Alternative approaches to reviewing the EU energy efficiency target

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Introduction

WHAT?

The European Union’s Energy Efficiency Directive sets a binding target to reduce final energy consumption by 11.7 percent by 2030.

While this target plays an important role in guiding Member States toward more sustainable and efficient energy systems, the transition currently underway in Europe is reshaping how energy is produced, consumed and valued.

Electrification, the expansion of renewable energy, the emergence of new industries such as data centres and green hydrogen produce a conflict of interest with the energy reduction target.

WHY?

The aim of this report is to explore alternative ways to understand and assess energy efficiency in this changing context.

Instead of relying on a single absolute consumption figure, the report introduces a broader set of indicators grouped into four themes.

These themes describe how energy use relates to competitiveness, sustainability, energy security and affordability.

Each theme captures a different dimension of the energy transition, helping to reveal not only how much energy is used but what this energy achieves.

HOW?

To demonstrate how a broader assessment can work in practice, this report applies alternative metrics to a case example using Finland’s 2024 energy balance.

Two simplified future scenarios were created for illustrative purposes. They are not forecasts or recommendations but designed to show how different changes in the energy system appear when viewed through the metrics.

The following chapters outline the key assumptions, show how the metrics respond in each scenario and highlight why a more holistic approach is needed to capture effects that a single consumption target would overlook.

Acronyms

ACER	EU's Agency for the Cooperation of Energy Regulators
CO2eq	Carbon Dioxide equivalent
CEER	Council of European Energy Regulators
EEA	European Environment Agency
EED	Energy Efficiency Directive
EEOS	Energy Efficiency Obligation Schemes
EPBD	Energy Performance of Buildings Directive
FEC	Final Energy Consumption
GDP	Gross Domestic Product
GHG	Greenhouse gas
IEA	International Energy Agency
JCR	Joint Research Centre
MWh	Megawatt-hour (10^3 kWh)
ODYSSEE	Database that contains data about EU member state's energy consumption and CO2 indicators
RED III	Renewable Energy Directive
SCOP	Seasonal Coefficient of Performance
TSO	Transmission System Operator
TWh	Terawatt-hour (10^9 kWh)

EU Energy Efficiency Directive (EED)

Background, Logic, Strengths and Weaknesses

Background:

The EED sets binding EU-level energy efficiency targets, aiming for at least an 11.7% reduction in final energy use by 2030 compared to the projections of the 2020 EU Reference Scenario.

Logic:

The directive pushes the member states to save energy and resources, not wasting them. It uses a top-down approach, requiring all member states to contribute to the common EU-level target. Each member country have their own target levels.

Strengths:

Provides a unified EU framework and comparability.
Drives investment and innovation in energy efficiency.

Weaknesses:

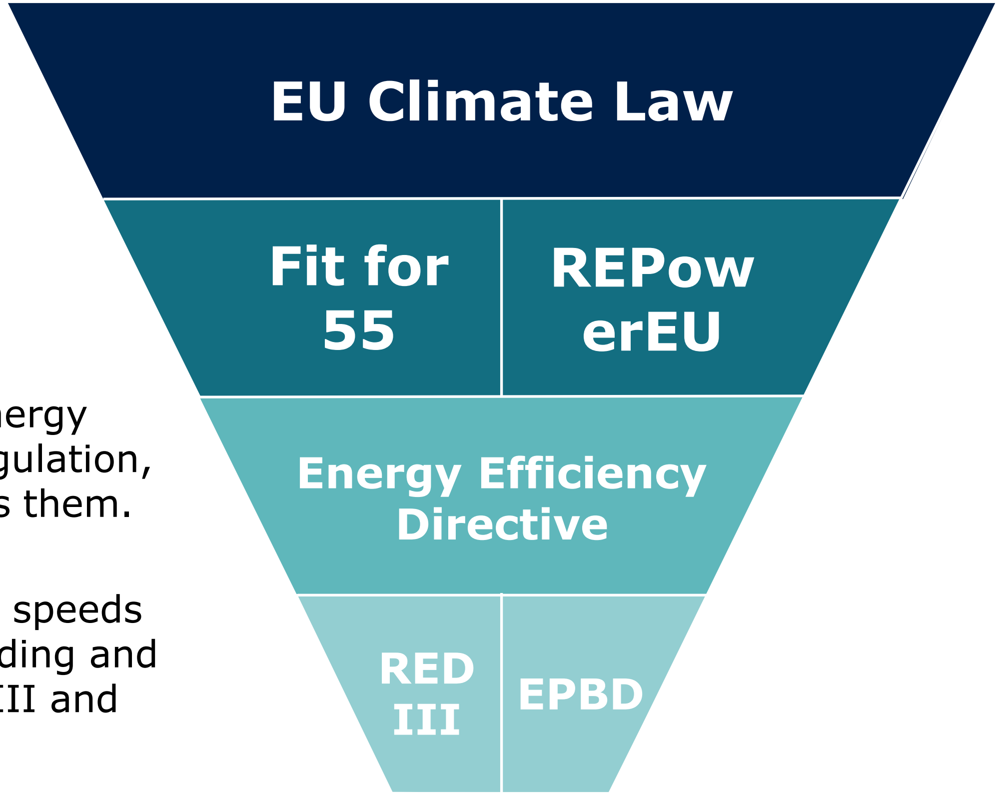
The absolute 11.7 percent reduction target does not reflect the realities of an electrifying, decarbonizing economy.

