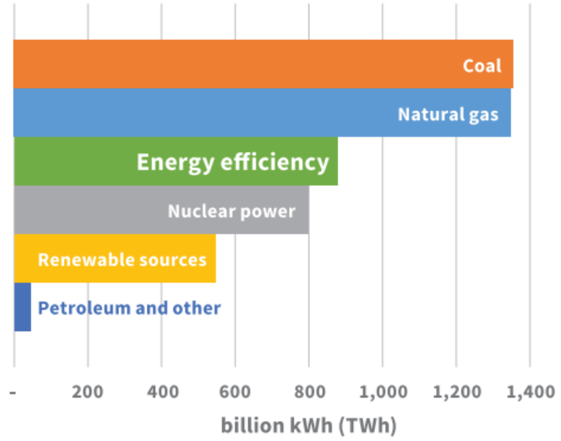
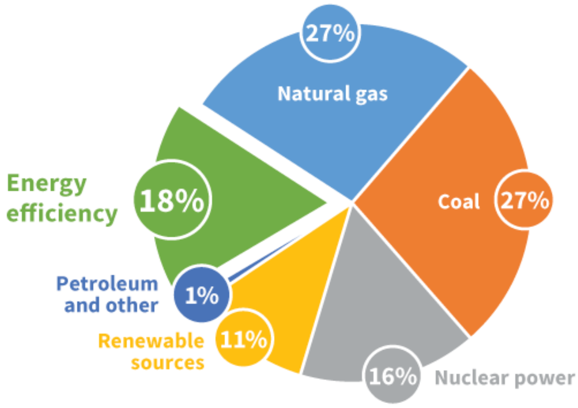
[2] See for example the G20 end use data and energy efficiency metrics initiative: https://www.iea.org/events/4th-g20-energy-end-use-data-and-energy-efficiency-metrics-initiative-workshop

[3] Some states and regions (e.g. California and the Northwest states) have data back to the 1970s.

[4] Factor of 6.2%, based on the national average rate for transmission and distribution losses estimated by the US EPA (Environmental Protection Agency).

The result of this compilation was integrated in the graphs below showing that based on these estimates, energy efficiency in 2015 was the third source of electricity generation in the US.



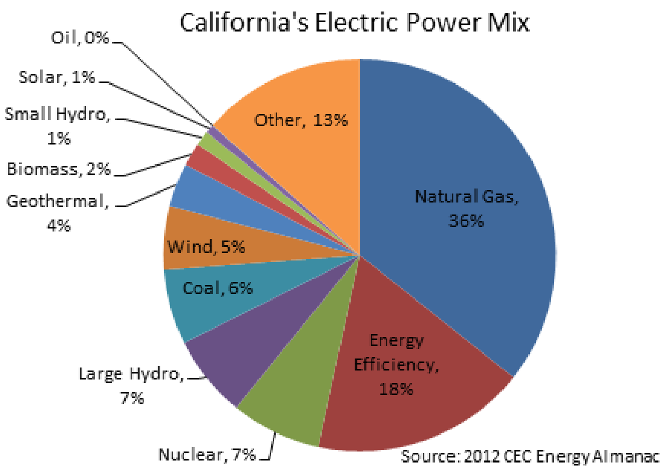


Source: Molina et al. 2016 (figures 5 (left) and 6 (right)), based on US EIA – Energy Information Administration (data of supply-side energy resources) and ACEEE – American Council for an Energy Efficient Economy (data of energy efficiency).

Figure 14. US electricity generation and savings from energy efficiency (left), and share of US electricity generation by resource (right), both for year 2015.

The ACEEE experts acknowledged that the assumptions used in their assessment have limitations and uncertainty. Meanwhile, their estimates of energy savings include the effects of policies and programmes only. They do not capture all energy efficiency improvements.

A similar graph was prepared by Lara Ettenson (NRDC – Natural Resources Defence Council), about California's electricity mix for the year 2012.



Source: https://www.nrdc.org/bio/lara-ettenson/californias-efficiency-good-news-story-part-ii-state-policymakers-support

Figure 15. share of California's electricity generation by resource (including energy efficiency) in 2012.

This graph was built from data published by the California Energy Commission (CEC) in its 2012 Energy Almanac. It includes the electricity generated by supply-side resources, as well as energy savings from utility energy efficiency programmes, and energy efficiency standards for buildings and appliances (similar approach as used by ACEEE for the graph about the whole US, and similar share of energy efficiency in the electricity mix, about 18%).

In both cases, it should be noted that these graphs have been published by NGOs (ACEEE and NRDC), and not by official institutions (that could be EIA for the whole US, or CEC about California). No similar example could be found in Europe. See also the section about bottom-up approach in the next part.

APPROACHES AND EXAMPLES TO MAKE ENERGY EFFICIENCY VISIBLE

The selection of the approach to assess energy efficiency improvements or energy savings mostly depends on what is to be assessed and shown:

- **Top-down methods** are more commonly used to assess the **total energy efficiency improvements or energy savings**. They are for example used to analyse the trends in energy consumption in the context of previously Article 3 now Article 4 of the Energy Efficiency Directive.
- **Bottom-up methods** are more commonly used to assess **energy savings from policy measures**. They are for example used to report energy savings to previously Article 7 now Article 8 of the Energy Efficiency Directive.

Top-down approach

The top-down approach starts from the bigger picture and then zooms in on the details. Top-down methods differ depending on their intended use or purpose, which can vary from macroeconomic issues to energy savings of a specific region and differ based on the timeline considered (Jacobsen, 1998).

From energy intensities to decomposition analysis

When the purpose is to assess energy savings, top-down methods use energy efficiency proxies or indicators. Proxies are most often related to **energy intensity** (energy consumption per unit of GDP). **Energy efficiency indicators** can be divided in three categories: specific energy consumption indicators describing one defined object (e.g., energy consumption of vehicle in J/km); sub-sector unit energy consumption indicators (e.g., electricity/employee in offices); and indicators describing the diffusion of energy-saving techniques (e.g., m^2 of solar energy collectors) (Thomas et al., 2012). With top-down methods, energy savings are calculated based on a reference year and compared to another given year.

Traditionally, **energy intensity** has been used as an overall proxy to illustrate energy savings and energy efficiency improvements. Primary energy intensity (total primary energy supply needed to produce one unit of GDP) can be used to monitor efficiency in converting primary energy supply into energy used by all final consumers. Final energy intensity (total final energy consumption to produce one unit of GDP) can be used to monitor end-use efficiency, i.e. in the way energy is used in the end-use sectors. The reason energy intensity has been vastly used, including in energy statistics, is because it is based on data commonly available (total energy supply/consumption and GDP) and its easiness of comparison. However, it presents shortcomings, namely, to separate energy efficiency improvements from other factors influencing energy consumption, such as structural effects (e.g. in case of larger share of services and smaller share of industry in the GDP). Moreover, when used to compare countries, energy intensities may be influenced by differences in sizes, national climates, social conditions, etc. (IEA, 2013).

To understand more accurately the changes in final energy consumption, the different explanatory factors need to be deconstructed, one of which being energy savings. These are often divided between activity, structure and efficiency improvements or energy savings (ISO 50049:2020). The growth in energy consumption is driven by activity effects (e.g. economic and population growths) but also by structural effects (see above). The more disaggregated the data used, the more the analysis can separate energy efficiency improvements from other factors. **Decomposition analysis** allows us to understand how changes in structural factors and energy efficiency affect the overall energy intensity, by analysing disaggregated data at (sub-)sectoral level or per energy-end use. Each sector is broken down into different components, which are at a later stage combined to achieve the final general picture.

One of such methods is the **Logarithmic Mean Divisia Index (LMDI) method**, which "involves factoring energy (or emissions), with energy intensity as one of the factors" (Torrie et al., 2018), and is used for example by the IEA. The sector intensities are thereafter further decomposed applying the same method, and at a later stage compared, summed, and integrated within the first order decomposition analysis. Every sector is decomposed following a different formula considering both the data availability and the sector characteristics. Each sector has different levels of energy efficiency and intra-sector structural factors which, depending on the area being analysed (e.g. country), influence the final energy intensity in different ways.

The ODYSSEE-MURE project uses another method, considering four different effects to disentangle variations in final energy consumption: the activity effects (e.g. change in industrial activity), the structural effects (e.g. changes in structure of each industrial branch), the energy savings, and other effects (e.g. industrial inefficiency not caused by energy efficiency policies). In this method, the energy savings are obtained from ODEX, which is "an indicator that measures the energy efficiency progress by main sector […] and for the whole economy" (ODYSSEE-MURE, 2020a). This **energy efficiency index** is calculated for every sector as a weighted average of sub-sectoral indices of energy efficiency progress, which are calculated from the changes in unit energy consumption indicators measured in physical units, allowing thus to choose for the best proxy and for comparisons among physical units (e.g., kWh/appliance, koe/m^2 etc.). The coefficient used to measure the weighted aggregate is the share of each sub-sector in the final energy consumption of every sector. The ODEX can be defined as the ratio between the energy consumption in a reference year and the consumption in a later given year without any energy savings having incurred. The ODEX can also be imagined as the "Dow Jones" of energy efficiency: similar as the Dow Jones Index presents a weighted sample of the shares of important individual companies, the ODEX presents a weighted average of individual energy efficiency indices.

Advantages and limitations of the different methods

Decomposition analysis, whatever the methods used, calculates the expected impact that would happen in a given year if energy efficiency would have remained at the same rate as in the base year. Decomposition analysis has two main drawbacks:

(1) **It requires disaggregated data**: data availability (or quality) can be an issue for some sub-sectors or countries, and more generally, part of the disaggregated data needed in the decomposition analysis are not yet official data as recognised by statistical offices.
(2) Results are available with a **2-year delay on average**: this can be an issue in case of sudden significant changes, when decision-making would need faster feedback.

Short-term projections may help to overcome this second drawback. These short-term projections can be based on data available with a shorter updating frequency (e.g. industrial production indices etc). Attempts to solve this are on-going, and could provide data with shorter time lag, similarly to the provisional estimates of total energy consumption.

Decomposition analysis provides a **detailed and segmented view of which factors affect which sectors of the economy**. This segmentation enables us to understand energy efficiency trends in the various end-use (sub-)sectors.

The main methods used for decomposition analysis are described in the standard ISO 50049:2020, mostly the **Divisia methods** (LMDI, LDMI II, and AMDI) and methods based on **energy efficiency indices**. About Divisia methods, LMDI is the most commonly used. The IEA uses a slightly modified version of the LMDI. The ODYSSEE-MURE project uses a methodology based on energy efficiency indices. Different methods of decomposition may give different results. Furthermore, energy savings can be displayed as to show: the additional annual energy savings (i.e., year to year); the savings in reference to a base year (e.g., 2020 vs. 2013); and cumulated over a period of time (e.g., from 2014 to 2020). One can compare the results obtained with different methods and analyse their differences to get a more in-depth understanding of the reasons for changes in energy consumption, including energy savings.

Each method has its own pros and cons. When comparing LMDI with the ODYSSEE-MURE methodology, the main differences are:

(1) ODYSSEE-MURE presents specific formulas by sector rather than a general one;
(2) ODYSSEE-MURE formulas are easier to understand for non-experts compared to LMDI;
(3) ODYSSEE-MURE results include a residual term[5]; and
(4) ODYSSEE-MURE's energy savings are derived from the ODEX indicator, as opposed to the LMDI where these are derived from an energy intensity effect.

The main advantages of the ODYSSEE-MURE methodology compared to LMDI are that it is easier to communicate to non-experts, easier to adapt, and provides very similar results to LMDI. The disadvantages include the presence of the residual term and the fact of having specific formulas for each sector, thus making it harder to generalise (ODYSSEE-MURE, 2017).

When looking more specifically at European countries, ODYSSEE-MURE is the most detailed database of energy efficiency indicators, with the longest time series, covering the 27 EU Member States and more (e.g. UK, Norway, Switzerland), as well as recently the nine Energy Community Parties (mostly Balkan, as well as Georgia, Ukraine and Moldova). Moreover, ODYSSEE-MURE developed online facilities[6] making energy savings data easily available, where users can select base and target years, as well as countries. This is why we used these facilities to illustrate below

[5] This residual term corresponds to the other effects not captured in activity, structure and energy efficiency improvements. These other effects often correspond to 'negative energy savings'. For example, in case of economic recession, energy efficiency in industry and freight transport may decrease because part of the energy consumption does not depend on the level of production (e.g. loading of trucks cannot be well optimized; industrial furnaces need to be maintained at high temperature despite lower production). Residuals may also include behavioural effects (ISO 50049:2020).

[6] See in particular, the Decomposition Tool and Energy Savings Tool.

how energy savings data from top-down methods can be used to integrate energy efficiency (or energy savings) in typical figures used to represent the energy mix.

Integrating energy efficiency in the energy mix from top-down results

From the review of current practices about representing the energy mix, we selected two visualisation options where energy efficiency (from energy savings data) can be integrated: pie charts and stacked-area charts. Both options are illustrated with graphs for EU27 and the five EU countries with the largest energy consumption (Germany, France, Italy, Poland, Spain).

Option 1: pie charts showing the final energy mix in a given year, without and with energy savings

Why this option?

This is a common representation of the energy mix. It provides the picture of the shares per energy carrier at a given point in time. It makes it easy to visualize the main energy carriers. Including an 'energy efficiency' or 'energy savings' share in this type of pie chart would help materialize the concept of energy efficiency as a resource.

Explanations about the graphs

Data about 'supply' energy carriers (oil, gas, etc.) come from Eurostat complete energy balances, to have EU27 and consistent data among the five countries.

Data about energy savings come from the ODYSSEE Energy Saving Tool. In this tool, energy savings correspond to energy efficiency improvements monitored at the level of 30 sub-sectors or end-uses. Energy efficiency indicators provide unitary energy consumption (e.g. kWh/m^2.year for buildings). Energy savings are then calculated by comparing the values of unitary energy consumption each year compared to the previous one. These annual new savings can be cumulated over a period, as shown in Figure 4 (p.16).

We used the latest data available from the ODYSSEE Energy Saving Tool at the time of the report, i.e. until year 2021 included.

To represent the contribution of energy efficiency in the year 2021, we chose to include energy savings cumulating year-to-year energy efficiency improvements since 2007. This choice is related to the source used for the energy savings data: the ODYSSEE Energy Saving Tool provides energy savings data from 2008 (comparing unitary energy consumption with 2007, then cumulating year-to-year savings), year of the entry into force of the Energy Services Directive, predecessor of the Energy Efficiency Directive.

Then we suggest using **two graphs for each area analysed**:

- The graph on the left shows the **usual final energy mix**, as commonly used in current main publications on energy statistics. It includes the 'supply' energy carriers, with shares from the actual final energy consumption in 2021. It does not show the contribution from energy efficiency.
- The graph on the right shows the **enhanced final energy mix**, integrating the energy efficiency contribution. The shares for each energy carrier (including energy savings) are

calculated from the final energy that would have been consumed in 2021 in the absence of the energy efficiency improvements since 2007.

Putting these two graphs next to each other makes it possible (1) to show the difference between the two representations, and (2) to include the data of actual final energy consumption (Actual FEC) and the data of what the final energy consumption would have been in the absence of energy efficiency improvements compared to the reference year (FEC "without EE"). These values are included in the centre of each pie chart respectively.

