ODYSSEE-MURE

Energy efficiency in time of crisis at EU level

Odyssee-MURE webinar series on Energy Efficiency

March 12, 2025

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This project has received funding from the European Union's LIFE programme under grant agreement No. 101075902

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About ODYSSEE-MURE

Supported by LIFE-CET programme

Coordinated by ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE **with the support of** Enerdata intelligence + consulting **and** Fraunhofer ISI

Enerdata intelligence + consulting → ODYSSEE

Fraunhofer ISI → MURE

Based on a network of 40 national partners

27 EU Member States + 9 Energy Community parties + Switzerland

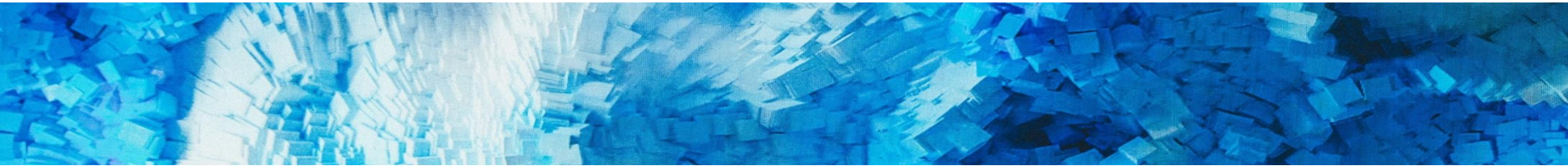
About ODYSSEE

- Data and energy efficiency indicators up to 2023:
  - From Eurostat for aggregate data (2023)*
  - From national partners for detailed data (2022), supplemented by early estimates for 2023 computed by Enerdata

- Data and indicators available in a database and 6 tools : www.odyssee-mure.eu

Agenda

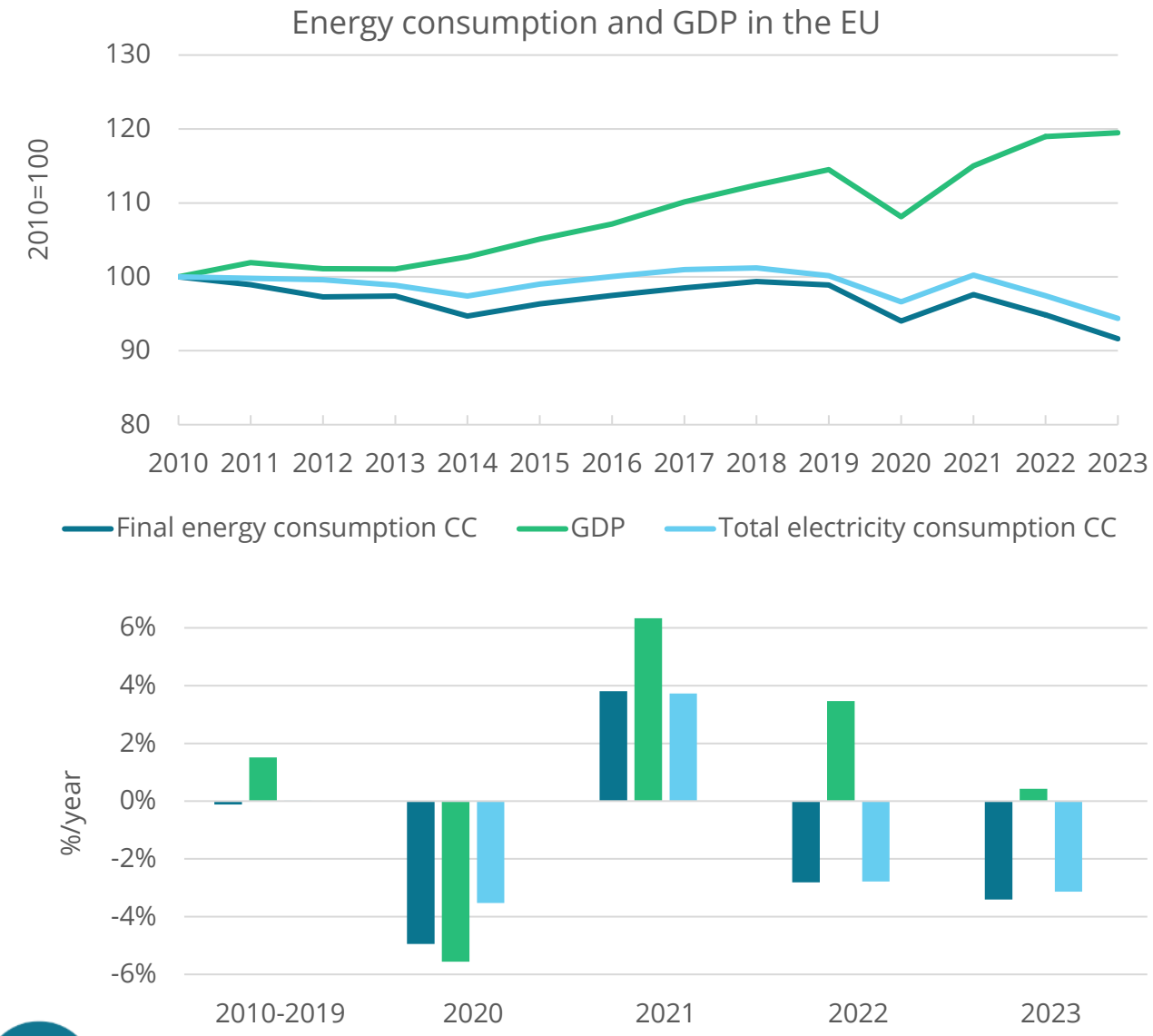
1. Final energy consumption trends
2. Energy efficiency trends
3. Drivers of final energy consumption changes
4. Total energy supply trends



1 Final energy consumption trends

Enerdata

Final energy consumption and GDP in the EU



- **Final energy consumption has been slightly decreasing since 2010.**
- **Stronger reduction after 2021**, (-3.1%/yr, compared to -0.2%/yr over 2010-2021), linked to steep price rises in 2022 and to a slower economic growth in 2023 (+0.4%).
- **Similar trend for electricity consumption** (-3%/yr, compared to stagnation before).
- Three years of "crisis":
  - 2020: Covid (-5% in final consumption)
  - 2022: price rises (-2.8%)
  - 2023: slow economic growth (-3.4%)

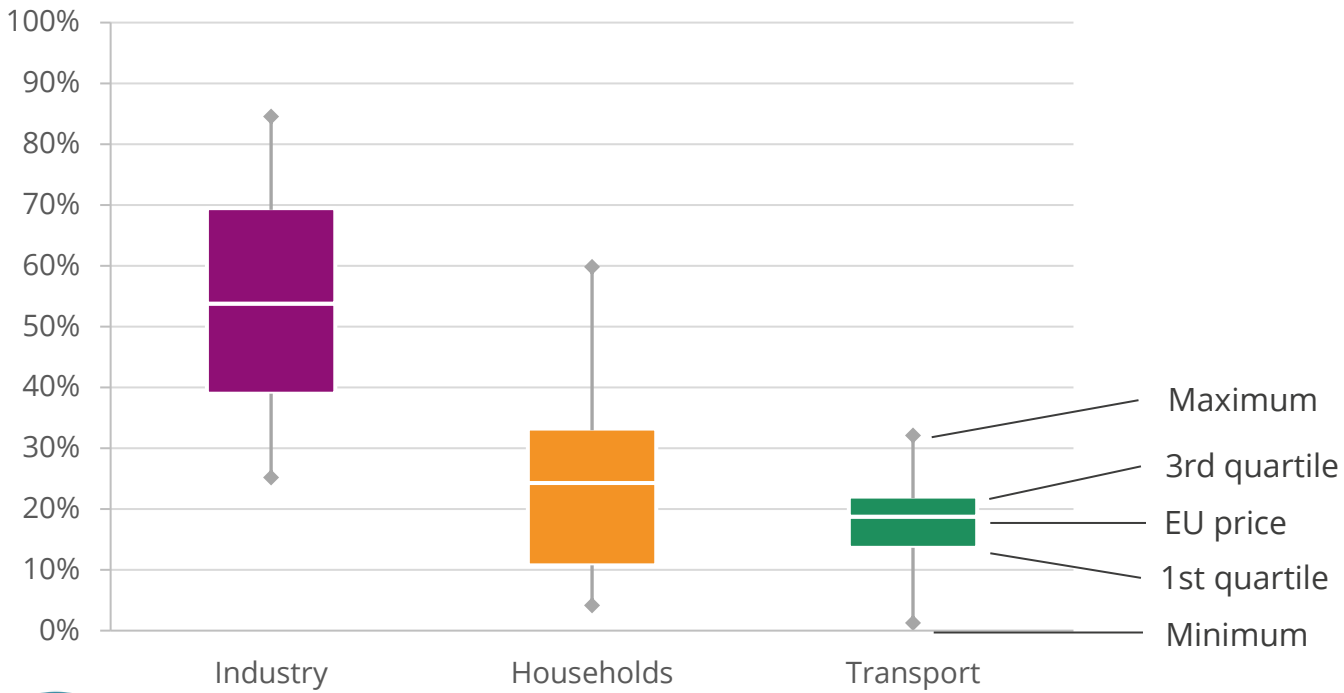
Source: ODYSSEE, based on Eurostat; consumption at normal climate, non-energy uses excluded.