The current metric risks discouraging investment in clean-tech sectors and necessary grid development.

Tight consumption limits increase the system’s exposure to price volatility and supply bottlenecks.

The absolute metric cannot distinguish real efficiency gains from reduced activity or energy deprivation.

Context with the other frameworks



EU Climate Law
The umbrella law that sets the legally binding 2050 climate-neutrality objective and frames the 2030 trajectory. All below instruments serve this law's purpose.

Fit for 55 package
A policy bundle that amends multiple laws to deliver the 2030 path.
It contains the recasts of the Energy Efficiency Directive and RenewableEnergy Directive, updates to the Emissions Trading System and Effort Sharing Regulation, among others. It is higher-level than individual directives and orchestrates them.

REPowerEU
An accelerator plan responding to the energy crisis. It raises ambition and speeds implementation, particularly on efficiency and renewables, and injects funding and permitting streamlining. It sits alongside Fit for 55, influencing EED, RED III and EPBD roll-out.

Energy Efficiency Directive (EED, 2023/1791)
Cross-sector efficiency instrument with the binding EU target to reduce final energy consumption by at least 11.7 percent by 2030, plus horizontal rules like the Energy Efficiency First principle and public sector obligations. Detail level: medium–high.

Renewable Energy Directive (RED III)
Supply-side renewables instrument that sets the binding EU renewables share target of at least 42.5 percent by 2030 and sectoral provisions. Detail level: medium–high.

Energy Performance of Buildings Directive (EPBD)
Sector-specific instrument for buildings with standards, renovation requirements and long-term renovation strategies. Detail level: high for buildings; it operationalizes EED targets within the building stock.