"Energy Savings 2008-2021" corresponds to the energy savings in year 2021 from energy efficiency improvements since 2007.

EU 27

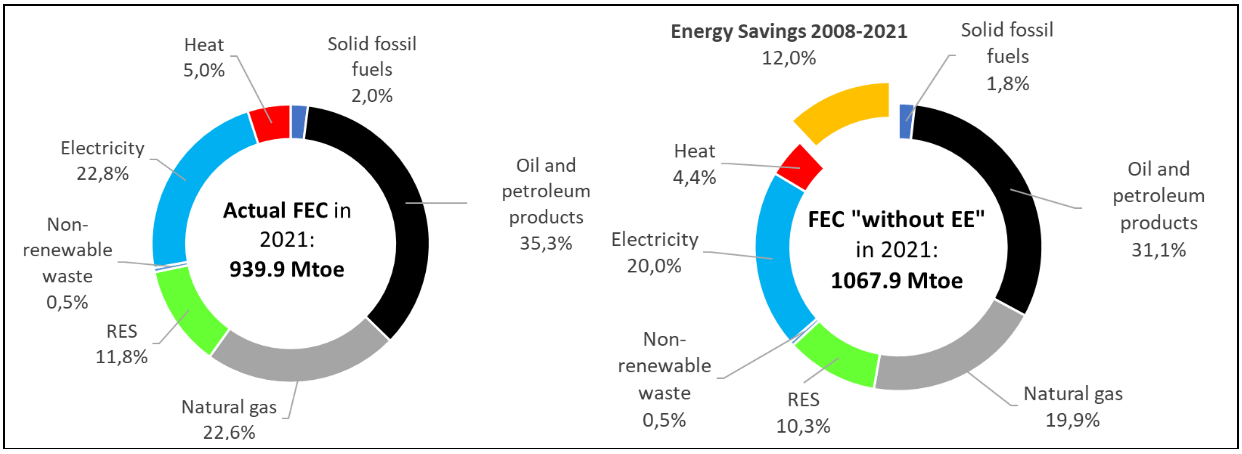


Figure 16. Pie charts without and with the energy efficiency contribution in the energy mix for year 2021, for EU27.

Figure 16 provides the pie charts for the EU27. The figures about France, Germany, Italy, Poland and Spain are included in the annex.

While the option of these pie charts could easily be used in a separate chapter on energy efficiency, or in a report dedicated to energy efficiency, it would be more challenging to use in the main figures of the energy mix, due to the time lag in the availability of energy efficiency data compared to the other energy data.

As discussed at the expert workshop (see summary below), energy efficiency data are available about one year later than the other energy data (when considering data about the same year). From a communication viewpoint, it could then be confusing, or too long, to include a series of pie charts with different years.

Option 2: stacked-areas charts showing the final energy mix over a given period

Why this option?

This is also a common representation of the energy mix. It provides the 'movie' about how the total final energy consumption and shares per energy carrier have evolved over a given period. It makes it easy to visualize the main trends.

A major advantage of the stacked-area chart is that it shows clearly that energy savings cumulate over time. Which is a major difference compared to the other energy sources that need to be renewed constantly.

Explanations about the graphs

Data come from the same sources as for the pie charts: [Eurostat complete energy balances] and [ODYSSEE Energy Saving Tool] (see details above).

For the same reason as for the pie charts, the latest year included in the stacked-areas charts is 2021, and the starting year is 2008.

The stacked area "energy savings" corresponds to the energy savings in a given year from energy efficiency improvements since 2007.

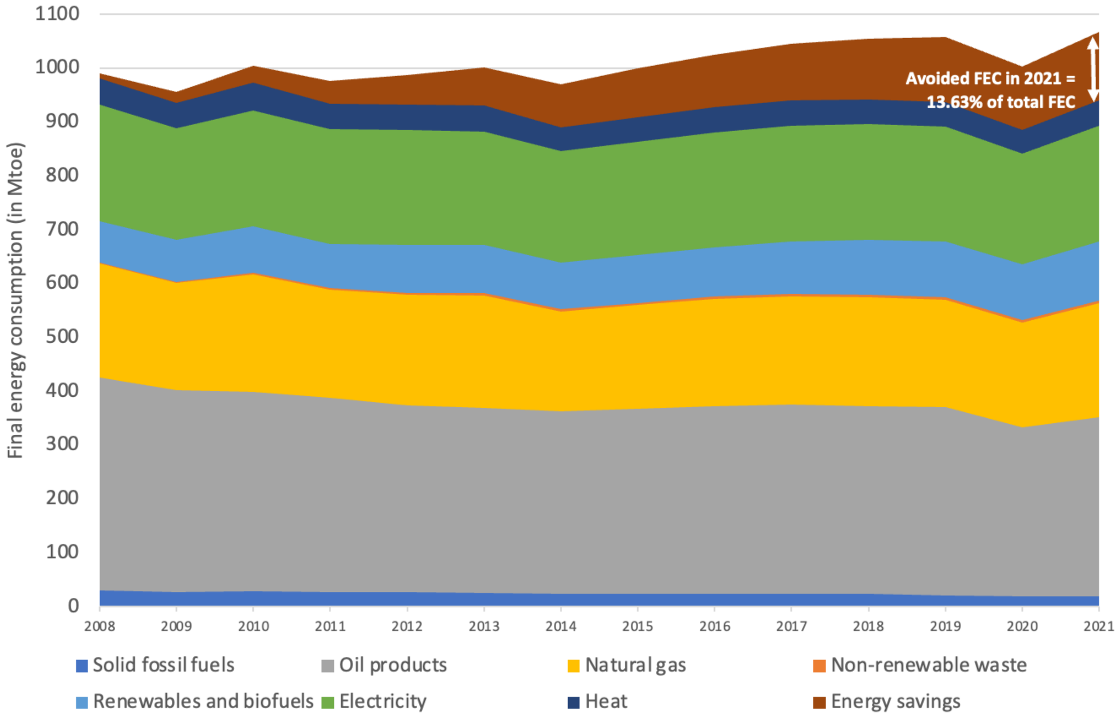


Figure 17. Final energy consumption (in Mtoe) in EU27 over 2008-2021, including energy savings (last area on top).

Figure 17 provides the stacked-area chart for the EU27. The figures about France, Germany, Italy, Poland and Spain are included in the annex.

One advantage of the stacked-area chart compared to the pie chart is that it could more easily be used in the main figures about the energy mix. Indeed, the stacked-area chart shows an evolution over the years. The issue of time lag mentioned above for the pie chart would remain: the latest year available for energy efficiency data will still be one year older than for the other energy data. But this could be overcome by extrapolating the energy efficiency data for one more year[7]. All data but one would then be actual observations, while the remaining data (energy savings in the last year) would be an estimate.

[7] ODYSSEE for example developed a methodology for early estimates of energy efficiency in year n-1, see: https://www.odyssee-mure.eu/publications/other/early-estimates-methodology.html

To make it clear and transparent the stacked area for energy savings in the last year could be devised/designed (or differentiated in another way), with a note in the caption of the figure, as illustrated below (where it is assumed that energy savings data for 2021 would have been extrapolated).

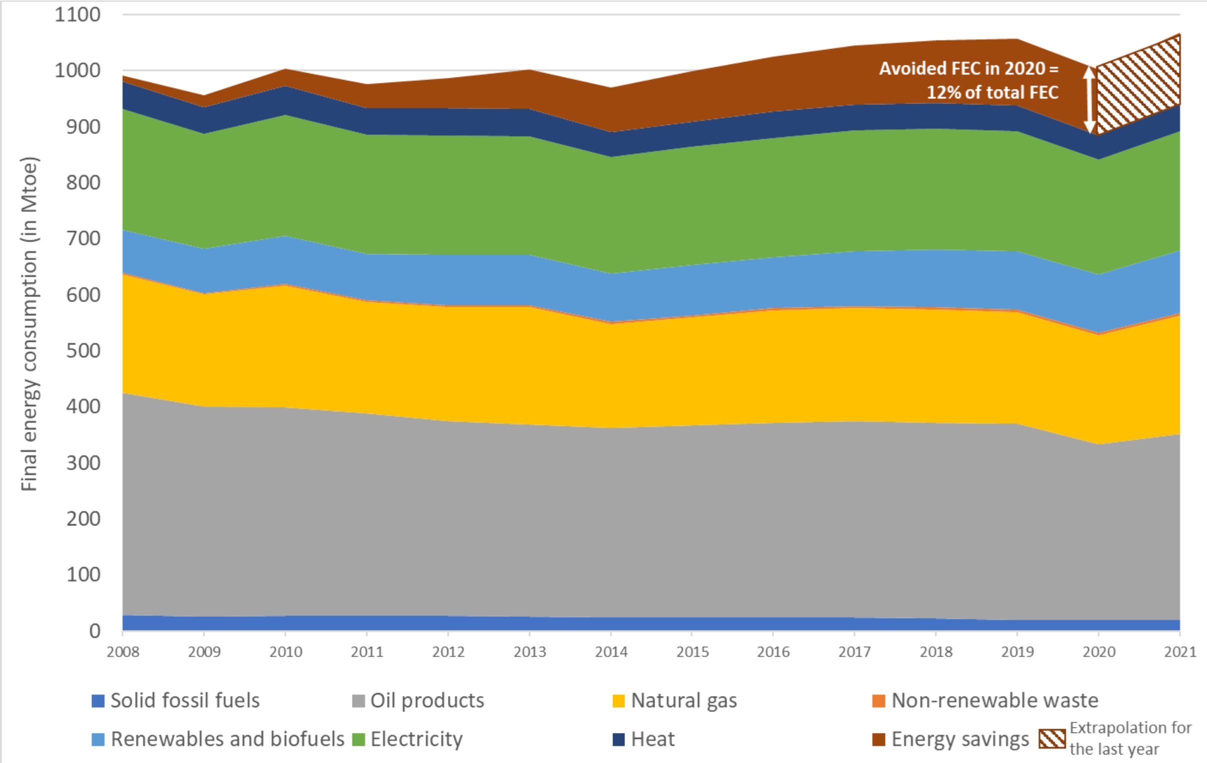


Figure 18. Adapted stacked-area chart, including extrapolation about energy savings in the last year, to match with the timing of data of the other energy data.

Option 3: stacked-bar chart for cross-country comparison

Why this option?

This is a common type of chart used to enable cross-country comparisons, as done for example in the energy statistics' overviews of Eurostat. The stacked-bar chart provides the same information as the pie charts shown in option 1 above (shares in a given year), however it can include more easily all countries at once. The drawback compared to the pie chart is that the values of the shares are usually not included in the graph, as otherwise this would make the graph more difficult to read.

Explanations about the graphs

Data comes from the same sources as for the pie charts: Eurostat complete energy balances and ODYSSEE Energy Saving Tool (see details above).

For the same reason as for the pie charts, the shares are for year 2021, and the contribution of energy efficiency in year 2021 corresponds to 'energy savings 2008-2021', i.e. calculated from cumulating year-to-year energy efficiency improvements since 2007.

The graph below includes data for EU27, France, Germany, Italy, Poland and Spain, in line with the scope of this study. The data used from Eurostat and ODYSSEE are available for all Member States. Therefore, this graph could be extended to include all EU countries.

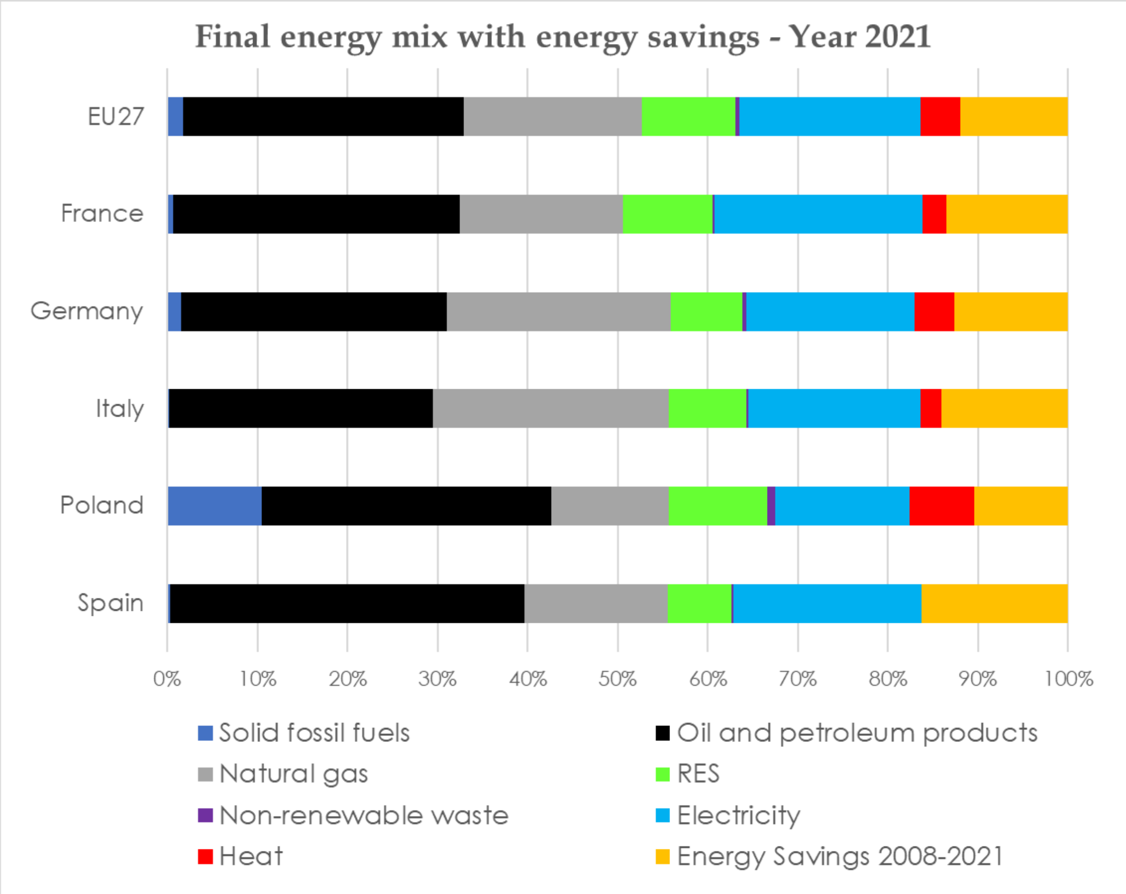


Figure 19. Stacked-bar chart showing the final energy mix including energy savings, for EU27, France, Germany, Italy, Poland and Spain.

Methodological discussions

Integrating the energy efficiency contribution in the main figures about the final energy mix would require agreeing on key methodological choices:

- ✓ **What method** to use for the decomposition analysis: LMDI (like done by the IEA or JRC) or energy efficiency indices (like done by ODYSSEE-MURE)?
- ✓ **What base year or period** to select for assessing the energy efficiency improvements: a fix base year (considering data availability or starting year of key policy framework) or a sliding period (considering average lifetime of energy efficiency actions)? (and also comparing the base year with the final year, or cumulating year-to-year changes from the base year to the final year?)
- ✓ **What disaggregation level** and **what indicators or indices** to select for each (sub-)sector?

It should be noted that energy statistics currently used in the national energy balances are produced according to the International Recommendations for Energy Statistics of the United Nations Statistical Commission (UN 2018) agreed upon by the members of the United Nations Statistical Commission. These recommendations include many methodological choices. For example, how to count renewable energy sources (RES), ambient heat used by heat pumps, heat and electricity produced from nuclear energy, etc.