Energy prices variations in 2022 in EU countries

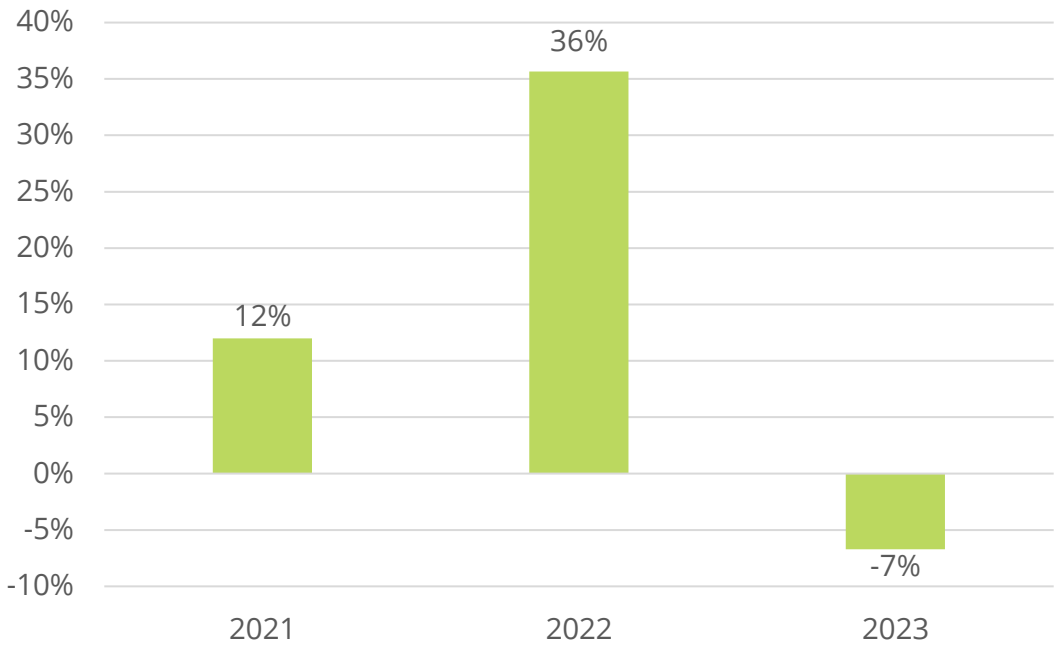
In industry, energy prices increased by more than **50% in 2022**, after a 16% rise in 2021. Prices for **households** rose by **24%**. In **transport**, the increase in motor fuel prices was more limited in 2022 (19%) but occurred after a 15% growth in 2021 (~30% over the 2 years).

The **average price** for final consumers increased by **36%** at EU level in 2022.

Energy prices variation by sector in 2022

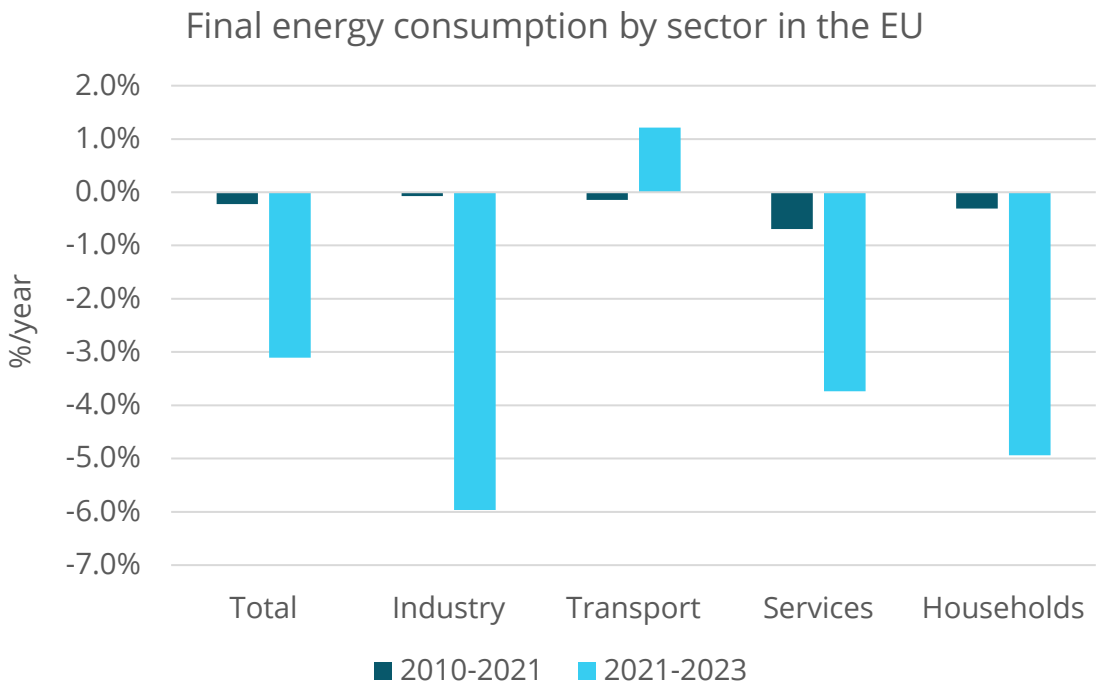


Variation in average energy price for final users at the EU level*



*Source: ODYSSEE. *Weighted average price for all end-use sectors.*

Final energy consumption by sector in the EU



Since **2021**, sharp decrease in final energy consumption in industry (-6%/year over 2021-23) and acceleration of the decreasing trend observed previously for buildings and total final consumption.

Increase in transport despite higher fuel prices.

Over **2010-2021**, total final energy consumption remained almost **stable**.

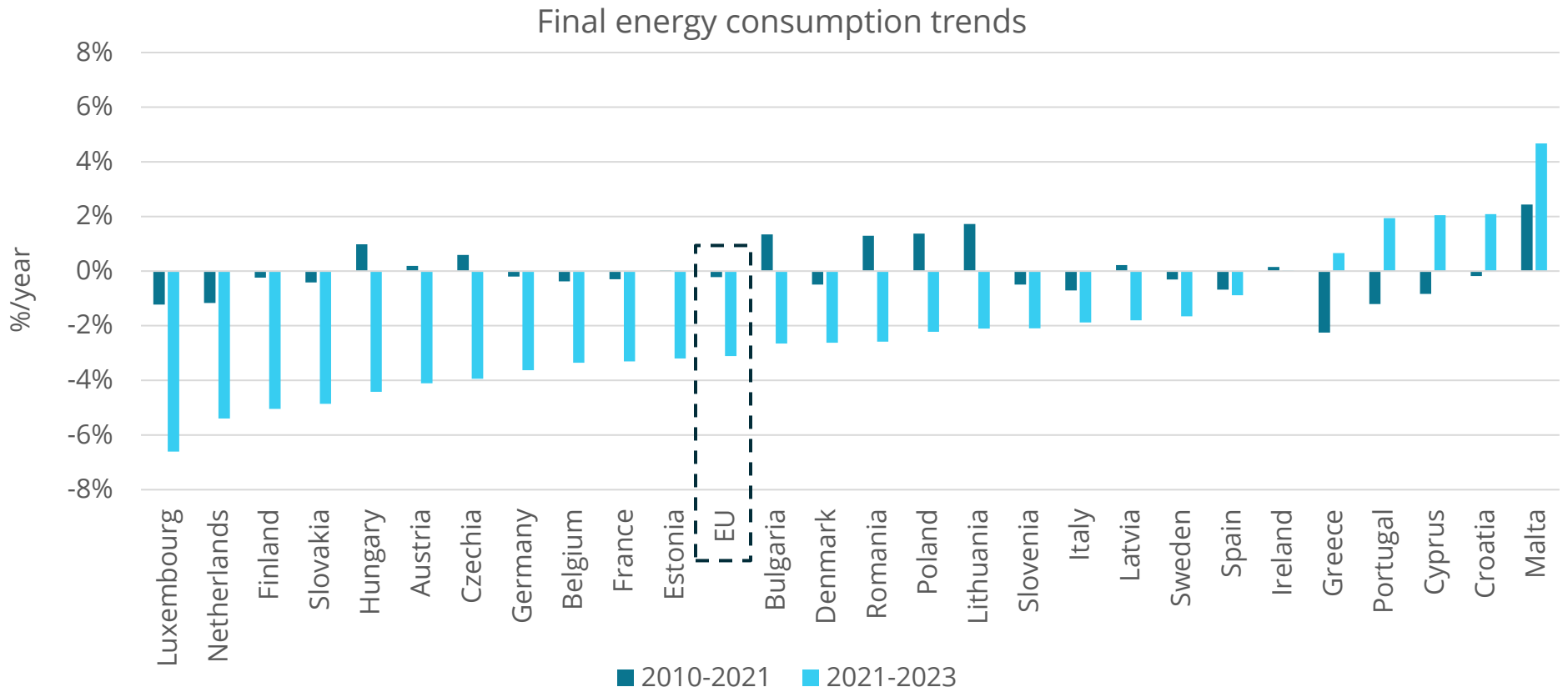
For **electricity**, the trends are similar except for services, for which the reduction was twice slower.

Source: ODYSSEE, based on Eurostat; consumption at normal climate, non-energy uses excluded.

Final energy consumption trends by country

Final consumption decreased in most EU MS since 2021 (except in 5 countries), with a steep reduction (above 3%/year) in 11 countries and at EU level.

Final consumption slightly decreased **before 2021** in 16 countries, as at EU level.



Source: ODYSSEE, based on Eurostat; consumption at normal climate, non-energy uses excluded.

2 Energy efficiency trends

Enerdata

How is energy efficiency progress measured in ODYSSEE?

Energy efficiency progress is measured by end-use or sub-sector with various indicators of specific consumption measured in **physical units** selected to be as as close as possible to energy efficiency*:

- For transport, in goe/km* and l/100 km for new cars, in toe/pkm for cars, in goe/tkm for trucks, etc.
- For households, in koe/m^2 for heating, in kWh/appliance for large appliances, in toe/dwelling for cooking or water heating, etc.
- For industry, in toe/ton for energy intensive products (steel, cement, pulp and paper), in toe/IPI for other branches.