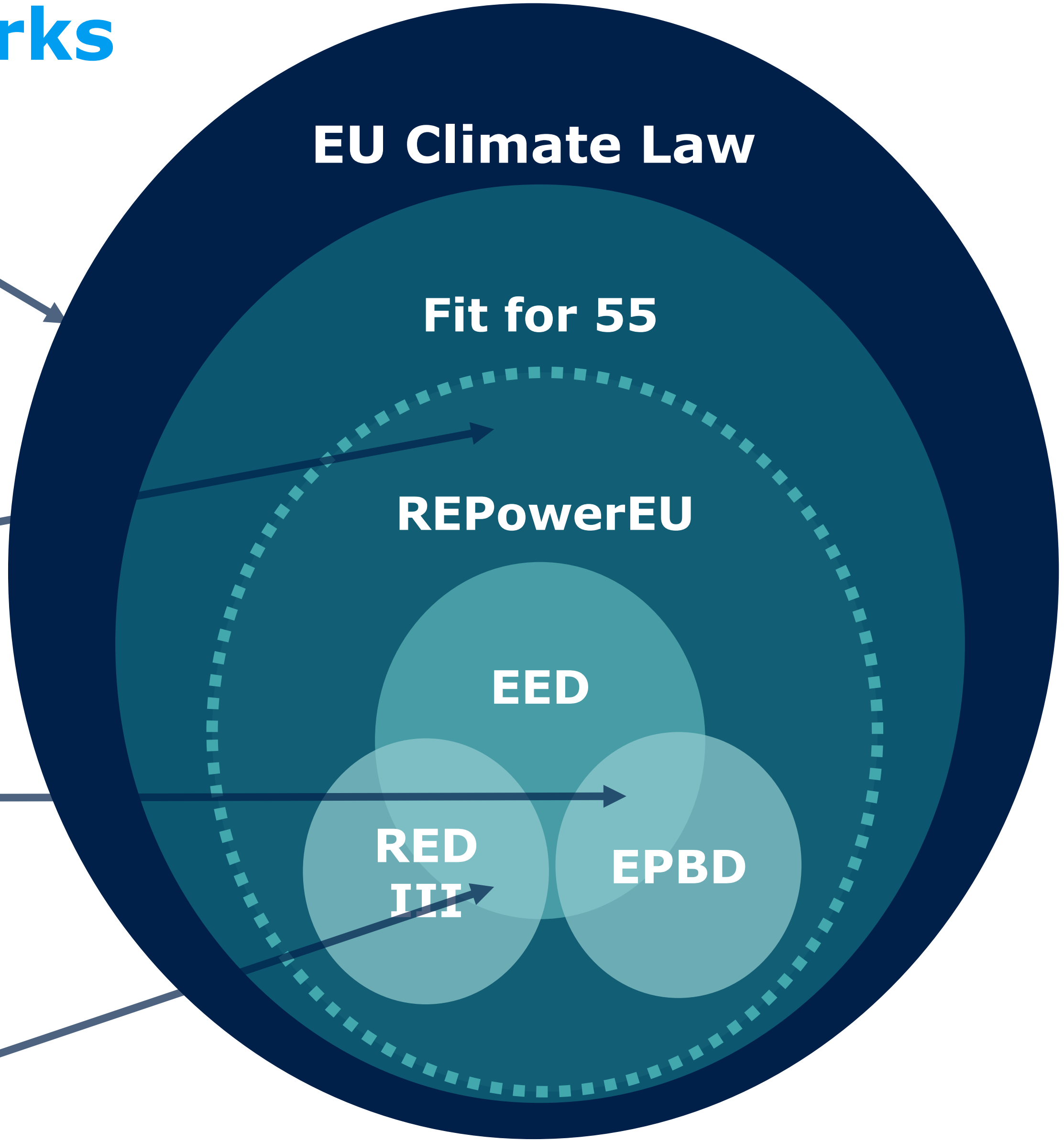
Context with the other frameworks

All instruments **work together to meet the 2030 targets and the 2050 neutrality goal** established by the EU Climate Law.

Fit for 55 is the **package**, REPowerEU is the **fast-track plan** that **raises and accelerates** action across the same instruments.

EPBD is the **buildings arm** of efficiency, implementing energy-saving measures and performance requirements in a major end-use sector.

Efficiency lowers demand while renewables decarbonize supply. EED and RED III **jointly deliver the 2030 pathway** under Fit for 55 and REPowerEU.



Context with the other frameworks

Counterproductivity in EPBD regarding EED:

Energy Performance of Buildings Directive's (EPBD) viewpoint is to look at an **individual building**. Compliance is checked per building using national calculation rules, with explicit recognition of the benefits of maximizing on-site renewables, plus new duties like solar deployment on buildings.

Energy Efficiency Directive (EED) then again **views the system-level**. It requires comprehensive heating and cooling assessments and local plans that prioritize least-cost, least-energy options such as integrating nearby industrial waste heat, keeping in mind the "Energy Efficiency First" principle.

According to EPBD, zero-emission buildings may be supplied by efficient district heating and cooling or nearby renewables. However, the national calculation factors and market habits make on-site heat look administratively "easier" to score for EPBD compliance. Even though in many industrial areas, the lowest-energy, lowest-cost option for the whole system is a network that captures waste heat and supplies it to multiple buildings close by.

Conflicts between EED and RED III:

Under Renewable energy directive (RED III), Member States chase renewable percentages in heating and cooling, while the EED demands verified end-use savings.

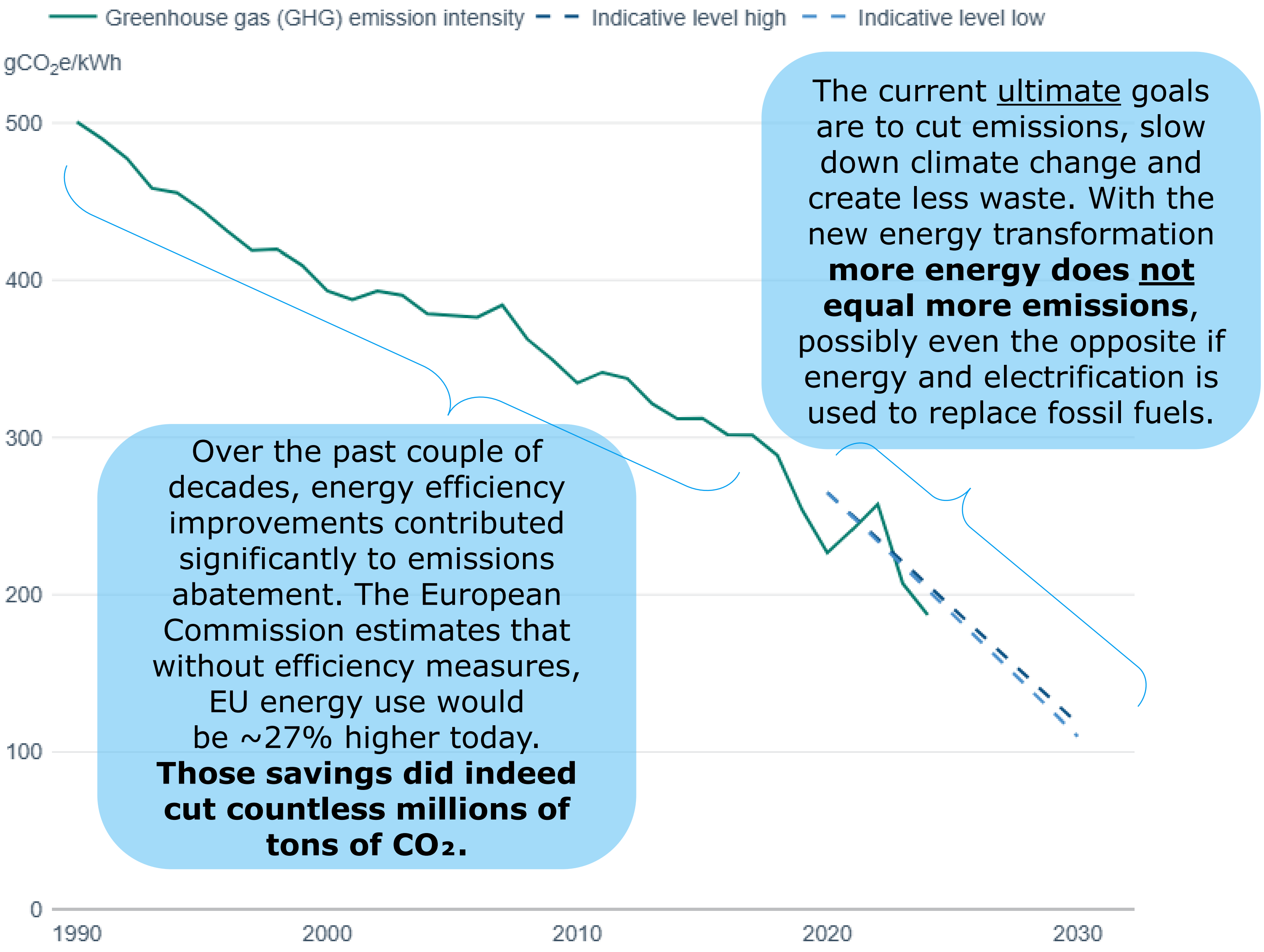
Switching the fuel from gas to biomass or direct electrification can improve the RED statistic but, unless accompanied by demand reduction or efficiency measures, it may deliver limited or even negative EED-countable savings.