Similarly, there is no single definition for primary energy consumption or final energy consumption. These definitions also result from agreements. For example, the definition of final energy consumption has been slightly revised in this year's recast of the Energy Efficiency Directive.

Therefore, the need to agree on methodological choices and definitions is not a technical issue. This is a political issue, common to any production of official data.

Bottom-up approach

The bottom-up approach starts from calculating energy savings at the level of one end-user or group of end-users. The summation of energy savings from all participants then gives the result for a given policy measure or policy package. Finally, the aggregation of the results from all policy measures or packages gives the total result for a country or area (e.g. EU27).

Bottom-up methods are therefore primarily used to assess energy savings related to the implementation of policy measures.

The bottom-up approach could also be used to assess energy savings from all energy efficiency improvements (whether related to a policy measure or not), by modelling the whole stock of buildings, equipment, vehicles, etc. This modelling can use surveys, market data and other data sources to assess the changes in the stock (e.g. due to renewal of equipment) and the resulting energy savings (Thomas et al. 2007). This approach has however, rarely been used by countries to report energy savings. It is more frequently used to prepare forward-looking scenarios.

Diversity of methods

There are various typologies of bottom-up methods (see e.g. Thomas et al. 2007). The Energy Efficiency Directive (EED) specifies four main types of methods in its Annex V applicable to Member States' energy savings obligation (formerly Article 7 now Article 8 of the EED):

- **deemed savings**: average energy savings ratios applied to standardised types of energy efficiency actions, possibly differentiating the ratios according to a few parameters (e.g. climate zone, type of building);
- **metered savings**: energy savings calculated from metered data of energy consumption, correcting for other factors influencing changes in energy consumption (e.g. occupancy, production level, weather);
- **scaled savings**: energy savings calculated with engineering formulas or models, using data specific to the energy efficiency actions evaluated (e.g. using energy audits);
- **surveyed savings**, where consumers' response to advice, information campaigns, labelling or certification schemes or smart metering is determined. This approach may be

used only for savings resulting from changes in consumer behaviour. It shall not be used for savings resulting from the installation of physical measures.

Annex V EED also specifies key methodological aspects to ensure consistency in the energy savings data reported by Member States for their energy savings obligation. This is complemented by the European Commission's Recommendation (EC 2019) that provides guidelines, for example about how to take into account additionality.

The methods are most often selected considering the practical conditions of the assessment (e.g. data availability, number and size of actions or projects to be monitored, time and cost constraints). For example, deemed savings can be relevant when assessing a large number of small to medium-size actions that can be specified in a standardised way. Scaled savings can be used when some data specific to the actions can easily be collected or have to be collected anyway (e.g. when an energy audit or Energy Performance Certificate is required). Metered savings can be relevant for large projects, where sub-metering of energy consumption is already in place or is anyway cost-effective for implementing the project.

Similar to the top-down approach, agreements and clear specifications about the methodological choices can ensure consistency in the results from different methods and help to interpret their differences. Differences between energy savings calculated from engineering estimates and from measurements have for example been discussed in the EPATEE project (see Sipma et al. 2019).

When the same methodological principles are used (e.g. to define the baseline), energy savings from different methods can be consistent and comparable and can be aggregated. Hence the need for a common methodology or framework, as specified in the Annex V of the EED or in the guidebooks defined by the Public Utility Commissions in the US[8].

Challenges to aggregate results

Bottom-up methods are often meant to monitor and evaluate results of policy measures. These results can then be aggregated to assess the overall energy savings at national level or for other scope (e.g. EU27). This aggregation raises several major challenges:

- Ensuring that all energy savings have been calculated according to the same **methodological guidelines**, and especially for the baseline against which the energy savings are calculated. This is essential to ensure **data consistency**. This is for example the aim of the guidelines defined by the European Commission for the energy savings obligation set to Member States in the EED, or in the rules specified by public authorities in charge of Energy Efficiency Obligation Schemes (EEOS) where energy savings are reported by various obligated parties.
- Avoiding or correct for **double counting**: there may be overlaps between policy measures. The same energy savings could then be counted several times when aggregating the results from these policy measures. Clear rules should then be used to avoid or correct for such double counting. A common practice to control for double

[8] About the US experience, see also the US Department of Energy's Uniform Methods Project: https://www.energy.gov/eere/uniform-methods-project-determining-energy-efficiency-savings-specific-measures

counting is to use centralised databases where every energy efficiency project is registered with an identifier (e.g. number of the electric meter) enabling to identify when the same project has been reported by several policy measures.

- **Being exhaustive** in the aggregation: assessing energy savings at national level (or at EU level) would require assessing energy savings from all policy measures, including EU policies, national policies and programmes, and regional and local programmes. The EED triggered major progress in the monitoring of energy savings from Member States' energy efficiency policies. However, the energy savings reported to Article 7 EED are not exhaustive. They do not include energy savings from EU policies excluded from the scope of Article 7 EED due to the additionality principle (e.g. energy savings from the EcoDesign regulations). Moreover, they do not necessarily include results from all the energy efficiency policies implemented by the Member States. For example, because some Member States can prove the achievement of their energy savings target by reporting their main policy measures only, or because energy savings from some types of policy measures can be difficult to report according to the requirements set in Annex V EED (e.g. modal shift in the transport sector).
- Taking into account **energy savings lifetime** when cumulating energy savings over the years: only considering first-year energy savings from the new energy efficiency projects implemented in a given year would considerably undervalue the contribution of these projects to the reduction of the final energy consumption. Most energy efficiency actions deliver energy savings for several years, sometimes for many years (e.g. wall insulation). However, the monitoring of energy efficiency policies and programmes does not always enable to know the types of energy efficiency actions implemented, and thereby to assume energy savings lifetimes.

Comparing top-down and bottom-up savings

Comparing top-down and bottom-up savings is particularly difficult, as both approaches do not consider energy savings in the same way (e.g. difference in the way to define a baseline), are based on different data collection or sources, etc. More detailed discussions about these methodological issues can be found for example in (Thomas et al. 2012).

Another challenge is to find data sources that can provide consistent bottom-up energy savings data for a similar scope and period as top-down energy savings data.

When looking for data about energy savings in EU Member States, the most comprehensive dataset is the data reported by Member States to their EED energy savings obligation. These data are produced according to the same requirements (cf. Annex V EED), and all Member States shall report their energy savings every two years in their National Energy and Climate Progress Reports[9].

These energy savings data have however limitations for a comparison with top-down energy savings. As explained above, they do not capture all energy savings from all policy measures. More generally, bottom-up energy savings are most often related to policy measures, whereas top-

[9] Until 2020, this reporting was done yearly, in Member States' annual reports to the EED.

down energy savings reflect all energy efficiency improvements, whether linked to a policy measure or not. One may therefore expect that top-down energy savings should be higher than bottom-up energy savings.

The figure below compiles the data for energy savings in year 2019 from energy efficiency improvements in 2019 compared to 2013 (for top-down savings) and from energy efficiency actions implemented from 2014 to 2019 and reported by Member States to their EED energy savings obligation (for bottom-up savings). The comparison is made over the period 2014-2019, because the implementation of the EED energy savings obligation started in 2014, and that complete data about energy savings in 2020 from all Member States were not yet publicly available by the time of finalizing this report[10].

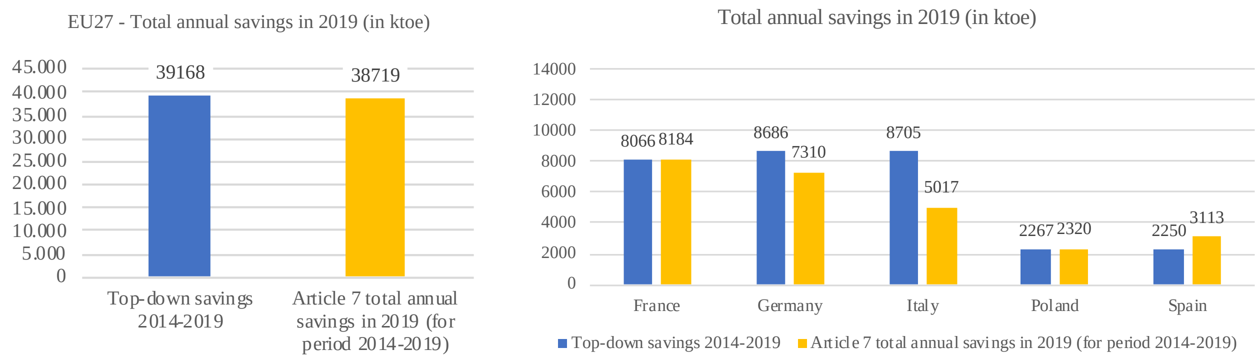


Figure 20. Comparing top-down and bottom-up energy savings in 2019, from energy efficiency improvements achieved over 2014-2019.

This comparison raises questions, as it would be expected to see smaller bottom-up energy savings compared to top-down energy savings, as discussed above. Possible explanations for this surprising result may include that bottom-up energy savings reported by Member States may be overestimated, and that rebound effects may reduce the impacts of energy efficiency actions. The top-down savings indeed directly captures direct rebound effects[11], whereas these effects are rarely taken into account in bottom-up savings reported by the Member States.

A detailed analysis comparing both, top-down and bottom-up, energy savings goes beyond the scope of this study. Examples of such analysis can be found in (Abeelen 2013; Jacobsen 1998; Reuters et al. 2021).

Independently of this comparison, **we suggest using top-down energy savings when integrating energy savings data in figures about the final energy mix**, for the two following main reasons:

[10] In the data published by the European Commission in 2022 in its report on the achievement of the 2020 energy efficiency targets, data about energy savings in 2020 were missing for three countries: Croatia, Hungary and Romania.
[11] For example, if an occupant increases indoor temperature after a building renovation, this will reduce the energy savings calculated with the top-down approach. Whereas this possible change in indoor temperature is rarely considered in the bottom-up methods used by the Member States when reporting to their energy savings obligation.

- Energy statistics in energy balances are about the whole energy supply or consumption, not restricted to the scope of policy measures. For example, RES data are about all energy generated or used from RES, whether linked to a policy measure or not.

- Part of the data used to assess top-down energy savings are official data approved by statistical offices. Some of the disaggregated data are not yet official data, but they are produced with similar practices as the ones recommended by statistical offices. Whereas bottom-up energy savings are often calculated with ad-hoc data.

It does not mean that bottom-up assessments cannot be used to show the energy efficiency contribution to the energy mix. The examples from the US about energy efficiency in the electricity mix show this is possible (see Figure 14 and Figure 15). This was used to show the contribution of energy efficiency policies and programmes. This is a **complementary approach** to considering the whole energy efficiency improvements (whether linked to a policy intervention or not), in line with the way statistics are built for the other energy resources.

Moreover, assessing and making available results from energy efficiency policies is essential for **policy accountability** and monitoring the contribution of these policies to the objectives of the EU or national energy and climate policy. Similarly, analysing changes in energy consumption at a disaggregated level (sub-sector or end-use) together with the evolutions of the related stock of equipment or buildings can be **another way to make energy efficiency visible, as a resource to meet a specific objective** (e.g. reducing energy consumption and bills in dwellings). The French observatory on energy efficient building renovation, created in 2019, has for example the missions of monitoring and analysing the energy consumption and energy performance of the housing stock, the dynamics of renovation (e.g. number of renovation works, with distribution per type of works and buildings), the results and effectiveness of the public schemes for renovation and the related energy savings[12].

Forward-looking scenarios

Forward-looking scenarios are complementary to the energy balances that provide the picture of the past and recent trends. These scenarios are **essential in the planning exercises** that can be done for example by a ministry of energy to anticipate the future needs in energy infrastructures, or by energy utilities for their development plans.

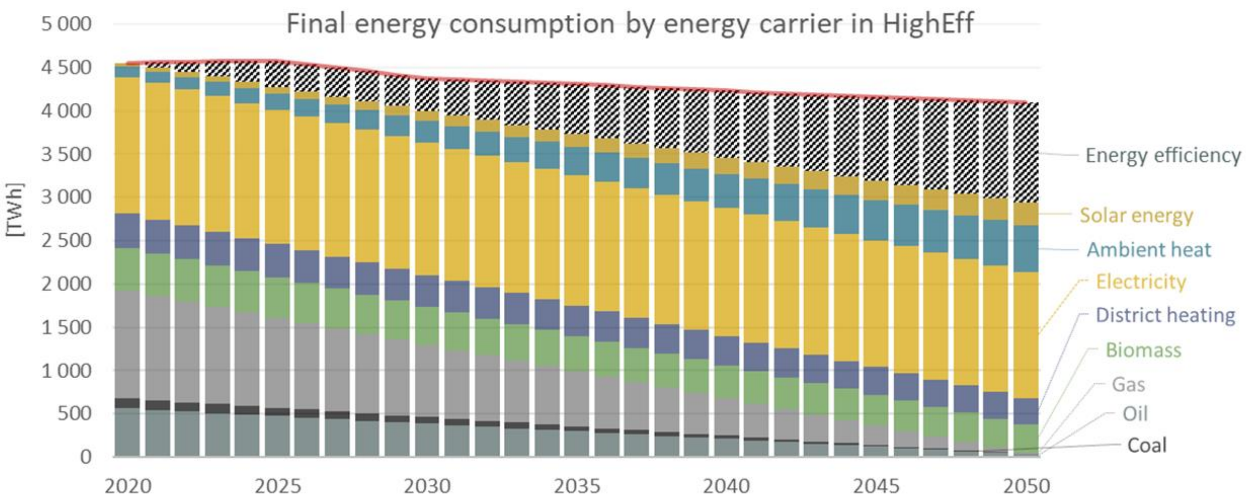
The representation of the energy efficiency contribution is usually already included in most scenarios about future energy consumption, either explicitly or implicitly. In most cases, a kind of business-as-usual or baseline scenario is compared with a target scenario. This is the case for example in the National Energy and Climate Plans reported by Member States according to the Governance Regulation of the Energy Union and Climate Action. These plans shall include a scenario without additional measure (that can be considered baseline scenario), and a scenario with additional measures (that can be considered target scenario).

The difference in energy consumption between both scenarios provides the total **additional energy savings** (when both scenarios use similar assumptions about GDP, demography, etc.). As

[12] See https://www.ecologie.gouv.fr/observatoire-national-renovation-energetique

these scenarios are about future developments, the energy efficiency contribution then corresponds to further energy efficiency improvements compared to the current situation. It should be reminded that **the whole energy efficiency contribution to the energy mix in future years is larger**. The baseline scenario indeed includes energy efficiency improvements due to energy efficiency actions already implemented in previous years, and possibly as well the future results from energy efficiency policies already in place at the time the scenarios are simulated (this is for example the case of the "With Existing Measures" scenarios in the NECPs).

The main discussion is then about the **ambition** considered for energy efficiency improvements in the target scenario. This is for example illustrated in the three scenarios about energy efficiency improvements in buildings, simulated in the ENEFIRST project (ENEFIRST 2022). These scenarios tested different ambitions for building renovations. The figure below shows on top ("Energy efficiency" area) the energy savings between the scenario with the highest ambition and the scenario with the lowest ambition.