Key indicators can be at https://www.indicators.odyssee-mure.eu/online-indicators.html
**goe: gram oil equivalent (1 goe = 10^{-6} toe); koe: kilogram oil equivalent (1 goe = 10^{-3} toe).*

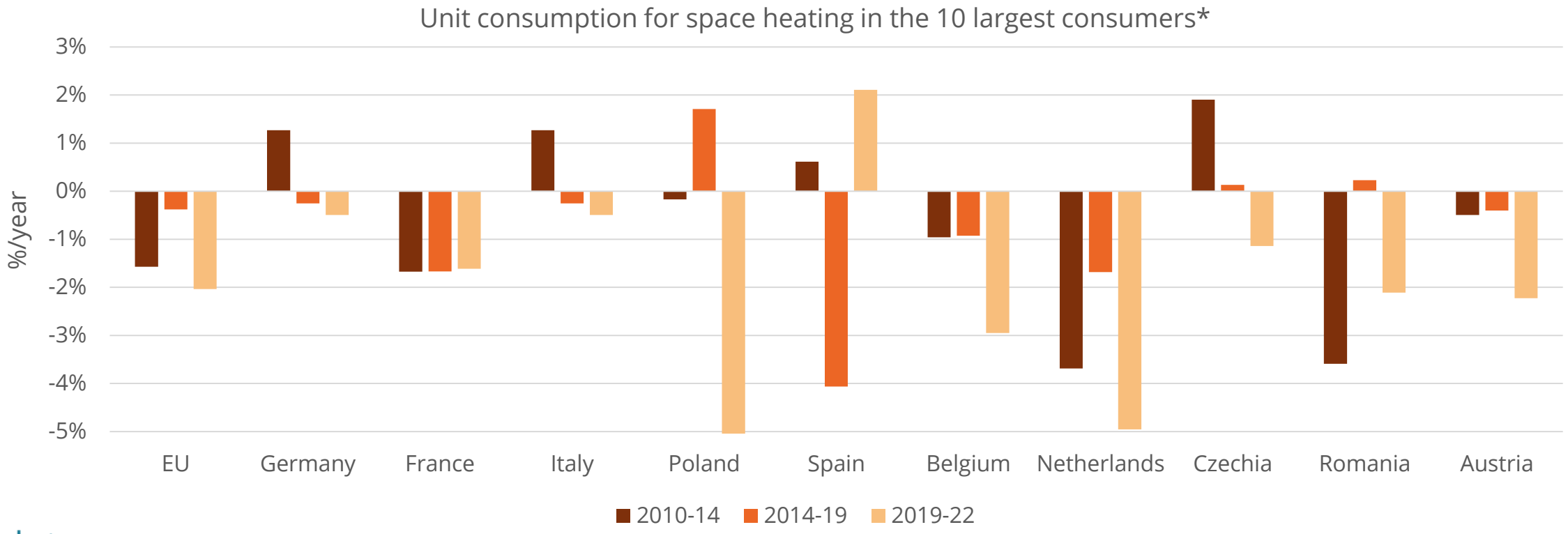
How is energy efficiency progress measured in ODYSSEE?
Case of households heating

- **Space heating** is the dominant end-use for households accounting for 64% of their consumption in 2023.
- Energy efficiency for space heating is monitored separately for new dwellings and for the dwelling stock (in **koe/m²**).
- For **new dwellings**, efficiency is driven by energy efficiency standards.
- For **existing dwellings**, efficiency is driven by renovation and changes in heating appliances:
  - **Renovation** is strongly linked to policy support which, depending on the country, is fluctuating over time; its impact depends on the number of renovations, their level (light/medium/deep) and their quality, as well as possible rebound effects.
  - Change of **heating appliances** is more regular and can be accelerated by policy measures. The trend is towards a large development of very efficient systems, mainly heat pumps, and condensing boilers for some countries.
- Changes in existing dwellings are the main drivers of the average specific consumption for heating, given the low share of new construction (< 1% every year of the total stock of dwellings).

Heating consumption per m^2: acceleration since 2019

Net acceleration since 2019 of the reduction of the heating consumption per m^2 (-2%/yr at EU level, i.e. above pre-2014 trends) and rapid reduction in 60% of the largest consumers; this reflects the strong price increases in 2022 and a sustained effort in energy efficiency.

Low decrease over 2014-2019 in half of the countries, especially in some of the largest ones (e.g. Germany, the Netherlands), or increase in Poland, partly driven by low prices and income increase.

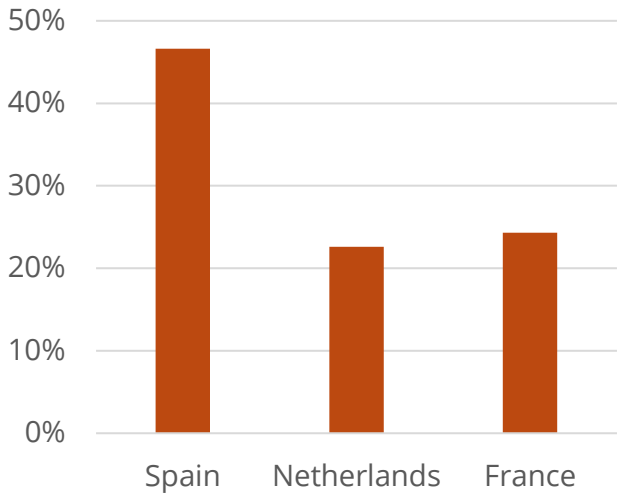


*Source: ODYSSEE. *Countries representing 85% of the EU heating consumption (Belgium: toe/dwelling).*

Renovation of existing dwellings

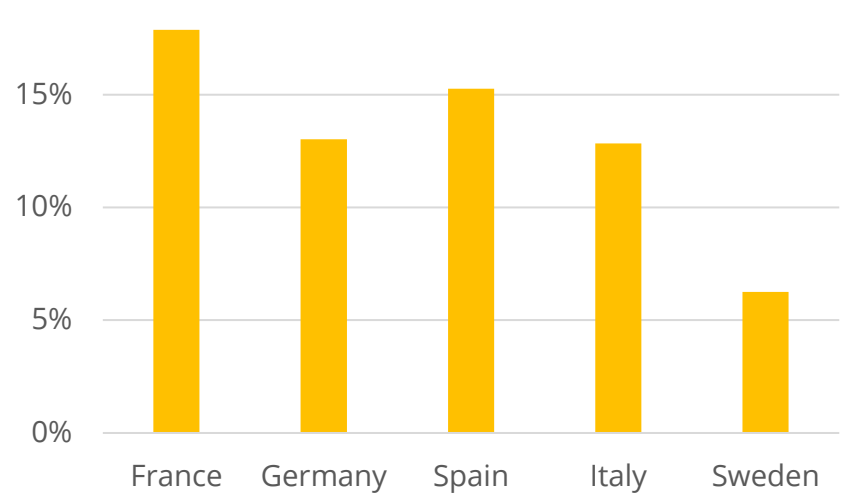
It is difficult to get data on renovation works and efficient new appliances. The various indicators collected in ODYSSEE indicate that refurbishment activities have amplified since 2019.

Variation in the number of annual renovations 2020-2022 vs. 2014-2019



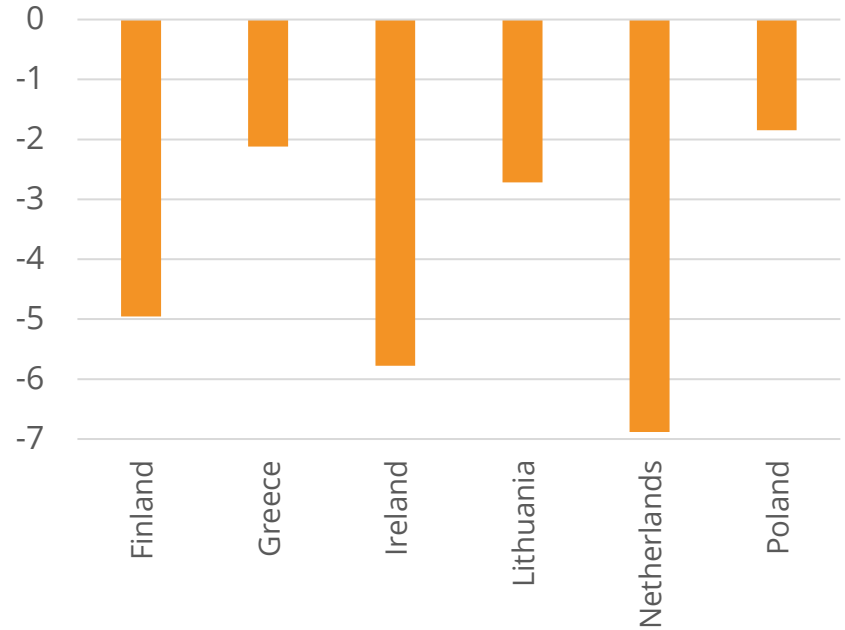
Source: ODYSSEE

Variation in the number of dwellings equipped with heat pumps (%/yr) 2019-2023



Source: ODYSSEE from EHPA

Variation in the share of poorly insulated dwellings (labels D to G) (% points) 2019-2022



Source: ODYSSEE

How is energy efficiency progress measured in ODYSSEE?
Case of cars

Cars absorb **half** of the consumption of the transport sector.

In Odyssee, we monitor the efficiency of **new cars** and the efficiency of the **car stock**.

For **new cars**, specific consumption corresponds to test values (l/100 km for thermal vehicles, goe/km for electric cars and average).