District energy planning is where this contradiction is most visible and requires careful baselines and additionality rules in national EED schemes.

Climate risks

Threats toward the climate and zero-emission targets that arise from the current 11.7% energy reduction target

Greenhouse gas emission intensity of electricity generation, EU level



Source: EEA, Greenhouse gas emission intensity of electricity generation in Europe. 06.11.2025

Historical context and recent changes

Previously energy production and consumption were big GHG emitters. However, during the recent years, the power grid and energy production has decarbonized.

This means that further energy consumption cuts do not yield similar emission savings, unless they target remaining fossil uses.

The one-dimensional energy saving target of 11.7% doesn’t measure *how savings are achieved*. Achieving it could even be counterproductive for emission reduction if it delays electrification of e.g. transport or industry.

The future process

EU decarbonization targets

European Climate law (2021/1119), Fit for 55, REPowerEU and Renewable Energy Directive (RED III, 2023/2413) have goals and binding targets to

- Increase the renewable energy production
- Decrease the use of fossil fuels
- Achieve carbon neutrality

Increased weather dependent renewable energy production

As climate and emission reduction targets are being achieved, the amount of renewable energy from wind and solar is increasing. This leads to fluctuations in the energy production; the energy system is highly weather dependent. In the future, there will be:

- More cheap / negative wholesale electricity prices
- Higher peak-prices during hours/days of low production and high consumption
- Increased need for grid stabilization, energy storage solutions and flexible consumption

Energy price volatility and direct electrification increases

With the energy transition towards weather dependent renewable energy, follows also price volatility and increased number of hours with low or negative electricity price. This will attract and enable new business models and ways to utilize cheap electricity. Such as:

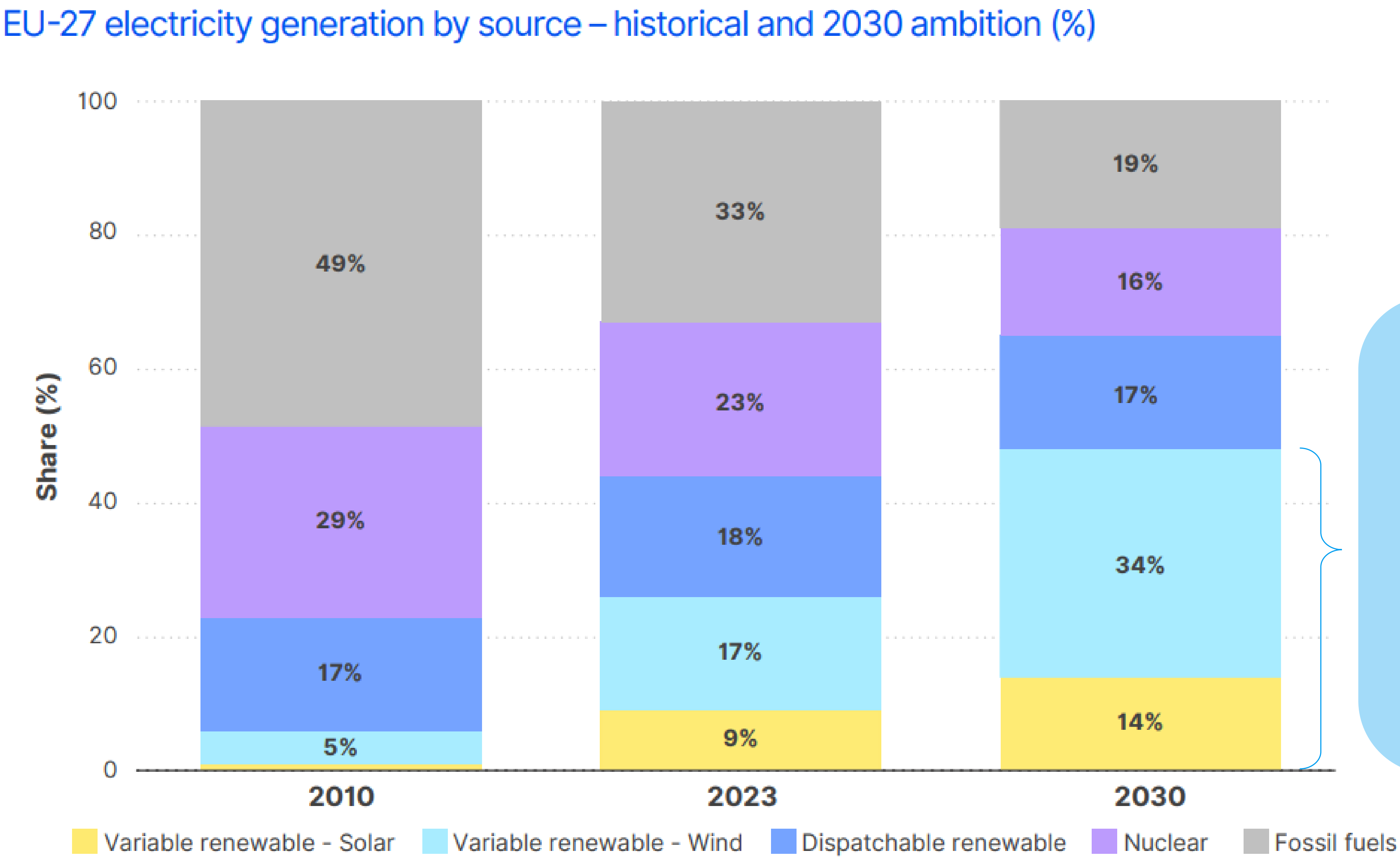
- Direct electrification, for example electrical boilers for heat production
- Electricity conversion into other forms or energy, for example green hydrogen and its derivatives
- Businesses with high electricity consumption, for example data centers and electrical arc furnaces

Flexible use and demand + grid investments will stabilize the energy system

New weather dependent energy production and new businesses requiring large amounts of electricity demand a strong electricity grid and vast energy distribution networks. Also, in order for the energy system to stay stabile, the following things are needed:

- Flexible demand and smart measuring systems for energy use
- Long- and short-term energy storages
- Reserve and back-up systems

Evolution of electricity generation towards **variable renewable**



In the 2030 scenario approximately half of the electricity generation is variable renewable and highly weather dependent. This will lead to increased need for **flexibility** and **grid stabilization**.

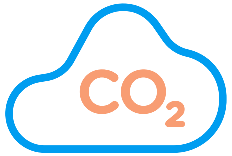
Note: Dispatchable renewable energy sources includes hydropower, bioenergy, and other renewables.

Source: ACER based on historical data from EMBER and 2030 projections from the 2023 European Environment Agency and ACER report Flexibility solutions to support a decarbonised and secure EU electricity system.

Not focused on emissions and hindering electrification & innovation

Reducing energy use doesn't necessarily lower emissions as the EED's 11.7 % energy consumption reduction target treats all energy equally. Even switching to cleaner energy isn't rewarded if total consumption doesn't decrease.

Strict energy limits can discourage shifting from fossil fuels to electric alternatives, as increased energy use is not accepted.
This hinders investment in energy-intensive innovations.



As a result, development and investments into renewable energy production and technologies that replace fossil fuels decrease, leading to higher future emissions.