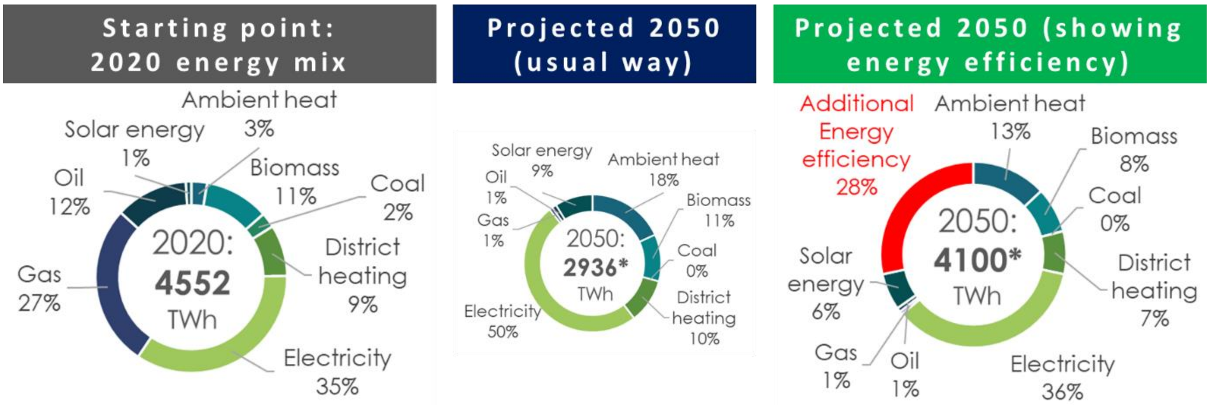
Source: graph prepared by Tim Mandel from the data of the ENEFIRST scenarios

Figure 21. Modelled developments in final energy consumption for EU27 in the HighEff scenario of the ENEFIRST project, showing energy efficiency improvements from higher ambition for building renovations, compared to the LowEff scenario.

The results show that the additional energy efficiency improvements (difference between low and high energy efficiency ambition[13]) would progressively replace most of the fossil fuels that were still used in buildings in 2020.

Results of forward-looking scenarios are classically presented with stacked-area charts or bars (like above), as it shows the evolution over time. Similar to the graphs presented above from the top-down approach, **pie charts can complement the stacked-area charts to show more explicitly the mix in starting and target years**, as shown below.

[13] The scenario with lower ambition is equivalent to a continuation of current levels of renovation measures. The scenario with higher ambition is in line with the initial objectives of the Renovation Wave.



Source: own graphs from the data of the [ENEFIRST scenarios] and [Scenario Explorer]
*: Buildings' energy consumption would be 4100 TWh in 2050 in the absence of the additional energy efficiency improvements (difference between lower and higher efficiency ambition)
Figure 22. Pie charts showing the energy mix in buildings in the ENEFIRST scenarios with higher efficiency ambition.

All pie charts include in their centre the corresponding final energy consumption. The combination of these three pie charts provides a **complementary view of the results**:

- The first pie chart on the left shows the energy mix as of 2020 (in line with Eurostat data).
- The second pie chart in the middle shows the energy mix in 2050, in the usual way (i.e. including only 'supply' energy carriers). It is voluntarily smaller to show the reduction in buildings' final energy consumption (i.e. reducing the energy supply issue).
- The third pie chart on the right shows the energy mix in 2050, **integrating the additional energy efficiency contribution**. It is voluntarily bigger to show what the final energy consumption would be without the additional energy efficiency improvements. This level of energy consumption corresponds to the scenario with lower efficiency ambition, that has nevertheless a lower final energy consumption in 2050 compared to 2020.

Similar to the points discussed above about the top-down and bottom-up approaches, the choices about the baseline scenario have a significant influence on the size of the energy efficiency contribution, together with the choices about the target scenario(s). In the case of forward-looking scenarios, these choices depend on what the scenarios are meant to explore. For example, scenarios can be designed to examine pathways to given targets (normative approach), such as carbon neutrality. Or to assess expected impacts of given sets of policies (exploratory approaches), such as in impact assessments of new policies.

Moreover, the ENEFIRST scenarios were assessed in line with the Energy Efficiency First principle: beyond assessing the overall impacts on final energy consumption, the modelling also assessed the **impacts on energy infrastructures** (e.g. avoided generation capacities). To do so, the modelling needs to assess **not only how much energy is saved, but also when and where**.

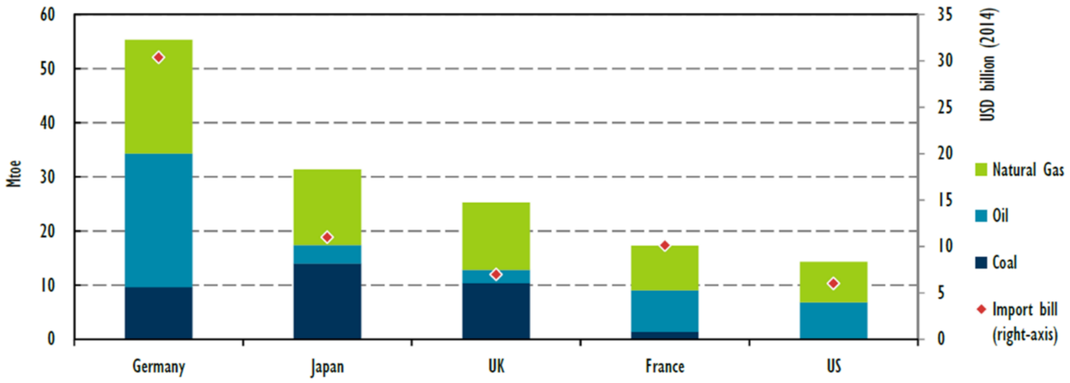
With the electrification of a larger share of energy end-uses, considering when and where energy is saved will be increasingly important.

Other ways to show the contribution of energy efficiency

This report is focused on how to make energy efficiency visible in the energy mix. There can also be **other ways to value the energy efficiency contribution** to the energy system and, more generally, to society welfare. Especially by considering the multiple impacts that energy efficiency improvements can have, beyond energy savings.

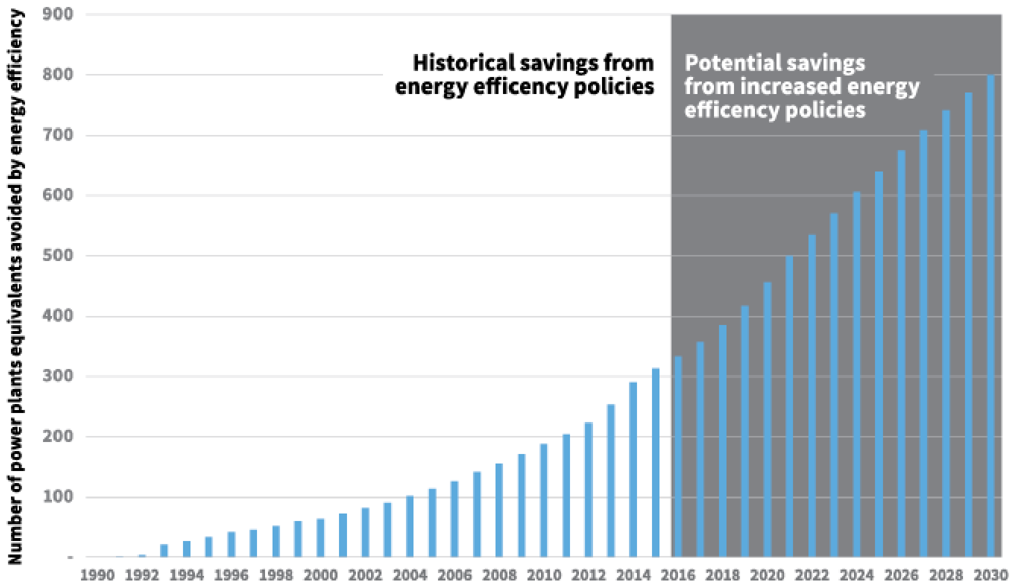
Considering **multiple impacts of energy efficiency** got a growing attention in the last decades, and especially since the publication of (IEA 2015a).

A variety of graphs can be used to show the energy efficiency contribution through these multiple impacts. Two examples are included below, about avoided energy imports in IEA countries and avoided power plants in the US, respectively.



Source: IEA 2015b, figure ES.2

Figure 23. Avoided volume and value of imports in 2014 from efficiency investments in IEA countries since 1990.



Source: Molina et al. 2016, figure 9

Figure 24. Number of power plant equivalents avoided by energy efficiency in the US since 1990, and potential through 2030.

Such graphs can be very useful to demonstrate the multiple added values of energy efficiency, and why it is essential to consider these multiple impacts to **compare on a level playing field the various energy resources** (supply-side resources, as well as demand-side resources). This is indeed a key point when implementing the Energy Efficiency First principle, as highlighted in the new Article 3 of the Energy Efficiency Directive.

These graphs may require **ad-hoc analyses** that are difficult to update on a regular basis. For example, this is the case when assessing avoiding energy impacts. Among others, this raises specific methodological issue to handle fuel switching, and specific data collection about imports and exports. This is why such graphs have mostly been published occasionally.

European projects such as COMBI, ODYSSEE-MURE, M-Benefits or MICAT, have developed methodologies and tools that support the development of considering, and whenever possible assessing, multiple impacts. This trend is now reinforced by the provisions included in the new Article 3 dedicated to Energy Efficiency First in the Energy Efficiency Directive. As data and results in this field grow, this will also be interesting to **explore effective ways to compile and display these results more regularly**.

SUMMARY OF KEY ISSUES DISCUSSED AT THE EXPERT WORKSHOP

A first version of this report and provisional conclusions were discussed during an online expert on 21st of September, 2023 (see Acknowledgements). The key issues discussed during this workshop are summarized below.

About the use of decomposition analysis

It was reminded that the first uses of decomposition analysis for assessing energy efficiency improvements or trends were based on differences in energy intensities (e.g. like done in World Energy Council's energy efficiency reports in the late 1990's).

Then the collection of more detailed data about end-use energy consumption enabled the use of an alternative approach, using energy efficiency indexes. The methods using energy intensities are usually based on more aggregated data and look at energy consumption vs. GDP or value added. Whereas the methods using energy efficiency indexes are usually based on more disaggregated data, and look at energy consumption vs. physical indicators (e.g. building areas, production volumes). ODYSSEE-MURE is using energy efficiency indexes, whereas the other organisations use energy intensities.

Independently of the method used, transparency is essential in the way to communicate the results. Explanations about how the results were obtained should remind the type of method used, the main data sources, and clarify whether energy savings have been assessed by comparing efficiency levels in the latest year with efficiency levels in a reference year, or by cumulating year-to-year differences.

Eurostat, the IEA, ODYSSEE-MURE and the JRC now all make use of decomposition analysis. However, the methods and data they use may differ.

Eurostat and the JRC aim at exploring the potential of using official statistics, for example for assessing top-down energy savings or determining hypothetical energy consumption in scenarios of frozen energy intensity (without further energy intensity improvements). There might then be differences in the way to define 'official statistics'. For Eurostat, 'official statistics' correspond to data published in the Eurostat datasets, i.e. data transmitted by a national statistical office or authorized body. National statistical offices may use other national 'official statistics' in their datasets. Other organisations may use a broader definition for 'official data', including data published or reported by public institutions, even when not statistical offices or delegated statistical bodies.

The IEA complements official statistics with data collected through its annual questionnaire, complemented with estimates by IEA experts. While the IEA database includes 60 countries, decomposition analysis is performed only for the countries that have provided comprehensive data in their questionnaire. In situations where there is a data gap for a particular year, estimations are sometimes made, but always based on official statistics. When a decomposition analysis is possible, the most frequent case is that it is based directly on data provided by the countries, without the need for estimations.

ODYSSEE-MURE complements official statistics with data entered by the national partners of the project. Eurostat data represents about half to two thirds of the data used to build ODYSSEE indicators. Complementary data provided by national partners are then essential to enable implementing the method of energy efficiency indexes.

All experts highlighted that implementing decomposition analysis requires a considerable amount of data. Assumptions may then be needed in case of missing data in some country or some year.

The reference year or starting year for the period under analysis often depends on data availability, also considering consistency in the time series.

In addition to the choice of the reference year, the choice of the method (energy intensities vs. energy efficiency indexes) and (dis)aggregation level can affect significantly the results. While using energy intensities is possible for more countries, especially when focusing on official data, energy efficiency indexes can be easier to analyse, as closer to the physical drivers of energy consumption. It was also suggested that relying solely on Eurostat data might lead to an underestimation of energy savings.

As regards uncertainties and inconsistencies, it was reminded that these issues are not specific to energy efficiency data.

About data availability, related needs and developments

Data availability differ according to world regions or countries, which may impact how energy efficiency is measured and reported. Using more granular data can offer better insights. For instance, data on energy consumption in transport can distinguish between trucks, cars, and buses. Experts mentioned improvements in data about buildings' energy use and related data, and that similar advancements could be made in transport data.

Digital technologies like smart meters and tools to process big data can be opportunities for further developments in data collection. However, there are also disparities across countries in this field. Sharing good practices about survey methodologies and practices was also pointed as an effective way to improve data collection. Another approach can be to combine surveys and modelling. This can be used for example to consolidate data, or to provide annual updates even when surveys are done for example every four years.

Several examples of efforts to develop data collection and improve data availability and quality were mentioned, for example about data on the service sector with dedicated surveys. These efforts may be driven either by needs for international reporting, or by the need to gain a deeper understanding of specific (sub-)sectors.

At the same time, experts also warned about the growing amount of disaggregated data that national statistical offices and related bodies need to collect and process (e.g. for reporting to Eurostat). This may be challenging, especially for national bodies with limited resources. Eurostat therefore develops cooperation with country authorities to address this. This is important as Eurostat needs to treat all countries equally.

IEA initiated the current data collection about energy efficiency indicators around 2009, with a strong emphasis on data enhancement. The IEA has been actively working on capacity building, providing countries with support to improve data collection and availability. Although this is a long-term endeavour, tools are being developed to facilitate this process (e.g. manuals, guide to define a roadmap).

Experts pointed that issues with data availability should not be a reason to postpone analysis of energy efficiency data. Work can start with data available at the moment, instead of waiting for perfect datasets in the future and staying without information until then. Currently missing data can usually be covered with estimations. Which may also be a driver to improve data collection.

Using a flexible approach has for example been the philosophy of ODYSSEE-MURE, trying to make the best out of the data available at the moment, complementing with estimates by national experts when needed, and supporting experience sharing for continuous improvements. Showing the differences between using official data only and using official data complemented with estimations could encourage countries to gather more data and standardize their reporting process.

It was also highlighted that the increase in budgets allocated to energy efficiency policies and investments has not necessarily resulted in increased means to collect energy efficiency data. Data collection is indeed rarely considered a priority. Promoting the importance of data collection to decision makers is essential. It was reminded that whatever the method used, if the data available is poor, then results will be poor as well, and so the inputs to decision-making.

A possible way forward could be a better integration of energy efficiency analysis in statistical offices, which may imply cooperation at national level.

About the way to make data available

In recent years, a key decision was made by Eurostat about its publication methods: traditional paper or pdf publications have mostly been discontinued. Instead, Eurostat has made a strategic shift towards digital means. Therefore, data is now primarily disseminated through online databases, complemented with new tools to visualize this data. This digital strategy provides Eurostat with the flexibility to emphasize statistics that are particularly relevant to ongoing societal or policy events. Moreover, to maximize outreach and connect with diverse audiences, Eurostat has expanded its presence across several digital platforms: Twitter, LinkedIn, Instagram, and Facebook. The objective is to cater to users across these platforms, recognizing that different audiences may prefer different platforms.