For the **car stock**, different indicators are used depending on the definition of energy efficiency:

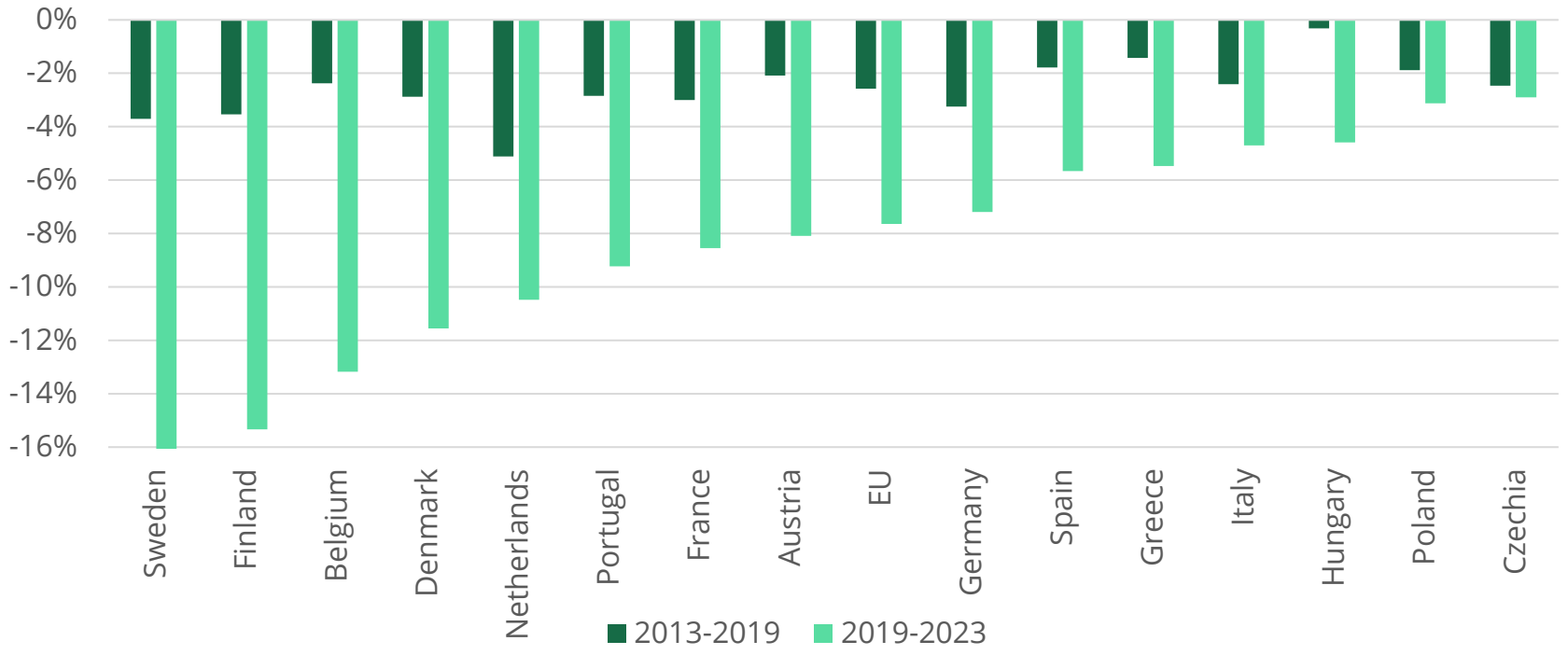
- **goe/km** to capture **technical efficiency**
- **goe/pkm** to measure the **overall efficiency** (i.e. including the effect of change in load factor)
  ➔ indicators used in ODYSSEE following the recommendation of the EU Commission

Energy efficiency progress for new cars

The specific consumption of **new cars is decreasing rapidly** (-4.5%/year at EU level from 2013 to 2023), with the greatest progress in Sweden (-9%/yr), followed by Finland (-8.5%/yr), the Netherlands and Belgium (-7%/year).

This reduction has **accelerated since 2020** (tripling at EU level), with the rapid **penetration of electric and hybrid cars**: from 3% in 2019 to 21% in 2023 at EU level (14% BEV).

Specific consumption of new thermal and electric cars in the largest countries* (test values, goe/km)



*Source: ODYSSEE from EEA, WLTP standard. *Countries representing 90% of the cars' consumption.*

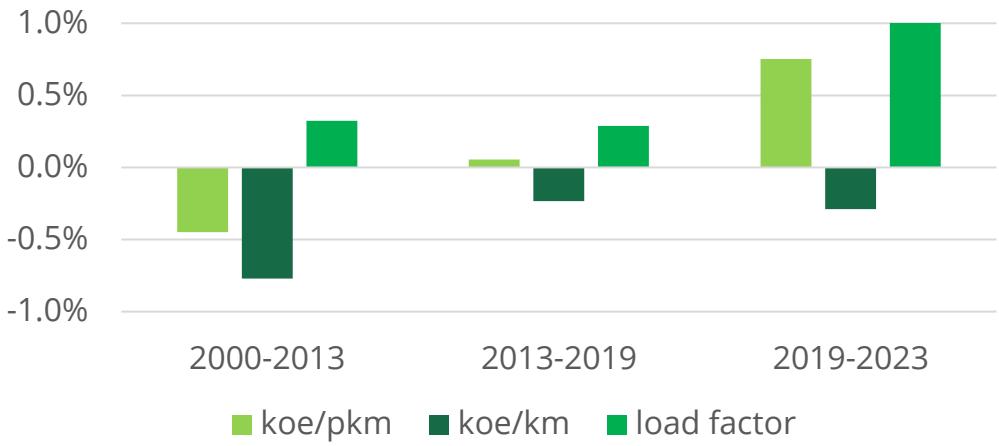
Energy efficiency trends for the stock of cars

In the EU, the **technical efficiency** of cars, measured in koe/km (orange), has only slightly improved since 2013 (0.2%/year).

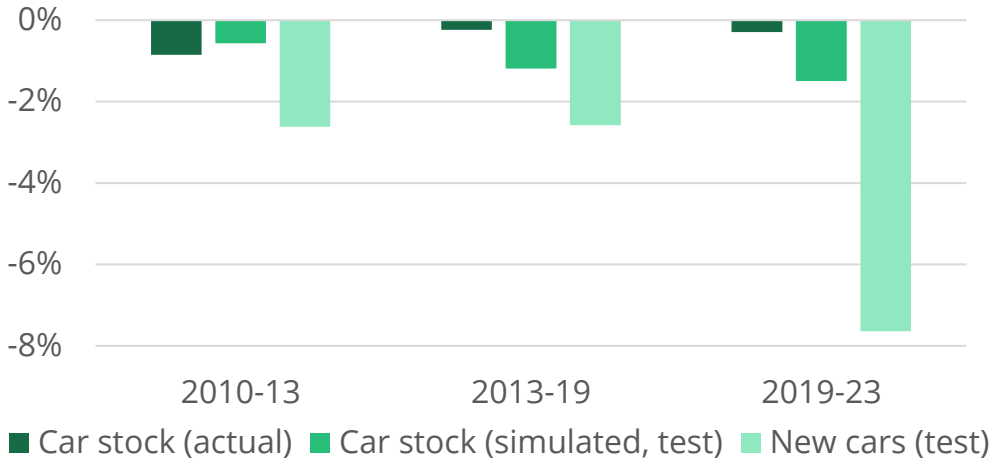
The **overall efficiency** (koe/pkm) has stopped improving since 2013, with a slight **deterioration** until 2019, which worsened significantly **since 2019**. This deterioration is the result of a significant **decrease in the occupancy rate** since 2020 (-8% in 2020, with only a slight rebound since then).

This situation contrasts with trends observed for **new cars.** A **simulation** of the specific consumption of cars in koe/km based on the performance of new cars (in blue) reveals a **gap** with the actual value (orange), which reflects the effect of real driving conditions vs test values (i.e. mostly driving behaviors).

Technical efficiency vs overall efficiency of cars (EU)



Technical efficiency of cars (koe/km): real vs test values (EU)



Source: ODYSSEE

How is energy efficiency progress measured at sector level in ODYSSEE?

From the different energy efficiency trends measured by end-use, sub-sector or transport mode, ODYSSEE calculates an **energy efficiency index** by sector, called "**ODEX**".

- ODEX is calculated:
  - by expressing variations in specific consumption by end-use or sub sector, as an **index of variation**;
  - then by calculating an **average index** for the sector **weighted** by the share of each end-use or sub-sector in the sector's consumption.
- Indexes of variation enable to mix different units for efficiency indicators
- ODEX is calculated based on 30 end-uses, sub-sectors or transport modes*.

** For more information on ODEX: https://www.odyssee-mure.eu/publications/archives/odex-indicators-database-definition.html*

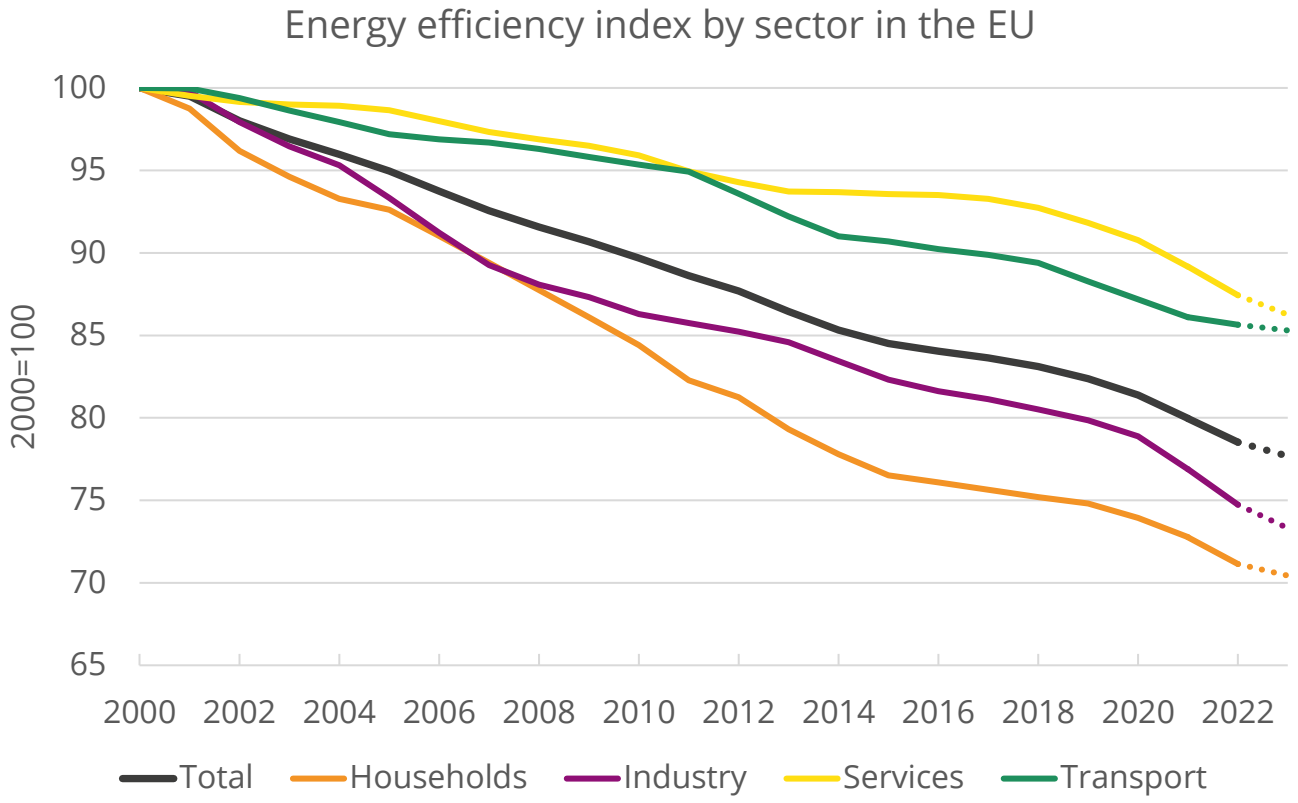
Energy efficiency trends in the EU: acceleration since 2019

Energy efficiency of final consumers has improved by **1.7%/yr** since **2019** in the EU. This represents a net **acceleration** compared to **1%/yr** since 2010.