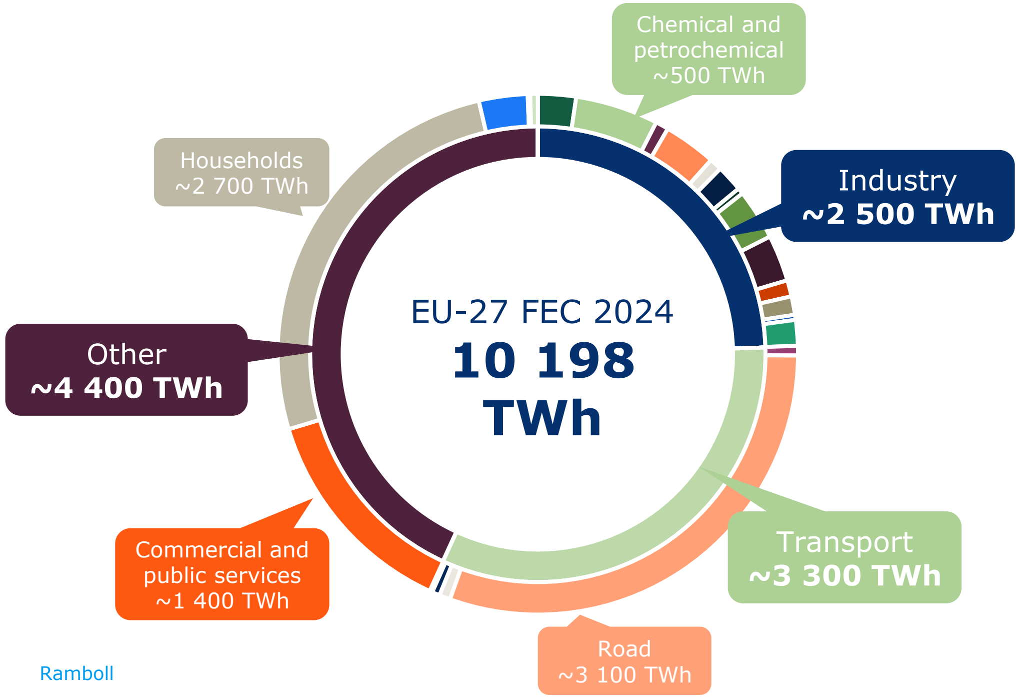
Growth risks

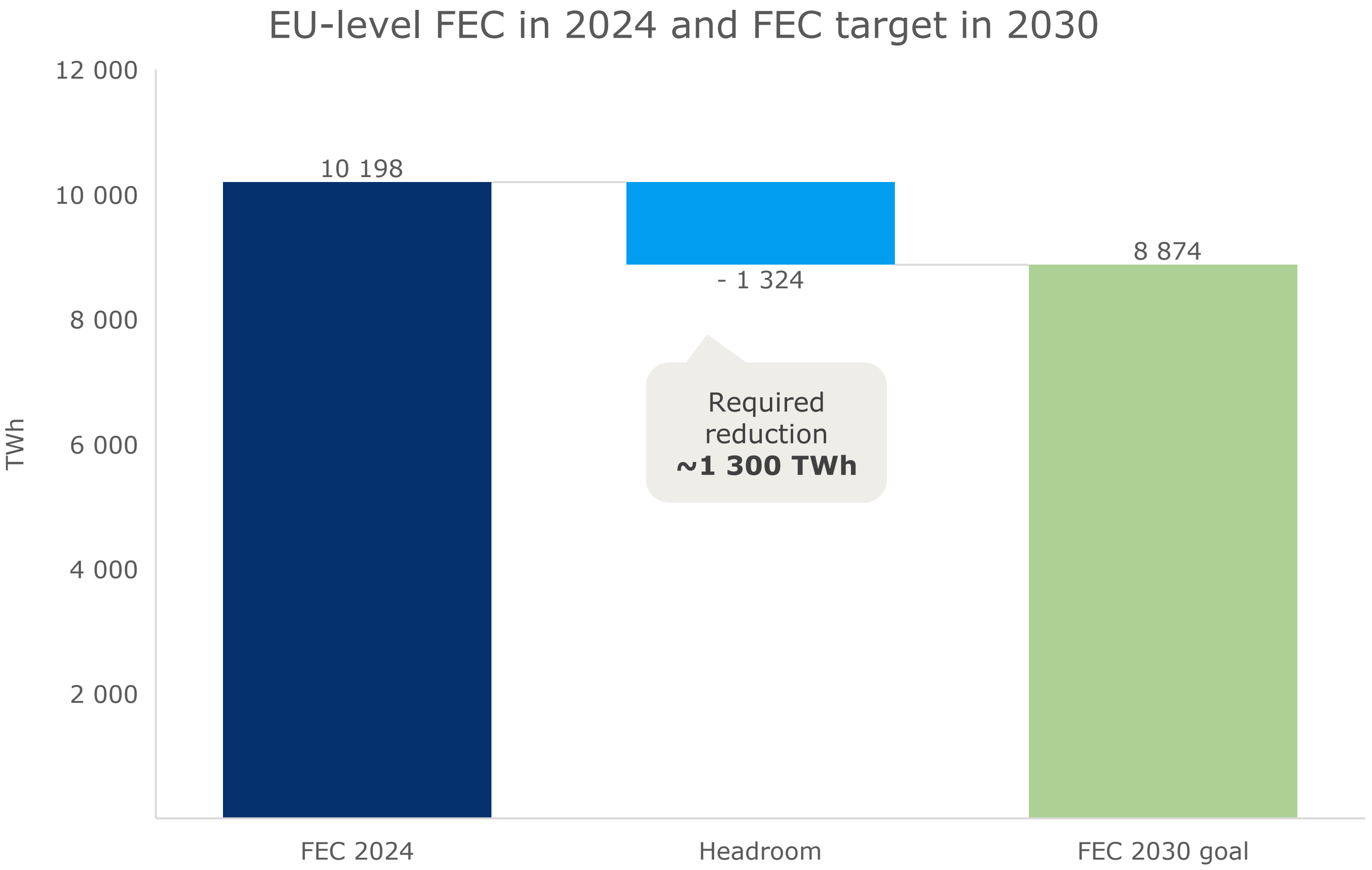
Threats toward the industrial growth potential in EU that arise from the current 11.7% energy reduction target

Europe has a final energy consumption **headroom problem**

EED sets a binding EU-level final energy consumption (FEC) cap for 2030 of 763 Mtoe, or 8 874 TWh. According to Eurostat, the EU's FEC in 2024 was 10 198 TWh.