The IEA continues to publish yearly reports (including one on energy efficiency) providing trend analysis and highlighting topical issues. More specifically about data and indicators, the IEA has developed online data facilities, including one dedicated to energy efficiency indicators, regularly updated: https://www.iea.org/data-and-statistics/data-tools/energy-efficiency-indicators-data-explorer

This confirms what was identified in the review of key sources on energy data: the increasing shift to online platforms to make it easier for users to navigate and visualize data.

About agreements on methodological choices and conventions

Introducing new methods or tools in the portfolios of statistical bodies might require time to gain acceptance, including iterations based on feedback and evolving needs. This was the case when developing, and then harmonizing energy balances. Decisions are required on foundational aspects, to set conventions used by all. Similar to the case of national energy balances, there can be many ways to use decomposition analysis. International conventions help ensure that data shared in the international context is consistent, and can then be compiled or compared.

Key choices for a convention on implementing decomposition analysis would include the base year, the type of input data and the level of (dis)aggregation of the end-use sectors. It was highlighted that there is no absolute or perfect choice. Moreover, methodologies and conventions may evolve over time. What is essential is that the choices and methods are accepted by the community, and that users have confidence in the data published.

An example about these choices was highlighting, referring to the graph published by the IEA in 2013 showing energy efficiency as the first fuel. The share for energy efficiency was larger than what can be found in figures more recently published, because in the figure of 2013 the base year was 1974. The longer the period considered, the higher the contribution of energy efficiency. This shows clearly how the choice of the base year can impact the visualisation and interpretation of the results.

There have been already attempts of harmonising methods to assess energy savings, for example at the time of the EU Energy Services Directive adopted in 2006. After two years of discussions, countries did not reach a consensus on defining a list of harmonized indicators for top-down methods. The Commission then published a set of recommended indicators. These were used by some of the Member States, but not all.

Another example is about ISO standards, and more specifically ISO 50049:2020. The development of ISO standards implies discussions to reach a consensus. This was achieved for ISO 50049:2020 on the way to define and specify the main options of methods. However, the standard does not specify what method or option to choose.

There can be a momentum for change and introducing new methods or tools about energy efficiency and energy savings. In any case, this will likely be a gradual process that requires deliberation and possible revisions. A continuous dialogue is indeed important to refine methodologies and enhance data representation, ensuring that the story told is both comprehensive and accurate.

About challenges and opportunities for further developments and integration of energy efficiency data in energy statistics

Key difficulties were highlighted about releasing energy efficiency indicators simultaneously with energy statistics, and particularly the time lag. This is mainly because energy statistics and decomposition analysis (or alternative methods) require data from different statistical domains.

Analysing drivers of energy consumption or producing energy efficiency indicators require to combine energy data with various other datasets (e.g. production per industry branches, evolution of the building stocks, distances travelled for passenger and freight transport). The delay to produce energy efficiency data therefore depends on the latest data domain available. This makes that energy efficiency data are available later than 'pure' energy statistics.

The collaboration with countries was emphasised as key to expedite data collection, in the process to produce international datasets.

In practice, Eurostat can now publish by December the consolidated energy statistics of the previous year. Preliminary results about a given year becoming now available from spring in the next year. As there is a constant demand to get data as soon as possible, statistical offices could not wait for energy efficiency data to be available to publish their energy statistics.

This creates a challenge, even if energy efficiency data are published with their own timeline. As the general public may have less interest in energy-related data coming later than the basic energy statistics on the same year. Moreover, the recent years also showed the needs for timely data to inform immediate policy actions. There is a compromise between being more precise and being more timely.

An alternative would be to include together with energy statistics on a given year, energy efficiency data about the previous year, as complementary explanations about recent trends. Research is also on-going to explore methods to estimate shorter-term projections for some of the energy efficiency data. Similarly, it could be examined how other official data sources could be used to estimate missing data when needed, or how digitalisation could provide more short-term data (e.g. monthly data).

This could also be complemented by comparison with previous projections, or updates in projections. In line with the Paris Agreement and the Governance Regulation of the Energy Union, EU Member States have to report official greenhouse gas emission projections every two years. As roughly 75% of GHG emissions are linked to energy use, these projections are fundamentally based on energy projections, especially for fossil fuels. The European Environment Agency manages the online platform used by the Member States to report their projections, and started to examine final energy consumption based on these projections. The energy parameters that underpin the projections of GHG emissions could be used to predict energy consumption, which could then be used to retrospectively compare with official statistics to understand developments over time.

Another alternative could be to include data on key results from energy efficiency policies, that can be combined with modelling to provide insights on the same year simultaneously with energy statistics. For example, results from Energy Efficiency Obligation Schemes can be available within the same timeline as energy statistics. Timely reporting of energy savings is important, especially in the context of significant investments (e.g. about policies for building renovations).

However, this option would remain feasible mostly at national level for the moment. First, because not all Member States have an M&V (monitoring & verification) system that enables them to get consolidated results from their energy efficiency policies within a 1-year lag. Second, because the European reporting framework, now streamlined within the National Energy & Climate Progress Reports, collects the data every two years, and as regards energy savings from energy efficiency policies, data are reported about year N-2 and N-3.

Energy efficiency data can already be found, for example on the ODYSSEE-MURE or IEA websites. Efforts are being made to present it as transparently as possible, and to provide visualisation tools meeting the needs of the users.

ODYSSEE-MURE has for example developed various facilities over time, like the Decomposition Tool or the Energy Savings Tool. ODYSSEE-MURE also developed an energy efficiency scorecard to raise awareness about energy efficiency data beyond the energy efficiency community.

The IEA is also continuously working on enhancing the presentation of data. The importance of splitting data by fuel type is acknowledged. This can indeed have a visual impact, to make it easier for readers to compare the share of energy savings (added on top of the actual energy consumption) with the shares of the other energy resources. When representing the actual energy consumption as a single block, this is not possible to appreciate directly.

Eurostat currently works on the use of decomposition analysis to add new visualization features to its data platform on energy. The objective is to consistently display hypothetical energy consumption for all countries. The visuals will present savings from improvements in energy intensity, changes in activity, and structural changes.

Overall, data about energy efficiency or analysing trends in final energy consumption are then more and more available, in different ways and for different purposes. Nevertheless, this remains aside of the key figures included in the executive summaries on energy data. Energy efficiency is a crucial component that should be part of the core data on energy statistics, and would therefore need to be incorporated better into the general narrative on energy. Energy efficiency is not just an explanatory factor for changes in energy consumption, it is a resource helping to meet energy needs while reducing the needs in energy supply.

In addition to the issue of time lag, the nature of news and public attention was also pointed out as a challenge: topics shift based on current events, with energy efficiency often being overlooked. An interesting example on this is the first IEA's Energy Efficiency Market report published in 2013, which garnered significant attention, especially with the catchphrase “energy efficiency from hidden to first fuel”.

This may suggest that two approaches should be considered:

- The first one is about integrating energy efficiency in the core energy data, on a regular basis. These core data are the first to be viewed by any user looking for information on energy.
- The second one is about considering the multiple ways in which the contributions of energy efficiency can be displayed. This could provide a basis to select every year the most relevant aspects to highlight, in line with the current events and concerns of decision

makers and the general public. This relates to the multiple benefits of energy efficiency, and the fact that energy efficiency is not an objective per se, but a means to an end.

It was for example highlighted that linking energy efficiency data to savings on GHG emissions could help get more attention, for example showing the shares of reductions in GHG emissions according to energy efficiency, RES and other sources of reductions. This however raises another methodological challenge to handle fuel switching.

CONCLUSIONS

Integrating energy efficiency in the mix is possible, but not yet done

Examples of graphs showing the contribution of energy efficiency to the energy mix exist. However, they have not yet been included in the main publications about energy statistics. They are included in separate reports or online publications.

Out of sight, out of mind: the fact that energy efficiency is represented or discussed aside is an important issue. This indeed impedes energy efficiency to be considered an energy resource as the supply energy resources. This may then contribute to a priority gap: while official communications regularly remind that the cleanest energy is the one not used and that energy efficiency is essential for the energy transition, major decisions and political efforts remain focused on the supply side, as seen in the recent energy crisis.

Possible reasons for this situation are summarized below (left column), with **opportunities for changes** (right column and italic).

Reasons related to **usual practices and conception of energy statistics**	
Main energy statistics are built according to a classical conception of the energy balance, showing energy flows. As energy efficiency is about what has not been used, it does not appear directly in this classical conception where it remains “hidden” as pointed in (IEA 2013).	*Publications on energy statistics have evolved significantly in recent years, especially in terms of design. There could be a **momentum** to suggest further changes or developments.*
Instead of being considered an energy issue per se, energy efficiency may be considered a related issue such as an environmental impact, for example together with data on GHG emissions, and therefore is included in separate sections or publications.	*The **Energy Efficiency First principle** adopted by the EU institutions requires to consider energy efficiency on a level playing field with other energy resources. This implies to **consider energy efficiency as an energy resource** and part of the energy mix or energy balance.*
Heads of energy statistics may not be familiar with the methodologies used to produce energy efficiency or energy savings data (e.g. because they are more experienced with energy supply data), or they may consider that these methodologies do not comply with usual standards of statistics.	*These methodologies have been widely discussed and implemented. They are also summarized in **ISO standards** (see ISO 50049:2020 about top-down approach; ISO 50046:2019 about bottom-up approach). Energy supply data also requires methodological choices and agreements.*

Reasons related to **data issues**	
Some of the data specifically needed to assess energy efficiency improvements or energy savings are not recognised as official statistics.	***Detailed data about energy demand*** *are progressively included in official datasets, at national and EU levels.*
Time lag: energy efficiency data are available about one year later than usual energy data.	*While this may indeed create a problem for pie charts,* ***this could be solved for stacked-area charts*** *by including an extrapolated value for the energy savings in the last year available for the other energy carriers.*
Availability of data needed to assess energy efficiency improvements or savings may vary too much from one country to another. Which may explain why some countries are more advanced than others in updating and publishing regularly energy efficiency data.	*The ODYSSEE-MURE project has developed for 30 years a* ***network of European experts*** *that has continuously improved the availability and consistency of data used for energy efficiency indicators and top-down calculations. This makes that* ***complete and consistent datasets and time series*** *are available.* *Similarly, the IEA has developed* ***training programmes*** *about energy efficiency data and indicators.*
Data on energy efficiency improvements or energy savings may be considered including too many inconsistencies or uncertainties.	***Energy supply data might also include inconsistencies and uncertainties*** *(e.g. about biomass). Which does not prevent these data to be included in the energy statistics.*

Reasons related to **political priorities and agreements**	
Highlighting the energy efficiency contribution to the energy mix may not be a political priority. The priority may instead be to monitor how energy efficiency indicators evolve against targets (see for example the graphs by Eurostat showing the evolution of primary and final energy consumption against the headline energy efficiency targets set in the Energy Efficiency Directive). This makes that energy efficiency is considered in a separate section.	*The* ***Energy Efficiency First principle*** *adopted by the EU institutions requires to consider energy efficiency on a* ***level playing field*** *with other energy resources. This implies to consider energy efficiency as an energy resource and part of the energy mix or energy balance.* *Moreover,* ***monitoring the achievement of the headline energy efficiency targets requires to analyse the factors influencing energy consumption****, in a similar way as assessing total energy efficiency improvements (e.g. with decomposition analysis).*
Integrating new data in statistics requires agreements on methodological choices. While there are national and international forums to agree on such choices for the usual energy statistics, these forums may not include on their agenda or have relevant working groups to discuss and agree on methodological choices for energy efficiency or savings data.	*Discussions on methodologies to assess energy efficiency improvements or savings already happened in the* ***working groups*** *that prepared the ISO standards. These standards describe the main possible options, based on current practices.* ***Further discussions*** *could be about agreeing on choices for international publications on energy. Which would not prevent the use of other choices for other purposes or other publications.*

The top-down approach is already applicable and in line with statistical practices

Considering top-down and bottom-up approaches to produce the data needed to integrate energy efficiency in figures showing the energy mix, both have their own main purposes:

- top-down methods are commonly used to assess total energy efficiency improvements and to monitor trends,
- whereas bottom-up methods are commonly used to assess energy savings from policy measures.

Both, top-down and bottom-up, are important. When choosing a method, it is essential to clarify what is to be shown and analysed. This is also key to analyse what data sources are the most relevant to answer the question(s).

When aiming at **integrating energy efficiency in the energy mix**, the **top-down approach** is **more relevant**. Mainly because it is designed to capture the whole energy efficiency improvements, whereas the bottom-up approach is designed to capture the policy-driven energy savings. Moreover, the aggregation of bottom-up savings can be challenging, especially to be comprehensive and cover all policy measures in place.

The long-lasting ODYSSEE-MURE project developed a network of European experts, as well as data availability and consistency. The **capacities** needed to use the top-down approach are therefore **already available**.

Promoting energy statistics including energy efficiency can already be done

The IEA, ODYSSEE-MURE and ACEEE already published figures where energy efficiency is integrated in the energy mix (see Figure 6 p.17; Figure 8 p.18; Figure 14 p.23). In all cases, **this was part of publications dedicated to energy efficiency**. Including such figures in publications of official statistics may require some time (see next point). However, it is already possible to publish reports or online contents that would complement or challenge publications of official energy statistics. This could stimulate changes.

Energy agencies or NGOs may have more flexibility to lead such publications. Public authorities may also enhance their publications on energy, depending on their policy agenda. The similarities and differences in the national publications on energy statistics show that there are margins in what they can include and display.

Other initiatives already exist to disseminate energy efficiency data and analysis, like the energy efficiency scoreboard or scorecards of ODYSSEE-MURE and ACEEE. Promoting energy statistics including energy efficiency is complementary, especially by aiming to reach a broader audience of policymakers, stakeholders and experts involved in energy policies and markets, and not necessarily familiar with the importance of energy efficiency and related trends.

The main objective is indeed to **bring energy efficiency to the forefront of the general energy debate**.

Political will and agreements are needed for a more systematic and official integration

An integration of energy efficiency in the official statistics on energy requires a clear political will, to **put this topic on the agenda** of the statistical offices and other institutions involved in preparing and publishing energy statistics.

Such dynamic could be first engaged at national level, in countries willing to lead in this field. International agreements are indeed longer processes, with a first and major step being to get the topic on the agenda of the international forums discussing the methodologies for energy statistics.

Main methodological choices that require an agreement include:
(1) the choice of the method(s) (e.g. LMDI and/or energy efficiency indices);
(2) the choice of the base year or period (e.g. fix vs. sliding base year); and
(3) the disaggregation level and related indicators or indices for each (sub-)sector.

Other actions can support this process

Building on existing initiatives such as the ODYSSEE-MURE project or IEA initiative on energy end-use data, **informal working groups** could examine the most important methodological or data issues, to facilitate the discussions in formal forums about energy statistics.

The scope of official statistics expands progressively. It would be useful to **have a view on current and planned developments about energy end-use data**, and whether these developments can help fill the gap between unofficial and official data used in top-down methods. Or where particular efforts would be needed. Experts point out the **need to dedicate means to data collection** in line with the importance given to achieving the energy and climate objectives.