Largest improvements for households (31%, i.e. 1.6%/year), followed by **industry** (26%, i.e. 1.3%/year).

Transport and services are lagging behind (0.7%/year each).

The recent intensification in energy efficiency progress may be partly linked to the high energy prices since 2021, which cannot always be well accounted for in indicators.



Source: ODYSSEE Energy Saving tool, https://www.indicators.odyssee-mure.eu/energy-saving.html

3 Drivers of final energy consumption changes

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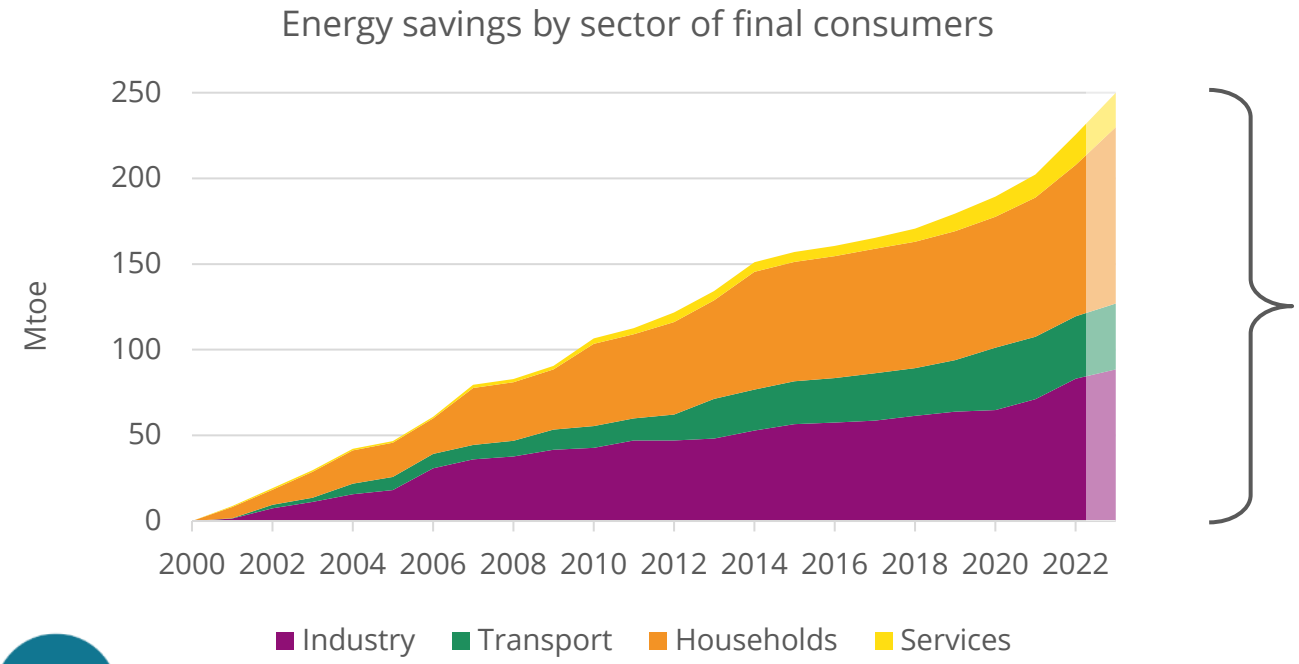
Acceleration of energy savings since 2020

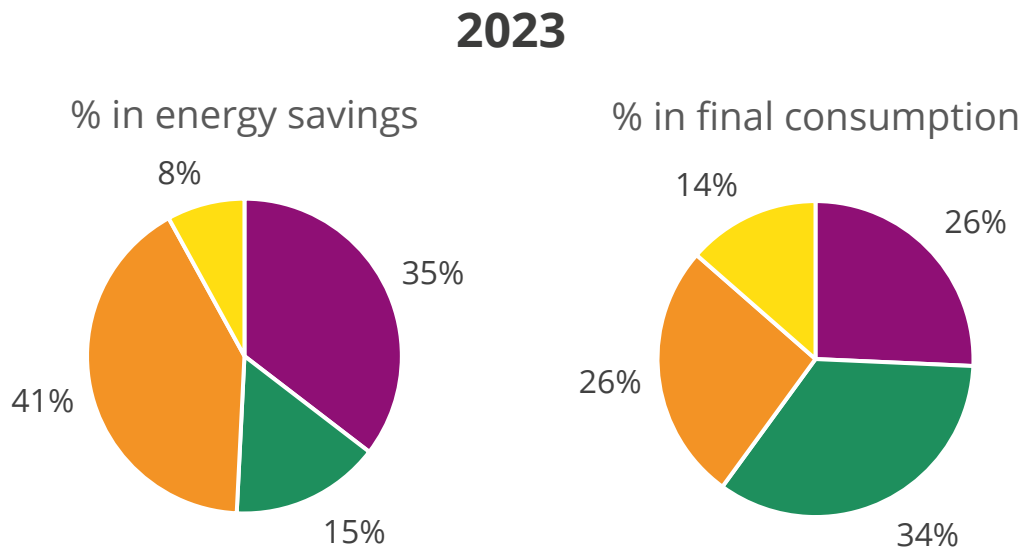
In 2023, **energy savings** of final consumers reached **250 Mtoe** in the EU: without these savings, final consumption would have been **29% higher**.

Annual additional savings have increased significantly since 2020 (~**17 Mtoe/yr**), well above the average registered over 2000-2014 (~**10 Mtoe/yr**), and 3 times higher than savings measured over 2015-2019.

Together, **industry** and **households** accounted for **77%** of these savings while representing 52% of final consumption. Transport and services lag behind with a share of savings **twice lower** than their shares in final consumption.

Thanks to these savings, EU households have saved in 2023 **540€** in their dwellings (+150€ with their cars).





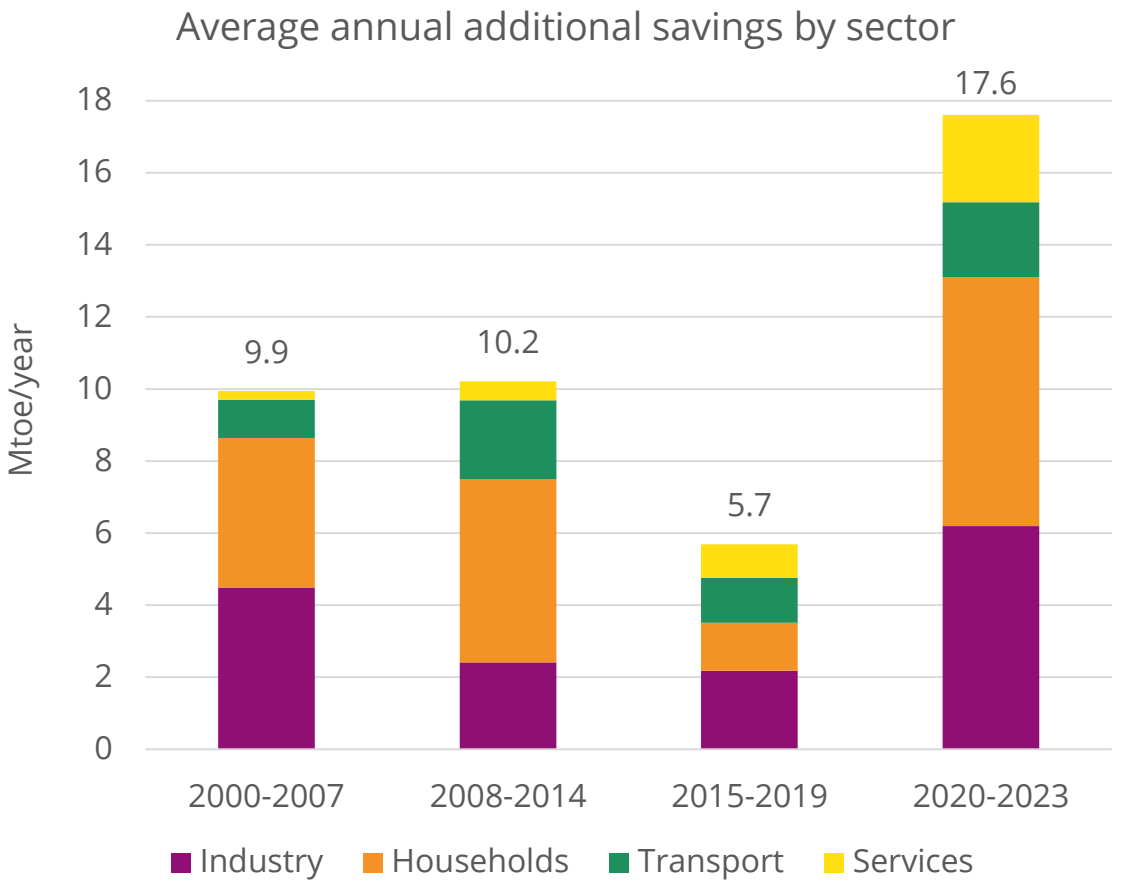
Source: ODYSSEE Energy Saving tool, https://www.indicators.odyssee-mure.eu/energy-saving.html

Acceleration of energy savings since 2020

Between 2000 and 2014, energy efficiency progress has saved an additional volume slightly over **10 Mtoe per year** at EU level.