EU must reduce FEC by **1 300 TWh** in less than 4 years to reach the goal. So even before adding any new growth loads, the system must shrink by that 1 300 TWh "headroom".





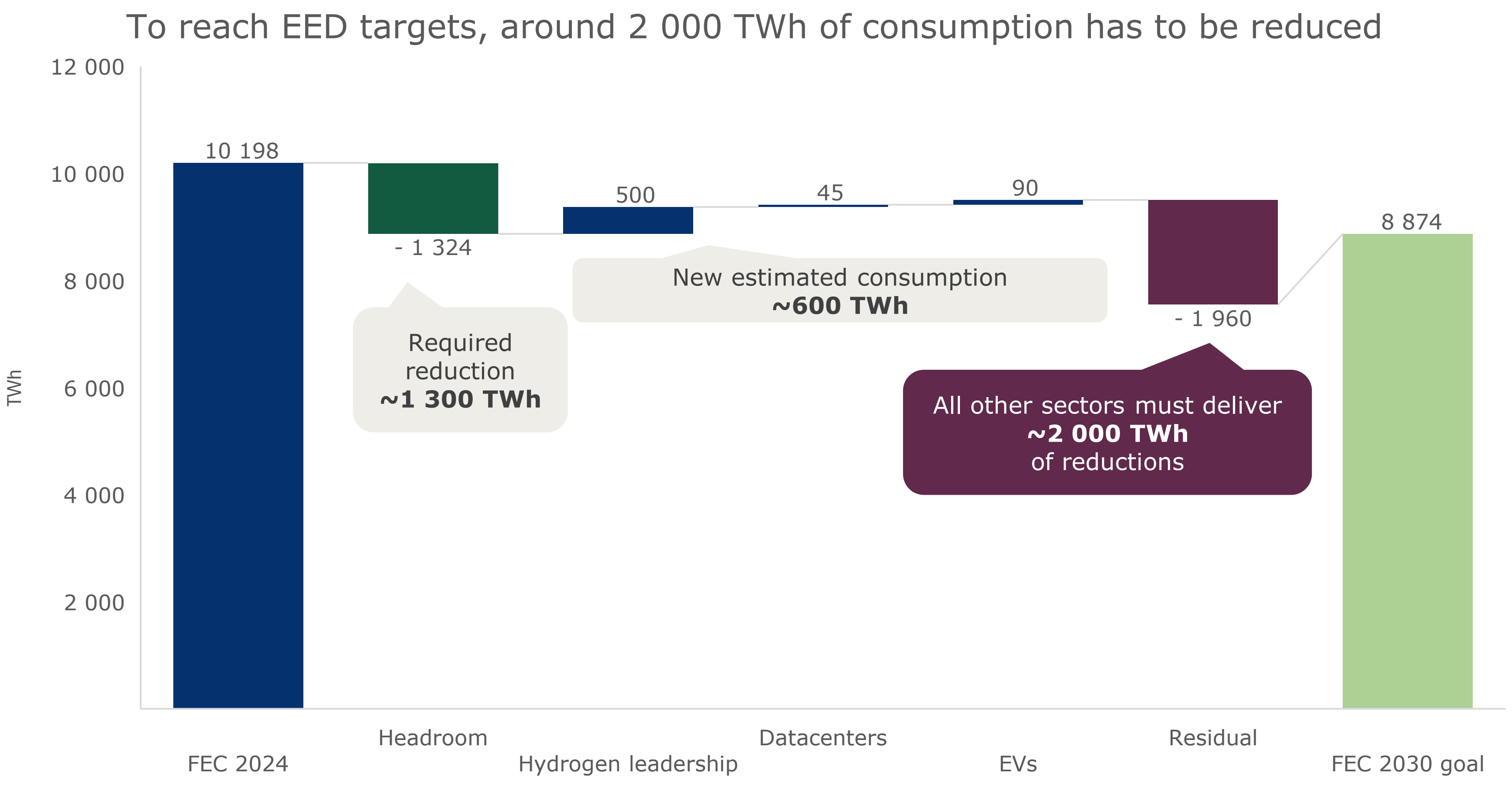
Europe has a final energy consumption **headroom problem**

FEC excludes non-energy uses such as natural-gas feedstock for conventional hydrogen. When production shifts to electrolysis, those feedstock tonnes become metered electricity in final energy, which raises measured final energy even if lifecycle emissions fall.

→ headroom squeeze.