Similarly, the experience of the existing initiatives can be used to communicate on the **multiple benefits of collecting data** to monitor energy efficiency, such as better understanding trends in energy consumption and towards targets, or benchmarking with other countries (see e.g. Bosseboeuf and Lapillonne 2021). This could help get more commitments and means for data collection, which is an essential prerequisite to informed policymaking.

Further research could be useful to further explore issues that currently create limitations in the top-down approach:

- **Providing provisional results with shorter delays** would help address the time lag currently of two years before having the data needed to assess top-down energy savings. Detailed data about national energy balances are usually available with a time lag of one year. Having provisional results of top-down savings with a time lag close to one year would thus enable to include first insights at the same time of the publication of the usual energy statistics. Research on this is on-going.
- Explore possible **options to better capture the effects of behaviour changes** would help address what may sometimes remain a blind spot in top-down analysis. This could

also help better understand part of the differences between top-down and bottom-up savings.

- Special years have become more frequent (see recently 2020 and 2022 for example, due to COVID19 and the war in Ukraine respectively). These major breaks in trends raise methodological issues. It would therefore be interesting to explore possible adjustments to ‘classical’ methods or other methods that could be more appropriate to make **assessments under rapidly and significantly changing trends**.

Other developments could help increase the visibility of energy efficiency

Further research would be useful about methodologies to **assess energy savings per energy carrier**. Key issues include how to deal with fuel switching, or modal shift (more specifically about transport). For the same reasons, results per energy carrier can be more difficult to interpret. This issue is of particular interest, as data of energy savings per energy carrier are needed to assess avoided GHG emissions thanks to energy efficiency improvements, or similarly about avoided energy imports. Both results would be useful to document and display the multiple benefits of energy efficiency on a more regular basis.

Assessing avoided energy imports can be done with different methods, mostly from energy intensities. But this requires detailed data analyses that are not easy to update. For example, due to difficulties linked to data about imports/exports.

More generally, exploring how **multiple impacts** of energy efficiency improvements could be **monitored and displayed on a more regular basis** could help getting data on these multiple impacts considered more systematically. As currently such data are mostly spread in ad-hoc studies or projects.

A complementary approach to integrating energy efficiency in the energy mix is to develop ‘**useful energy balance**’. ‘Useful energy consumption’ is obtained by multiplying final energy consumption by end-use efficiencies, at the level of the different types of equipment and technology. Useful energy consumption thus provides what amount of energy is really available for the end-users. A useful energy balance enables to measure the level of energy needs (or energy services) and identify the potential technologies that could be promoted to meet them to further improve end-use efficiency (Bosseboeuf and Lapillonne 2021).

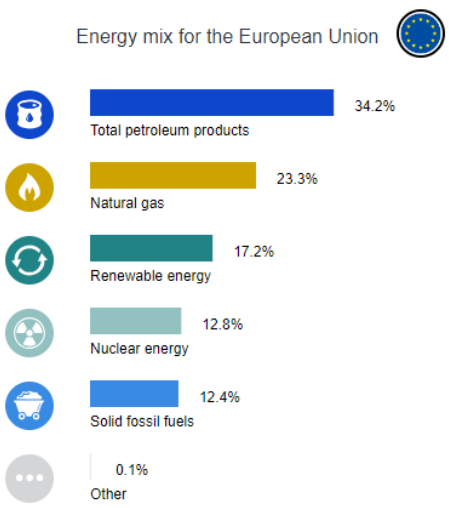
Similarly, **flexibility or load impacts** become increasingly important to assess, as electricity will soon be mostly generated from renewable energy sources and that electrification of end-uses is also progressing rapidly. Therefore, assessing energy efficiency results should be not only about **how much** energy is saved, but also about **when and where** energy is saved. This might require considering new indicators and figures, for example to show the contribution of energy efficiency to the flexibility of the electricity system. Which is part of the Energy Efficiency First principle, when considering energy efficiency as a resource.

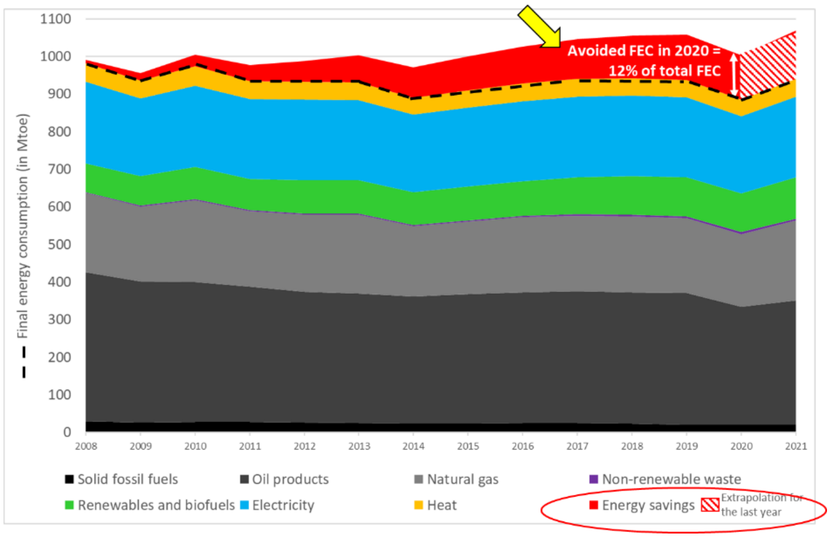
PERSPECTIVES: 7 ACTIONS TO MAKE ENERGY EFFICIENCY MORE VISIBLE IN THE OVERALL ENERGY PICTURE

NOTE: *These actions have been identified after the discussions at the experts workshop. They are suggestions from the authors only. They are not meant to reflect the opinions of the experts who attended the workshop. Actions 1 to 5 are directly related to the scope of this study. Actions 6 and 7 are complementary suggestions, building on the analysis of this study to go further.*

Action 1: Integrating energy efficiency in the energy mix

What? Adding next to the current figure about the energy mix (in terms of energy supply in the latest year available), a graph showing the evolution of final energy consumption per energy carrier, including 'energy savings' or 'energy efficiency' on the top. This can be done with available methodologies and datasets (e.g. ODYSSEE Energy Savings Tool).



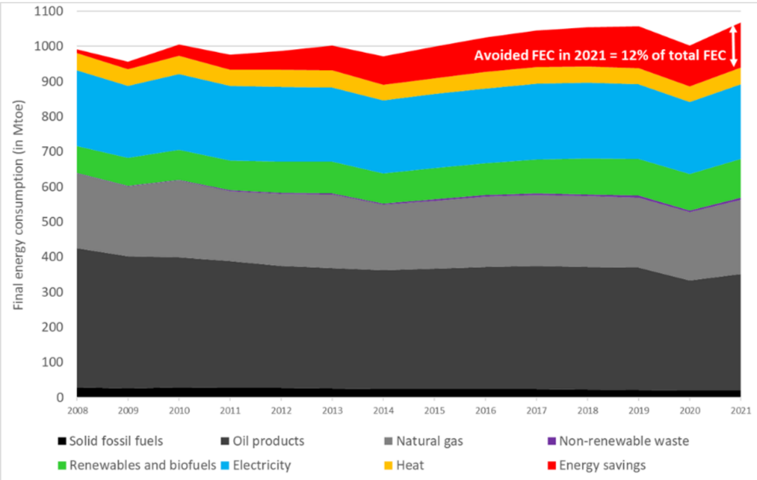


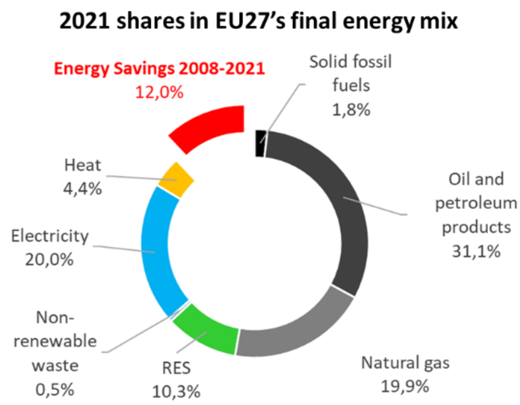
Why? This would make an energy efficiency share visible in the final energy mix. The use of a stacked-area chart including an extrapolation for the last year would overcome the time lag issue in the availability of energy efficiency data. Such graph would help visualize energy efficiency as a resource, together with the other energy carriers. Similar graph could be built for the primary energy mix. In this case the energy efficiency share would include energy efficiency improvements in energy generation, transmission and distribution, in addition to energy efficiency improvements in energy end-use.

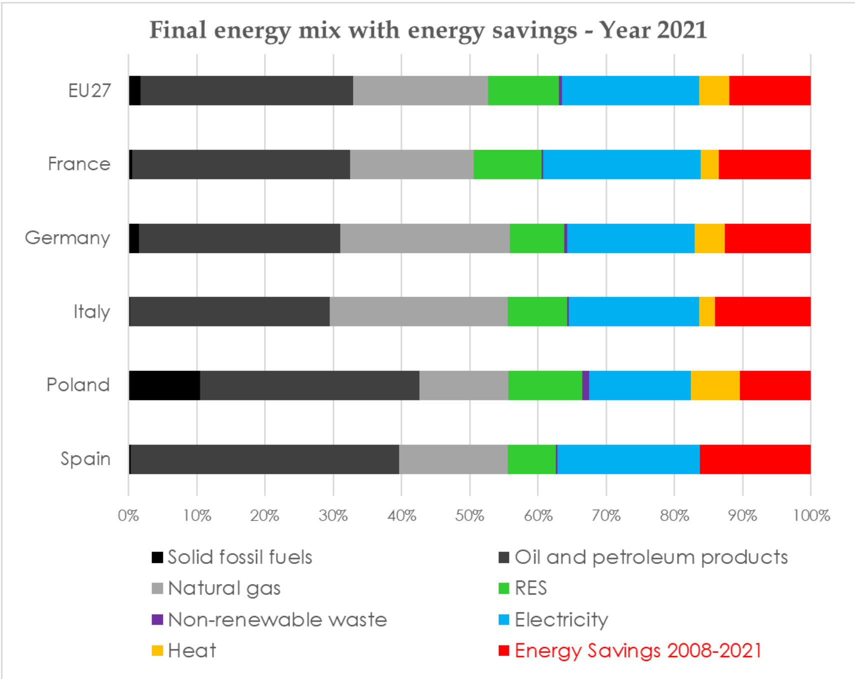
Who? This could be done by publishers of energy statistics, and by organisations willing to provide decision makers and stakeholders with key information on energy. This could start at national level, as this would not need achieving an international agreement on methodological choices. For the same reason, initiatives like ODYSSEE-MURE or NGOs could publish such figures integrating energy efficiency in the energy mix.

Action 2: Integrating the energy mix in the energy efficiency publications

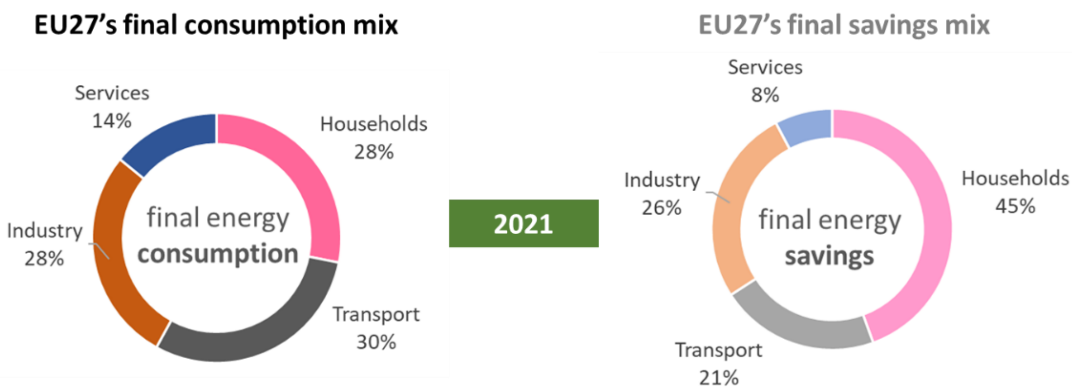
What? Adding in the main figures of energy efficiency publications (or chapters dedicated to energy efficiency) figures showing the energy efficiency share in the energy mix.







This could be complemented with figures providing an 'energy savings balance', next to the energy balance, as shown below with the 'final savings mix' next to the 'final consumption mix'.

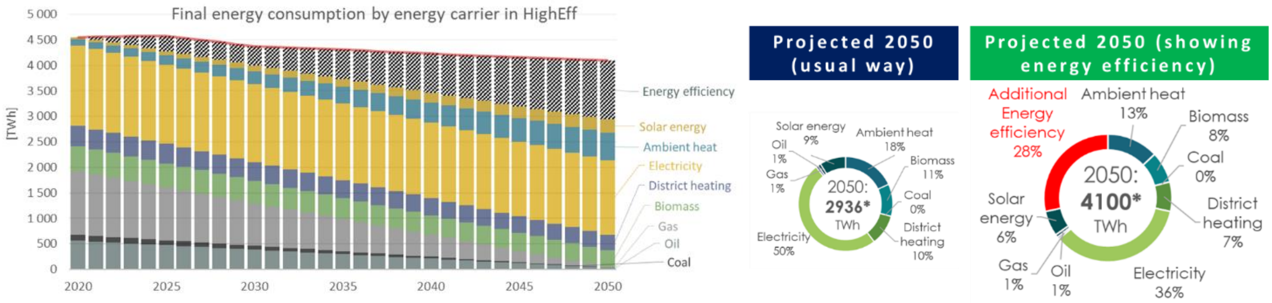


Why? The link between energy efficiency and the energy mix should be made in both ways. It is therefore important that energy efficiency publications also include figures representing the energy efficiency share in the energy mix. This would complement figures on trends in energy consumption, that usually show the shares per end-use sector. In addition, energy efficiency publications could develop an 'energy savings balance' that could mirror the usual energy balance.

Who? Energy efficiency publications are often published by the national energy agencies or institutes. Many of them are partners of the ODYSSEE-MURE project that could also include these types of graphs in its publications, for example in the country profiles.

Action 3: Making energy efficiency visible in forward-looking scenarios

What? Adding the share related to additional energy savings or energy efficiency improvements in the graphs showing the results of the scenarios. This can be done as shown below about the HighEff scenario produced by the ENEFIRST project, by making it clear that the difference in final energy consumption between the target scenario and the baseline scenario corresponds to additional energy efficiency improvements. Like for the energy mix discussed above, this can be done using stacked-area charts (to show the evolution over the years) and pie charts (to show the values of the shares in the target year).



Why? Showing only the development of final energy consumption as expected in the target scenario would hide the energy efficiency contribution. This may then result in focusing the debates, and possibly the policies, on the evolution in the shares of the supply energy carriers.

Who? Scenarios are prepared and published by various organisations and initiatives: public institutions and agencies, research institutes and projects, energy utilities, NGOs, ... Making the energy efficiency contribution visible in their results would also increase the transparency of their scenarios.

Action 4: Allocate means to data collection in line with data needs

What? Ensuring that enough means are allocated to collect, process and analyse the data needed to monitor trends in energy efficiency improvements and results from energy efficiency policies, having in mind the differences among countries.