These additional savings slowed down considerably between 2015 and 2019 (-44%) before increasing significantly since 2020 (17.6 Mtoe/year).

Since 2020, **households** and **industry** accounted for most of these savings (**75%**, 40% and 35% respectively).



Source: ODYSSEE

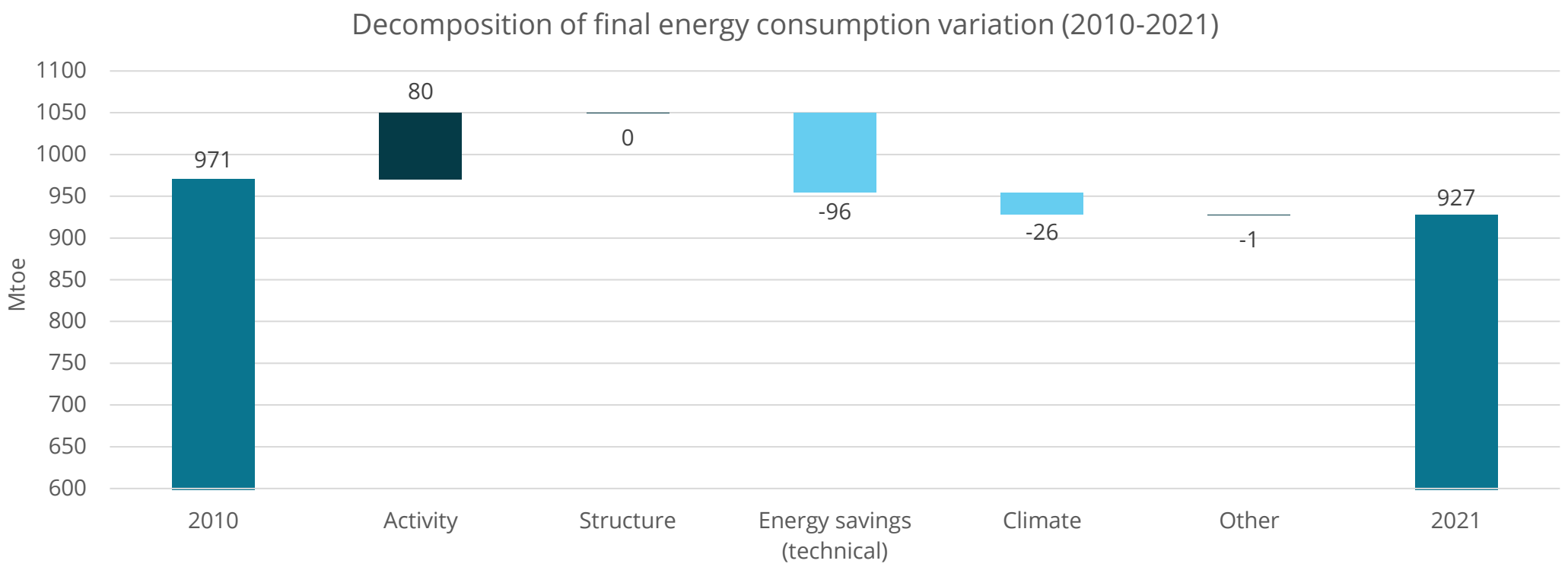
Drivers of final energy consumption variation (2010-2021)

Between 2010 and 2021, final energy consumption decreased by **43 Mtoe**.

Economic and demographic growth, increase in traffic and in number of household appliances (**activity effect**) contributed to increase final consumption by **80 Mtoe** (35% in industry, 35% from households and 25% in services).

Energy **savings more than offset** this activity effect and reduced consumption by **96 Mtoe** (35% in households, 30% in industry, 25% in transport and 10% in services).

Climatic variations between these two years were significant and reduced consumption by a further **26 Mtoe**.



Source: ODYSSEE Decomposition tool, https://www.indicators.odyssee-mure.eu/decomposition.html

Drivers of final energy consumption variation (2021-2023)

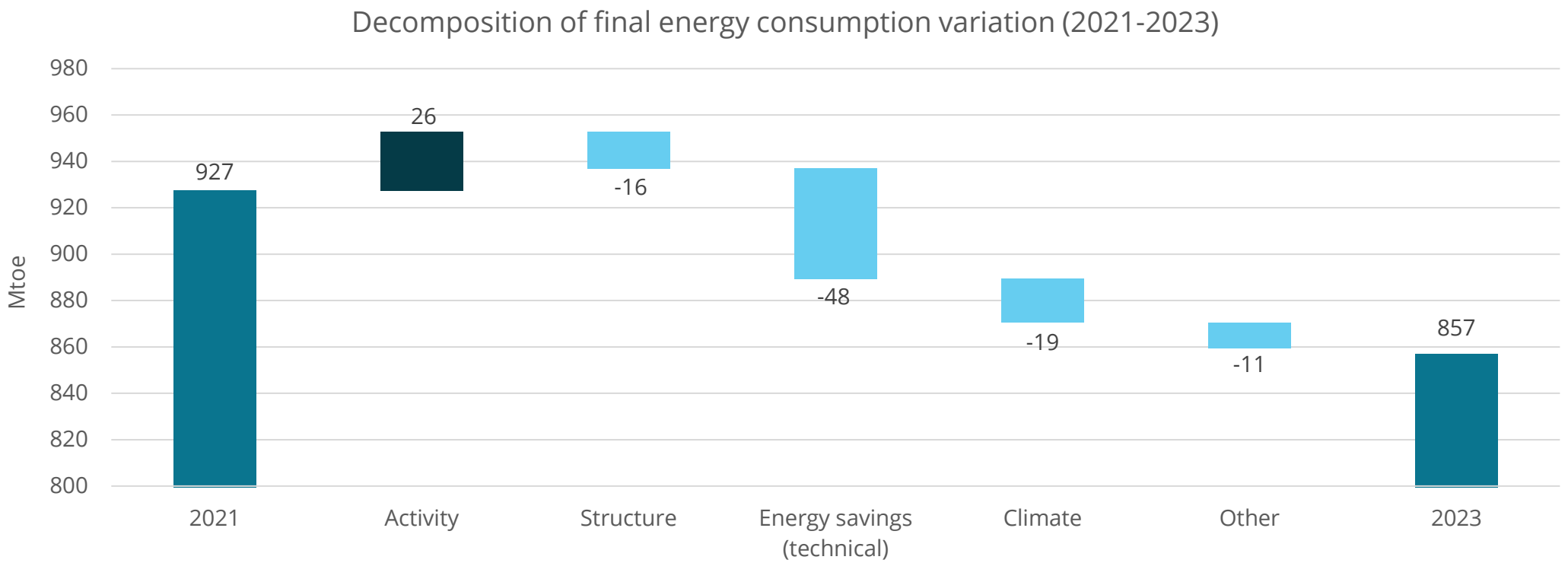
Between 2021 and 2023, final energy consumption decreased by **70 Mtoe**.

The **activity effect** contributed to increase final consumption by **26 Mtoe** (35% in transport and 30% in services).

Energy **savings more than offset** this activity effect by reducing consumption by **48 Mtoe** (45% in households and 35% in industry).

Climatic variations largely contributed to the reduction, cutting consumption by **19 Mtoe** (1/4 of total reduction).

Structural changes, towards less energy-intensive branches in industry and towards more efficient modes in transport, further reduced consumption by **16 Mtoe** (of which 85% in industry).



Source: ODYSSEE Decomposition tool, https://www.indicators.odyssee-mure.eu/decomposition.html

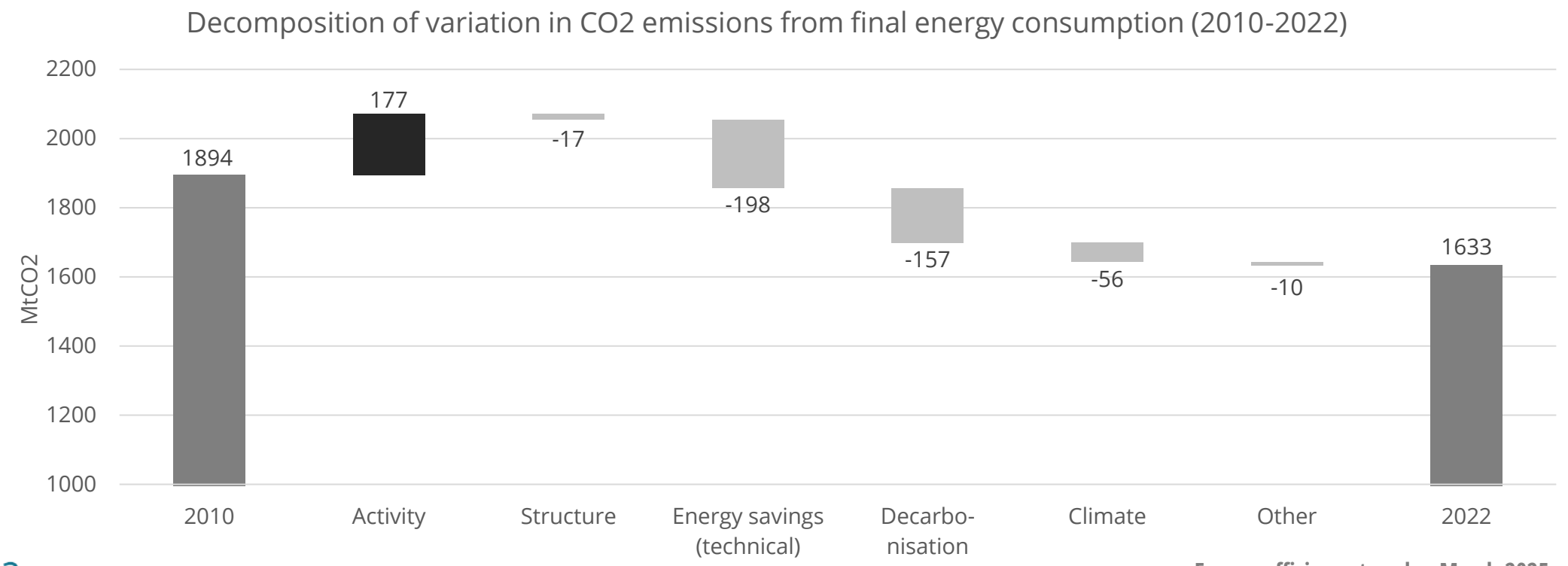
Drivers of CO2 emissions variation (2010-2022)

Between 2010 and 2022, CO_2 emissions from final energy consumption decreased by **262 $MtCO_2$**.

The **activity effect** contributed to increase CO_2 emissions by **177 $MtCO_2$** (~30% in both industry and transport).

Energy **savings and decarbonation** of the energy mix **offset** this activity effect **twice** over by reducing consumption by **198 and 157 $MtCO_2$**, respectively.

Climatic variations also contributed to the reduction, cutting CO_2 emissions by **56 $MtCO_2$** (13% of total reduction).



Source: ODYSSEE CO2 Decomposition tool, https://www.indicators.odyssee-mure.eu/co2-decomposition.html

4 Total energy supply trends

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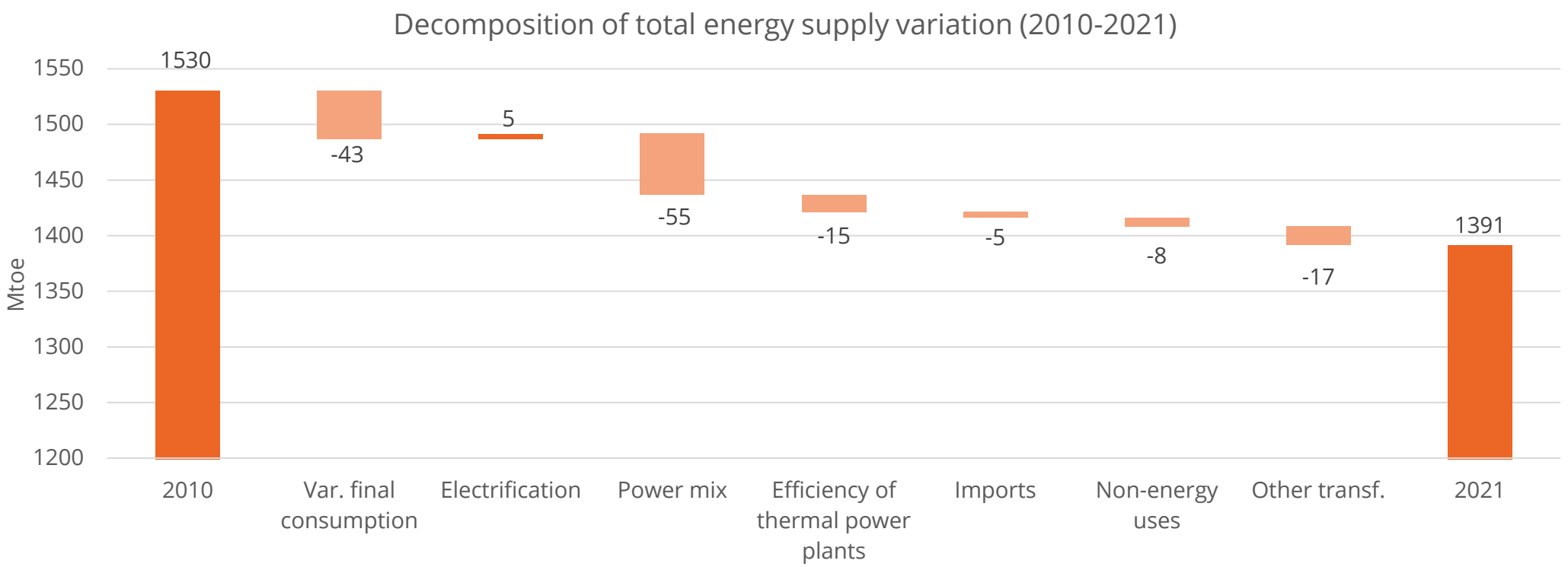
Drivers of total energy supply variation (2010-2021)

Between 2010 and 2021, **total energy supply decreased 3 times faster than final consumption**: **-139 Mtoe** vs **-43 Mtoe**.

Around 50% of the total energy supply decrease is explained by changes in the power generation:

- A **higher share of renewables** (+13.5 pts) and lower shares of thermal (-9.5 pts) and nuclear (-3.5 pts) reduced total supply by **55 Mtoe**.
- An **improved efficiency of thermal generation** (+2.1 pts), which contributed to a reduction of 15 Mtoe.



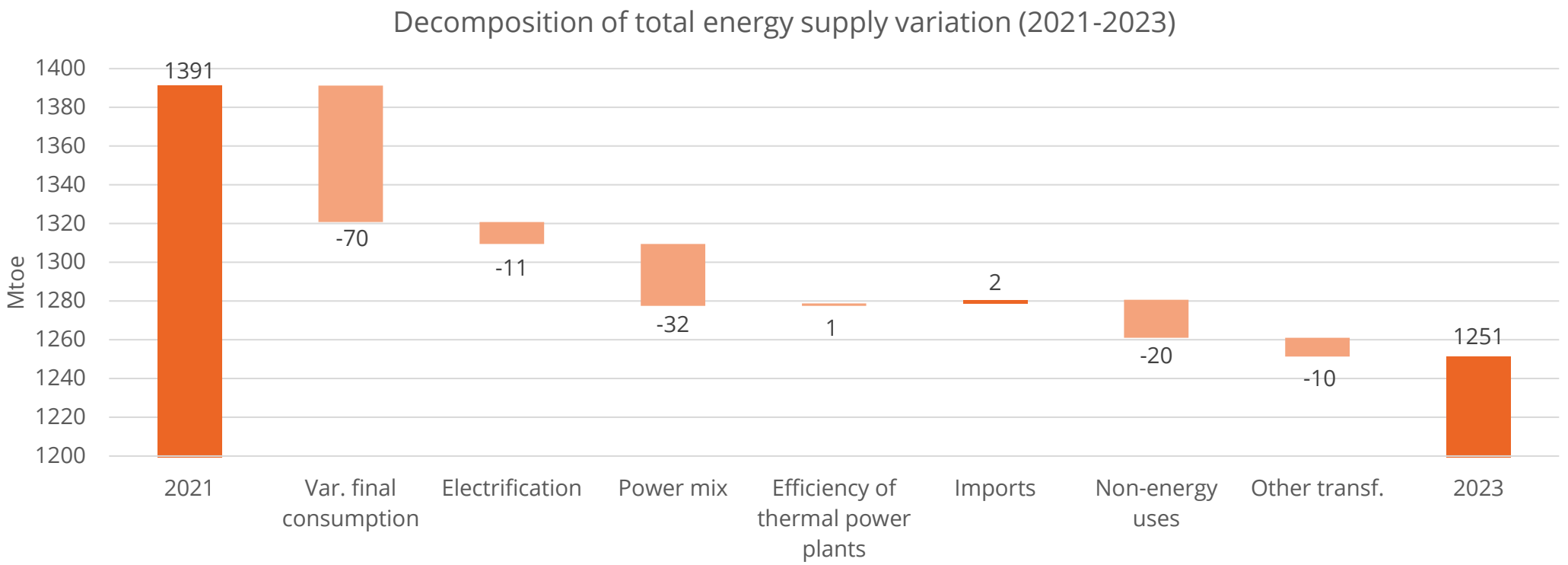
Source: ODYSSEE Decomposition tool, https://www.indicators.odyssee-mure.eu/decomposition.html

Drivers of total energy supply variation (2021-2023)

Between 2021 and 2023, **total energy supply decreased twice faster than final consumption**: **-140 Mtoe** vs. **-70 Mtoe**. This is the same reduction as over 2010-2021.

A quarter of the total supply decrease is explained by changes in the power mix: a **higher share of renewables** (+8 pts) and lower shares of thermal (-5.5 pts) and nuclear (-2.5 pts), which reduced total supply by **32 Mtoe**.

Non-energy uses also contributed significantly to this decrease (-20 Mtoe), with a drop in petrochemicals production linked to high gas prices.