Why? Independently of the methodology used, the reliability and relevance of energy efficiency data strongly depends on data availability and quality. The needs in monitoring and reporting related to the energy and climate objectives and policies have increased significantly. While digitalisation provides ways to develop data collection and processing, these increased needs require sufficient means.

Who? Governments can review the needs with their statistical offices and related bodies. Eurostat has also an important role in supporting Member States in this field, depending on its mandates and the means allocated to provide such support. The ODYSSEE-MURE project and initiatives such as the ones led by the IEA provide complementary support for capacity building and experience sharing.

Action 5: Establish a European working group on energy efficiency data

What? Providing a forum where national and European experts could exchange regularly about methodologies, in view of preparing more formal discussions to agree on methodological choices for the publications of energy efficiency data in a consistent manner across countries.

Why? ODYSSEE-MURE or the G20 Energy End-Use Data and Energy Efficiency Metrics initiative (supported by the IEA and ADEME) have already provided opportunities for discussions among European countries and beyond. The objectives of these initiatives have been primarily to build capacities, facilitate experience sharing and develop datasets on energy efficiency indicators or detailed energy end-use data. These activities included methodological discussions. Which facilitated the development of ISO standards. However, there were not yet discussions to agree on methodological choices, so that different organisations may publish energy efficiency data according to the same method.

Who? The most legitimate organisations to establish such European working group could be Eurostat or the European Commission. This could also be led by other organisations such as the European Environment Agency or the ENR network of national energy agencies.

Action 6: Improving the visibility of the results of energy efficiency policies

What? Ensuring that results from energy efficiency policies are published on a regular basis, and can be easily found and accessed. This is for example required by the Energy Efficiency Directive for the policy measures reported to its Article 8 (Member States' energy savings obligation). This could also include monitoring and publishing the achievements related to major objectives such as the renovation of the building stock.

Why? The way suggested to integrate energy efficiency in the energy mix figures covers the whole energy efficiency improvements, whether they are linked to a policy measure or not. It is therefore complementary to publish data about results from energy efficiency policies, especially the major ones. This is essential to inform policymaking, as well as to provide visibility to market players and transparency to citizens.

Who? Publishing policy results is usually done either by the energy ministries or agencies, or by other public bodies in charge of monitoring or implementing the policy measures. When the budget of the policy measure reaches certain thresholds, the Court of Auditor (or equivalent body in the country) may also publish occasionally a policy review or assessment.

About the second point (tracking achievements of major objectives), this can be done by the same organisations, or by a dedicated observatory. See the example mentioned in the report about the French observatory on energy efficient building renovations.

Action 7: Highlighting the topical impacts of energy efficiency

What? Complementing the energy efficiency data available on a regular basis with ad-hoc studies providing evidence and key figures about the multiple impacts of energy efficiency, selecting the impacts in focus according to what is in the top of the policy priorities or in the news (e.g. energy security in the current energy crisis, GHG emissions ahead of a COP).

Why? Making energy efficiency visible should go beyond its direct impacts on the energy mix (i.e. reduction in energy consumption). Illustrating other impacts from energy efficiency improvements show how strategic they can be for multiple objectives, and especially the objectives being the main priorities at a given point in time. In many cases, assessing these impacts requires complementary data and analysis compared to the regular data collection and processing for energy efficiency indicators. Hence the suggestion for ad-hoc studies.

Who? Research institutes, consultancies, the IEA and national energy agencies and other organisations with experts and assessment capacities have already contributed to grow the evidence base in this field, as documented by the IEA or European projects such as COMBI, MICAT or ODYSSEE-MURE. These previous works could facilitate further updates according to topical needs.

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ACKNOWLEDGEMENTS

The authors would like to thank very much Renée Bruel for raising this topic, and Katarzyna Wardal-Szmit (Knauf Insulation), and Ting Zhang (European Climate Foundation) for their supervision of the study.

The authors would like to thank very much the experts who attended the online workshop organised on 21st of September, 2023 (see attendance list below), as well as Bogdan Atanasiu, for the very useful discussions and their valuable comments and inputs.

Name	First name	Organisation
Bosseboeuf	Didier	ADEME / ODYSSEE-MURE (France)
Clementi	Enrico	JRC
de Arriba	Pilar	IDAE (Spain)
De Chicchis	Livio	ENEA (Italy)
Eichhammer	Wolfgang	Fraunhofer ISI (Germany)
García Montes	Jesús Pedro	IDAE (Spain)
Gilewski	Paweł	KAPE (Poland)
Herry	Malo	SDES (Service of Data and Statistical Studies), Ministry of Ecological Transition (France)
Kontinakis	Nikolaos	European Commission
Lattanzio	Domenico	IEA
Mesqui	Bérengère	SDES (Service of Data and Statistical Studies), Ministry of Ecological Transition (France)
Pinto da Rocha	Frédéric	ENERDATA
Quadrelli	Roberta	IEA
Rousselot	Marie	ENERDATA
Santos	Miguel	MITECO (Spain)
Sturc	Marek	Eurostat
Tomescu	Mihai	EEA
Tsemekidi Tzeiranaki	Sofia	Trasys International (and external expert to JRC)

ANNEX: ENERGY EFFICIENCY SHARE IN THE ENERGY MIX OF THE FIVE MEMBER STATES WITH THE LARGEST ENERGY CONSUMPTION

Option 1: pie charts showing the final energy mix in a given year, without and with energy savings

Data about 'supply' energy carriers (oil, gas, etc.) come from Eurostat complete energy balances, to have EU27 and consistent data among the five countries. Data about energy savings come from the ODYSSEE Energy Saving Tool.

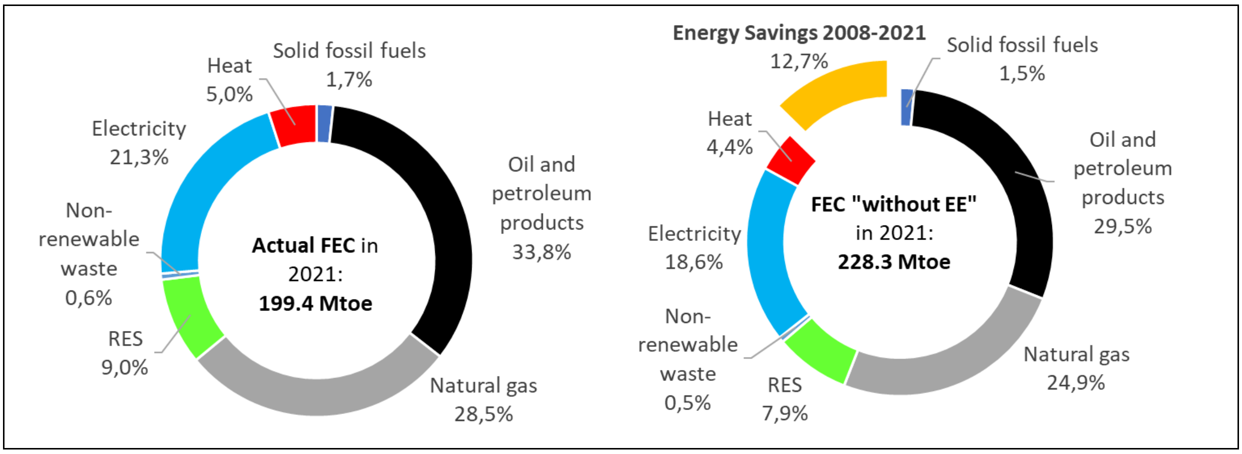
The graph on the left shows the **usual final energy mix**, as commonly used in main publications on energy statistics. It includes the 'supply' energy carriers, with shares from the actual final energy consumption in 2021. It does not show the contribution from energy efficiency.

The graph on the right shows the **enhanced final energy mix**, integrating the energy efficiency contribution. The shares for each energy carrier (including energy savings) are calculated from the final energy that would have been consumed in 2021 in the absence of the energy efficiency improvements since 2007.

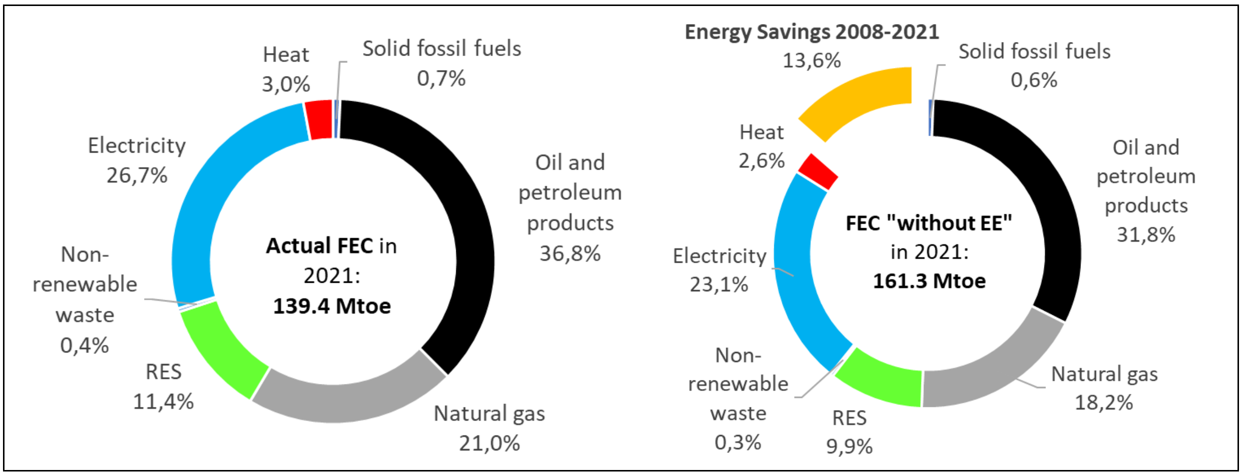
"Energy Savings 2008-2021" corresponds to the energy savings in year 2021 from energy efficiency improvements since 2007. For more explanations, see section "Integrating energy efficiency in the energy mix from top-down results" above.

Countries are shown below by decreasing order of final energy consumption in 2021.

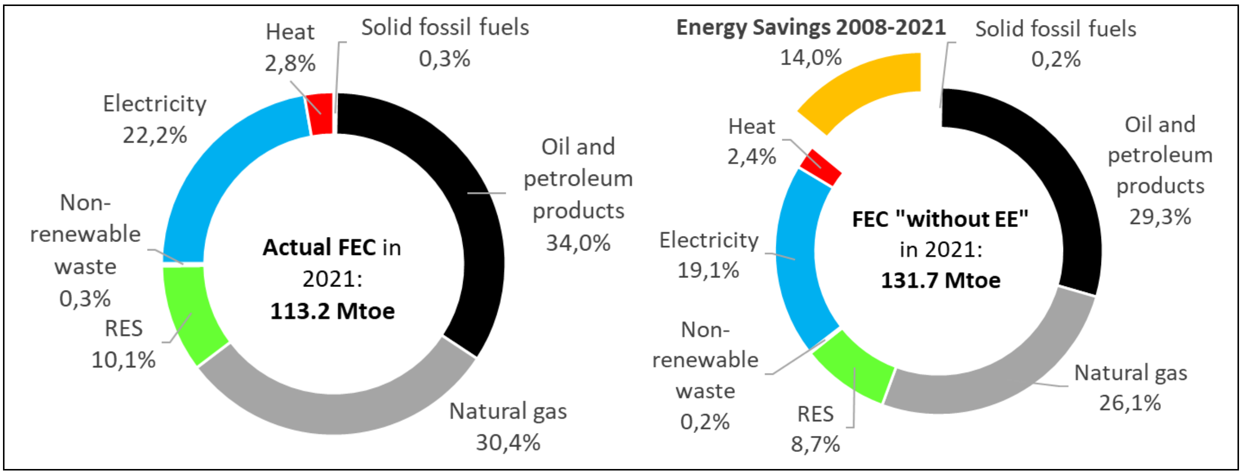
Germany



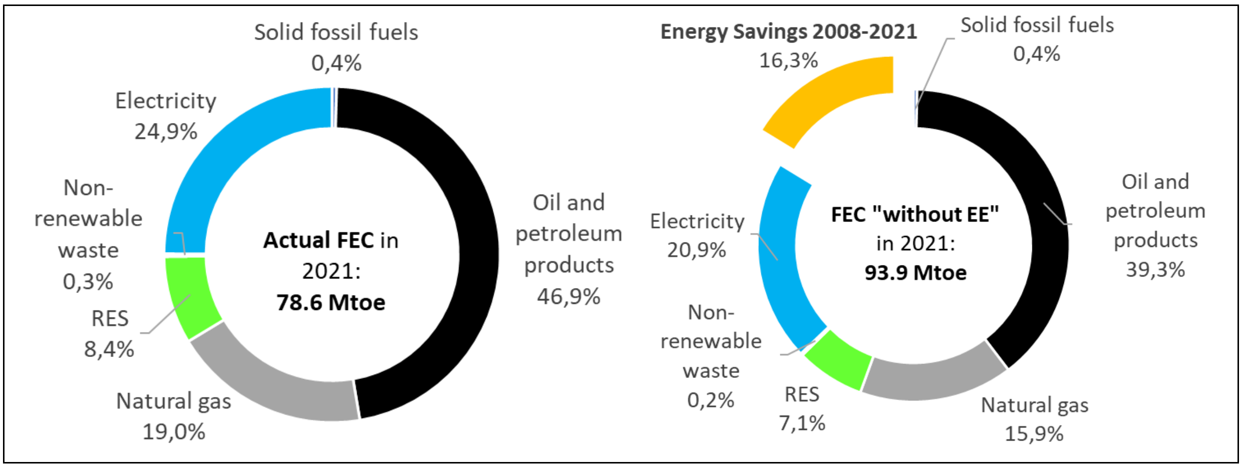
France



Italy



Spain



Poland

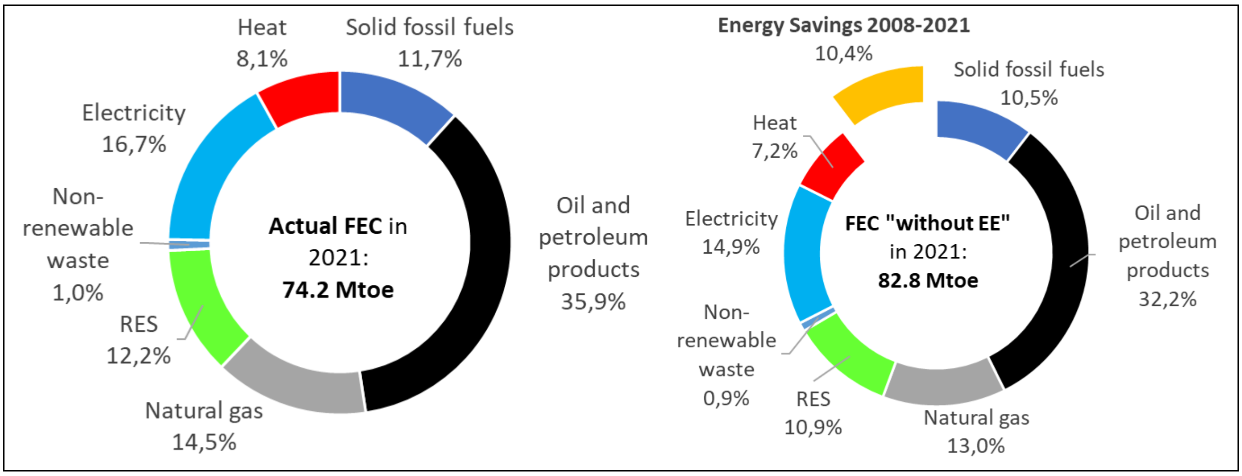


Figure 25. Pie charts without and with the energy efficiency contribution in the energy mix for year 2021, for Germany, France, Italy, Spain and Poland.