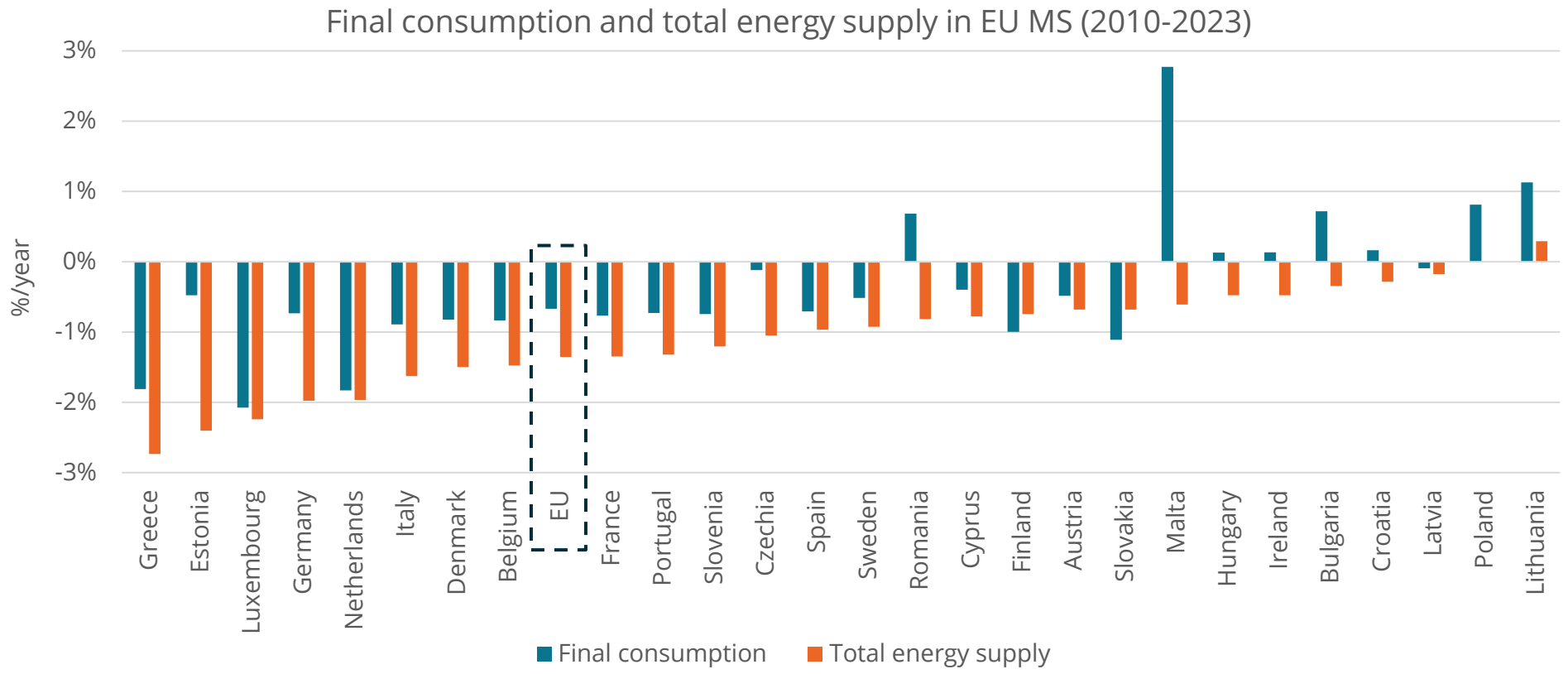


Source: ODYSSEE Decomposition tool, https://www.indicators.odyssee-mure.eu/decomposition.html

Divergent trends for total energy supply and final energy consumption

Faster decrease in total supply than in final consumption in 17 EU MS and decrease in total supply despite a growth in final consumption in 7 countries due to the development of renewables.

Reverse trend in Slovakia and Finland, because of a rising share of nuclear in the power mix (+9 and +14 pts).

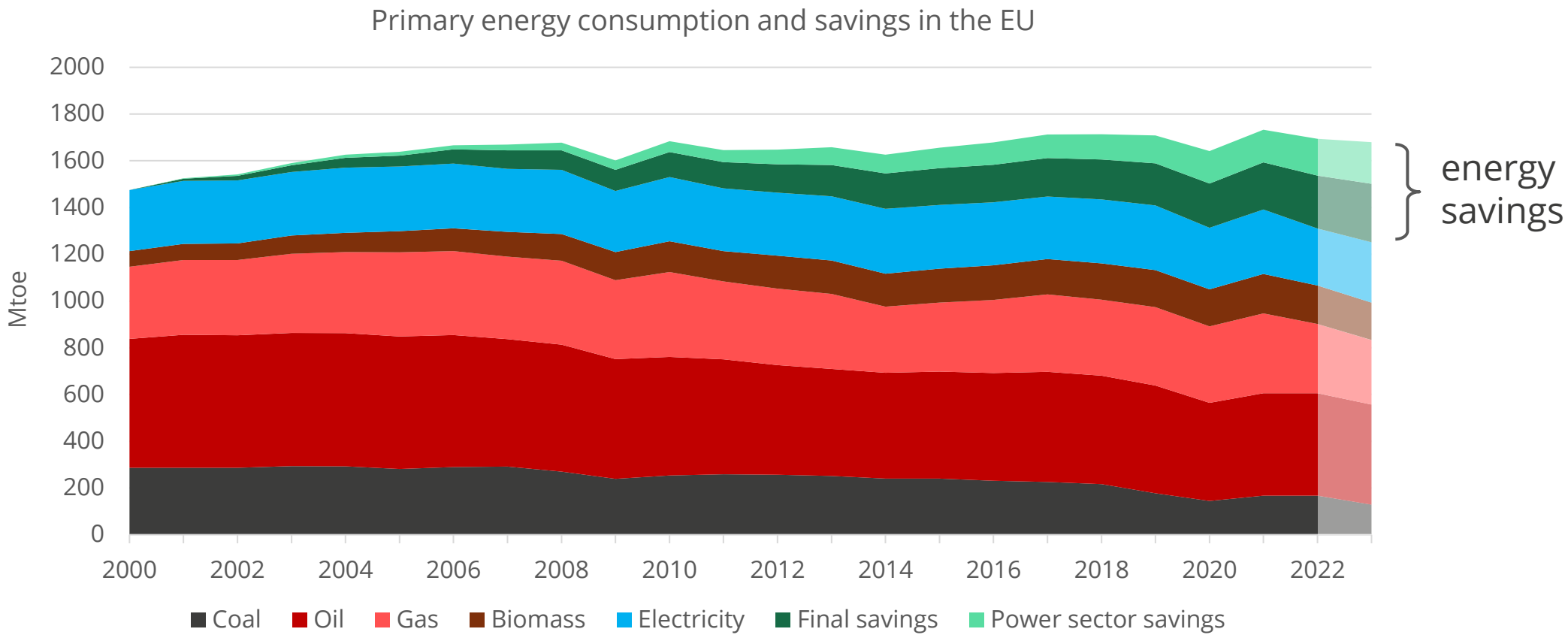


Source: ODYSSEE, based on Eurostat; consumption at normal climate.

Energy efficiency first principle

Total energy savings contributed to **428 Mtoe** in 2023 (58% from final users and 42% from power sector). They represent the "**first fuel**", just ahead of oil.

If we added up the savings since 1990 (instead of 2000), energy efficiency would be by far the first fuel.



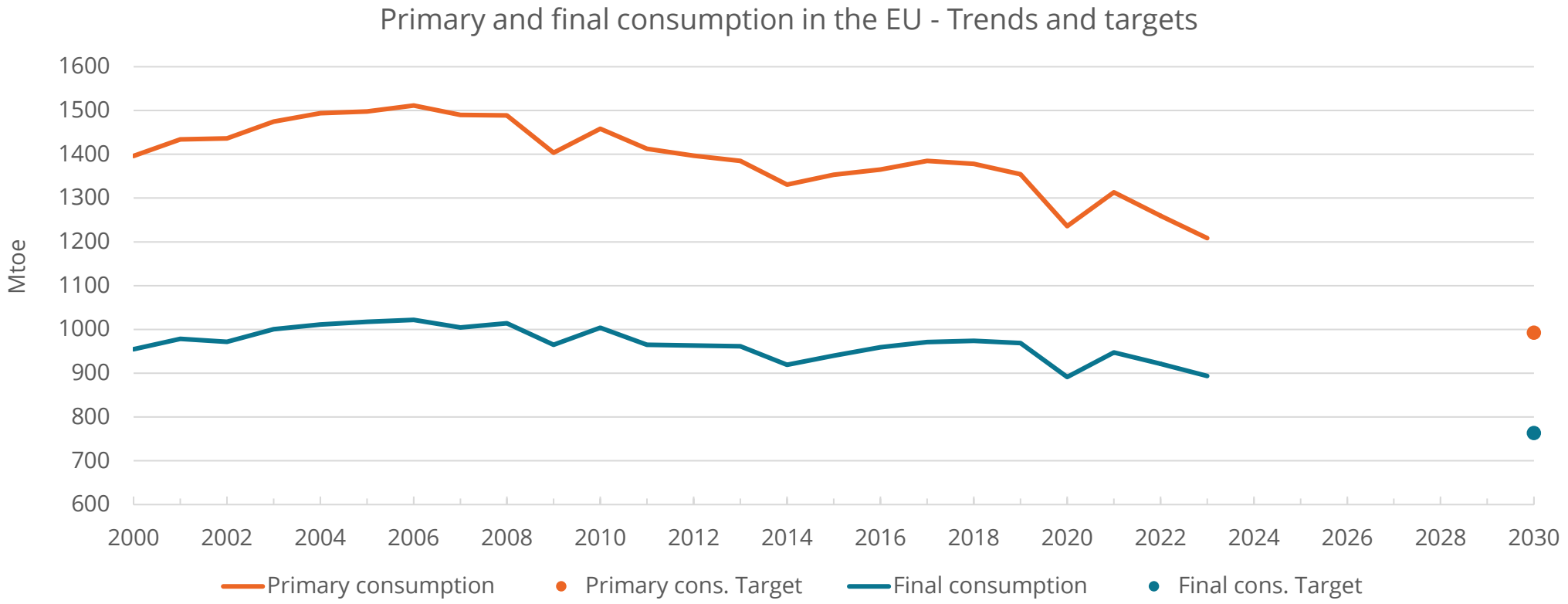
Source: ODYSSEE Energy saving tool, https://www.indicators.odyssee-mure.eu/energy-saving.html

Are we on track with Article 4 of the EED?

Article 4 of the EED targets an absolute level of consumption in 2030 for both primary and final consumption.

The integration of renewables into the power mix is rapidly reducing **primary consumption**, and this trend will continue until 2030, so the **target should be met**.

For final consumption, this will depend on the pace of economic growth, the impact of energy efficiency policies, and consumer behaviors.



Source: ODYSSEE Energy saving tool, https://www.indicators.odyssee-mure.eu/energy-saving.html

Conclusions on energy consumption and energy efficiency

- The rate of energy efficiency improvement has clearly **accelerated since 2019**: the various crises did not play a negative role (for energy efficiency), because of the intensification of policy measures and higher prices; this is particularly true in industry and for households.
- **Transport** shows mitigated results: poor savings for cars but the diffusion of electric vehicles should provide good results in the future.
- **Behaviours** play an increasing role for both cars and heating: negative for cars but positive for households. For households, part of this may be due to higher energy prices and may be partly reversible.
- Since 2021, **energy savings** strongly contributed to the rapid decrease in consumption. Behaviours, structural changes and climate also contributed.
- **Primary consumption** has decreased much **faster than final consumption** because of a higher contribution of wind and solar in the power mix; this decoupling will continue in the future, with the growing share of renewables in power generation.

HELPING YOU SHAPE THE ENERGY TRANSITION

About Enerdata:

Enerdata is an independent research company established in 1991, specializing in the analysis and forecasting of energy and climate issues, at world and country level.

Leveraging our globally recognised databases, intelligence systems and models, we assist our clients in designing their policies, strategies and business plans.

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