Option 2: stacked-areas charts showing the final energy mix over a given period

Data come from the same sources as for the pie charts: Eurostat complete energy balances and ODYSSEE Energy Saving Tool (see details above).

The stacked area "energy savings" corresponds to the energy savings in a given year from energy efficiency improvements since 2007.

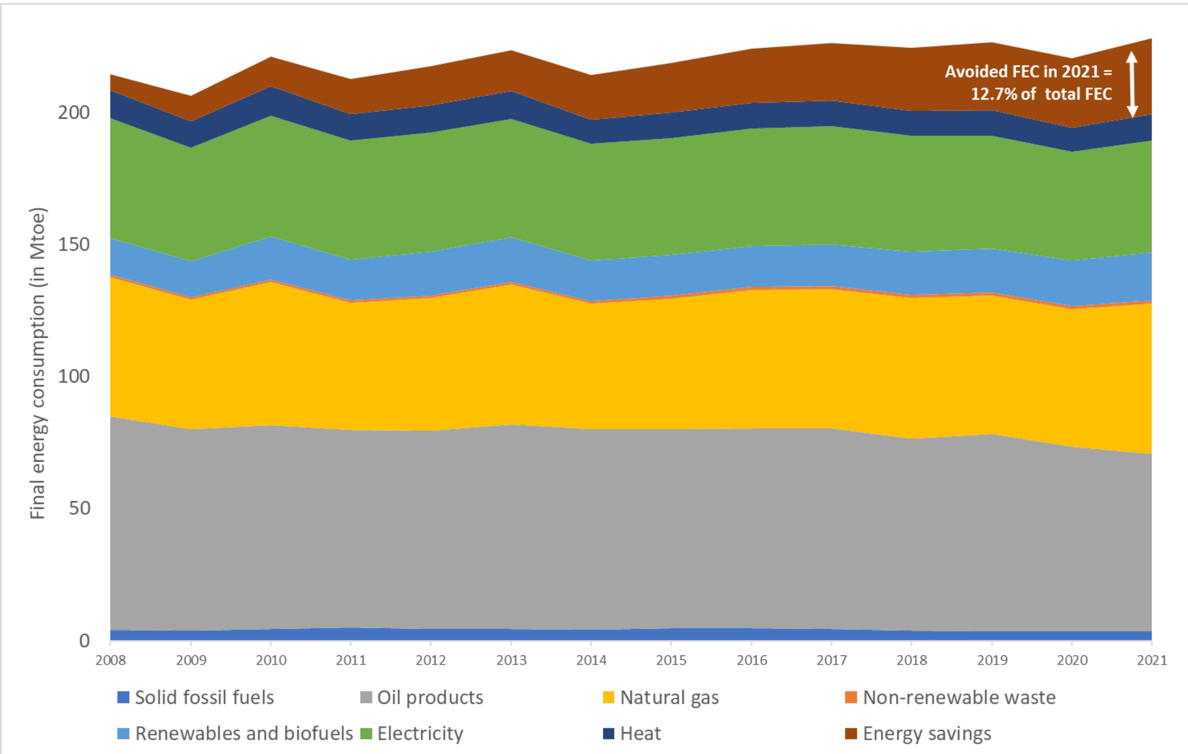


Figure 26. Final energy consumption (in Mtoe) in Germany over 2008-2021, including energy savings (last area on top).

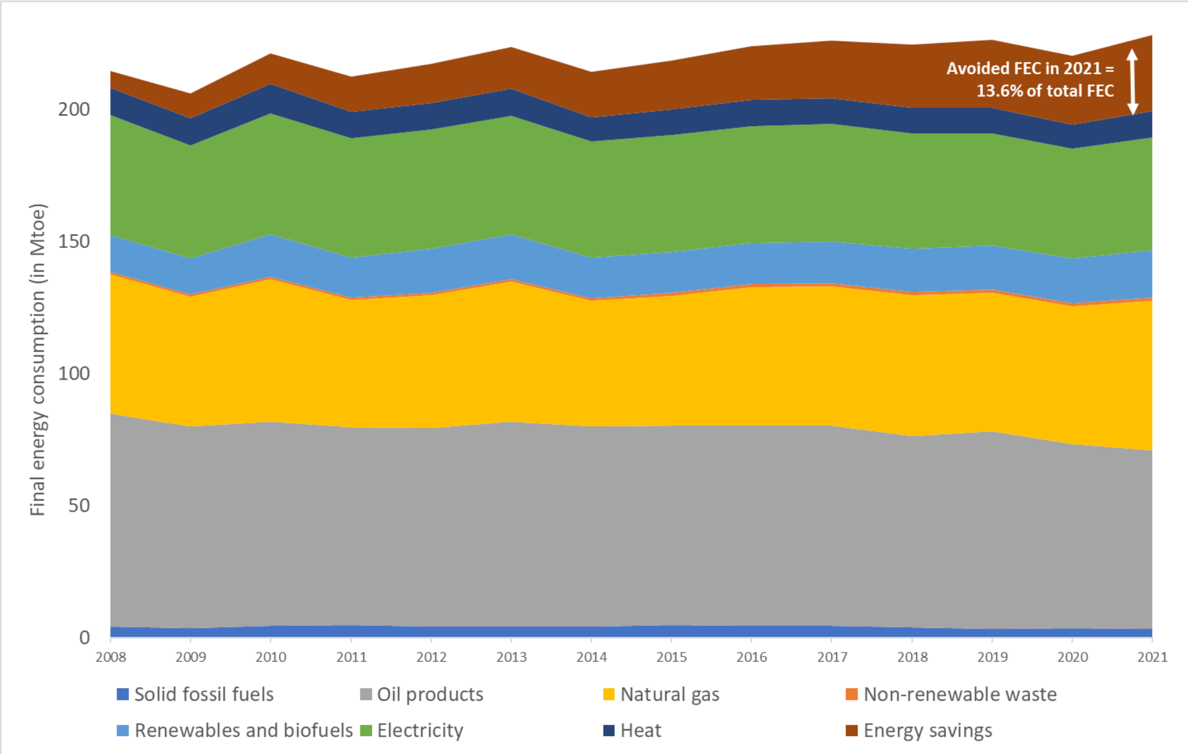


Figure 27. Final energy consumption (in Mtoe) in France over 2008-2021, including energy savings (last area on top).

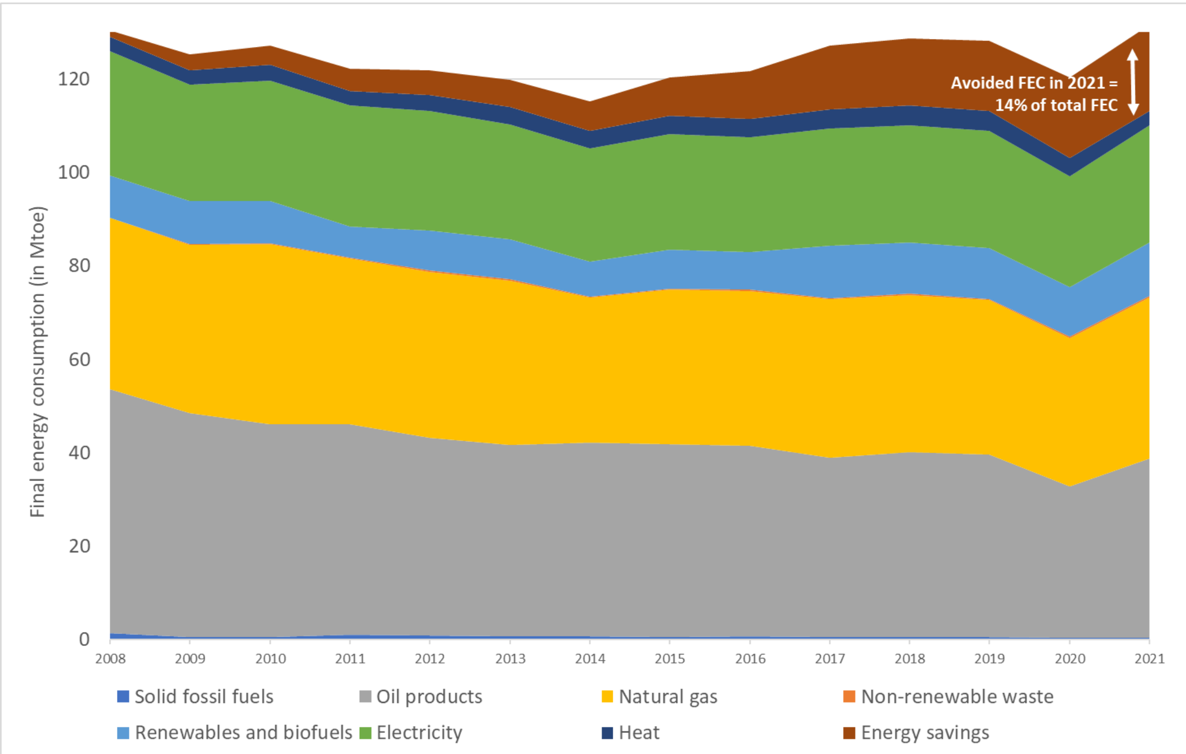


Figure 28. Final energy consumption (in Mtoe) in Italy over 2008-2021, including energy savings (last area on top).

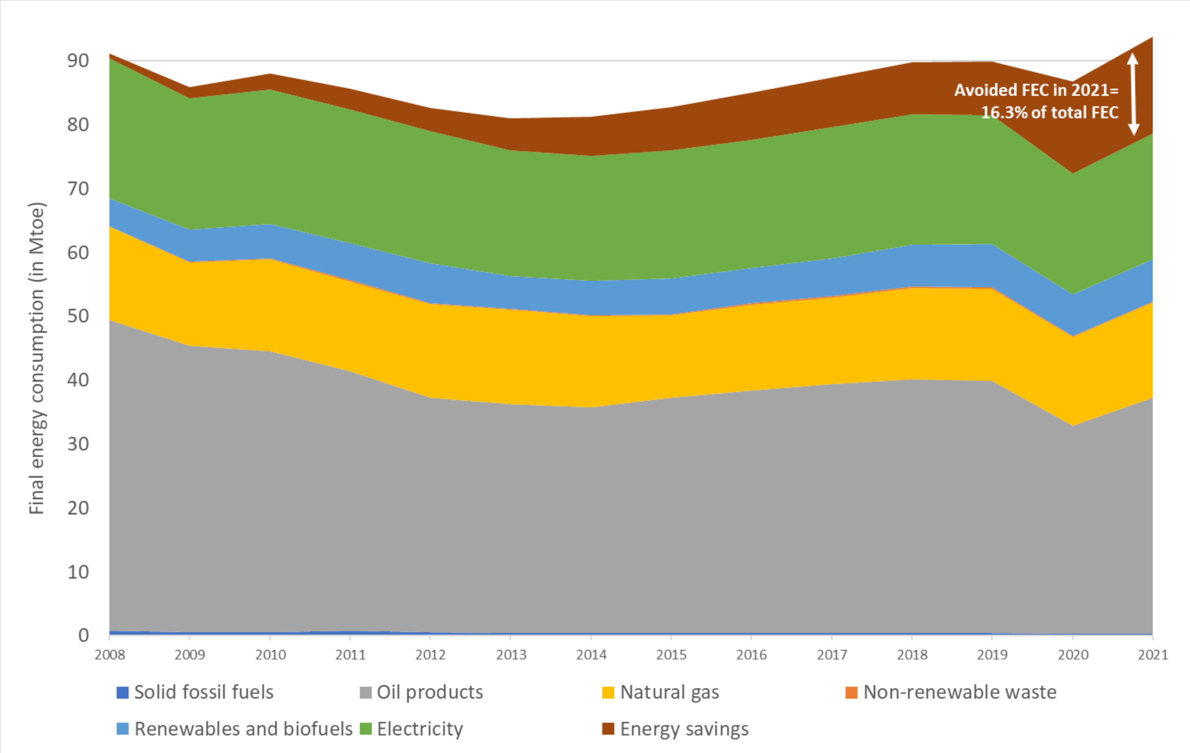


Figure 29. Final energy consumption (in Mtoe) in Spain over 2008-2021, including energy savings (last area on top).

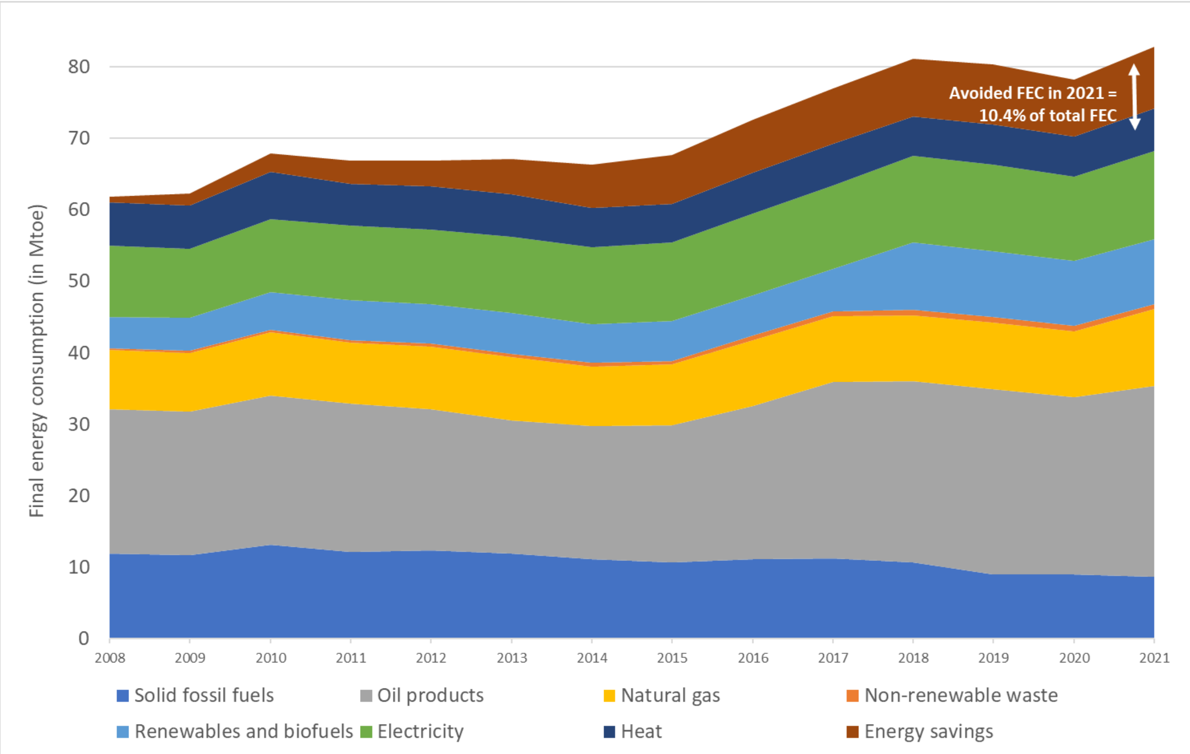


Figure 30. Final energy consumption (in Mtoe) in Poland over 2008-2021, including energy savings (last area on top).