This shrinkage conflicts with e.g., Europe's flagship target to produce 10 million tonnes of renewable hydrogen domestically by 2030 under REPowerEU. To produce 10 Mt of hydrogen, around 500 TWh of electricity is needed. What was previously not included in FEC, is now part of it.

The new measured consumption (hydrogen, datacenters, EVs,…) would further increase the need for reductions that other sectors need to fulfill.



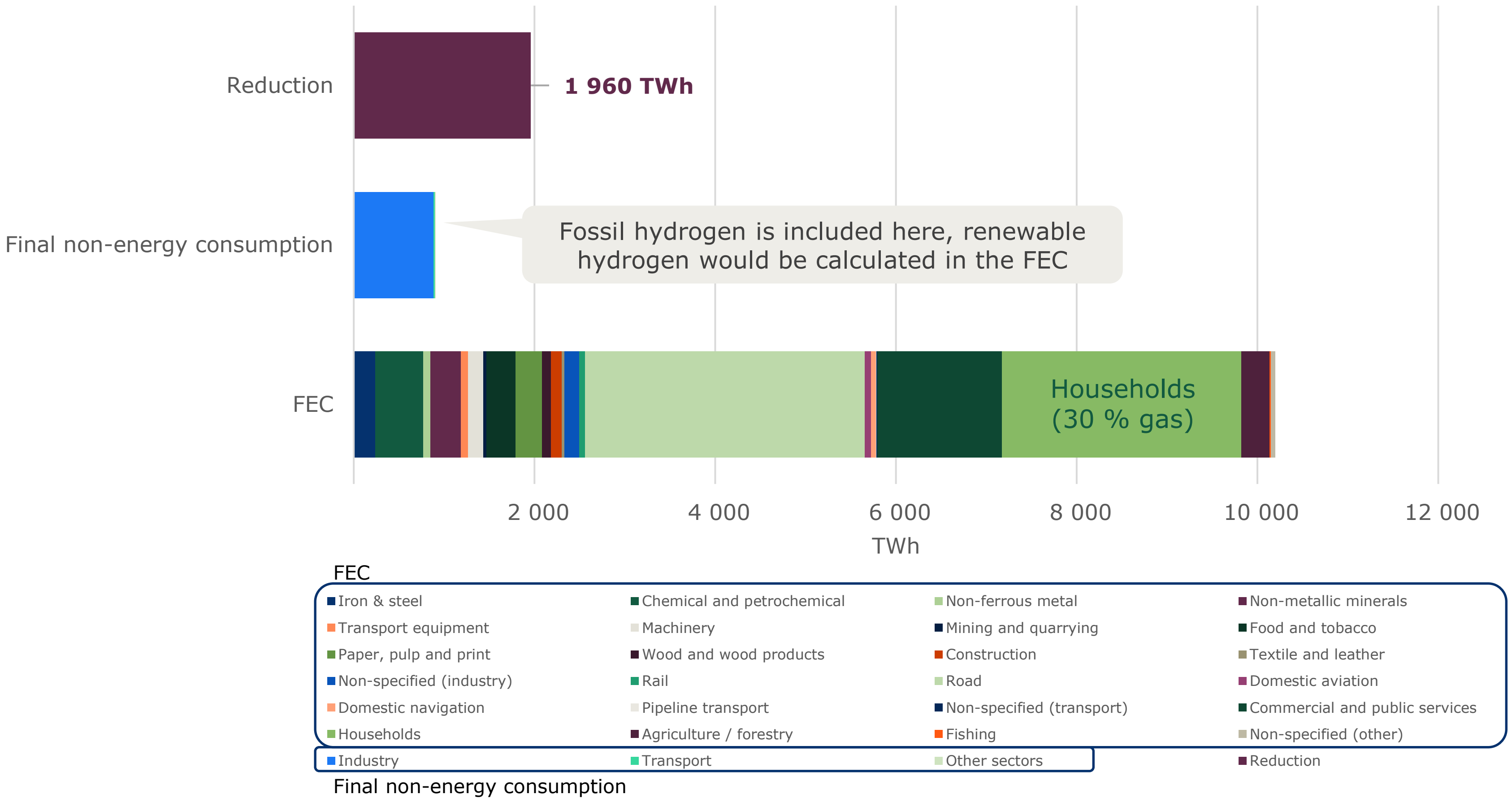
The reduction requirement is almost 20 % – **Where is the reduction taken?**

What would it take?

Eliminating all household gas used in EU (800 TWh) does **not** reduce comfort, it becomes ~240 TWh of electricity when delivered by heat pumps (SCOP ~3). Net FEC reduction ~560 TWh.

To hit the reduction (2 000 TWh) through industry alone would mathematically imply **cutting industrial final energy use by ~78%.**

This illustrates the implausibility of reaching the target solely through efficiency without structural adjustments to the directive.



Economic growth correlates to energy consumption

It can often be seen that when economies grow, total energy demand tends to rise as well, even though energy used per unit of GDP improves over time.

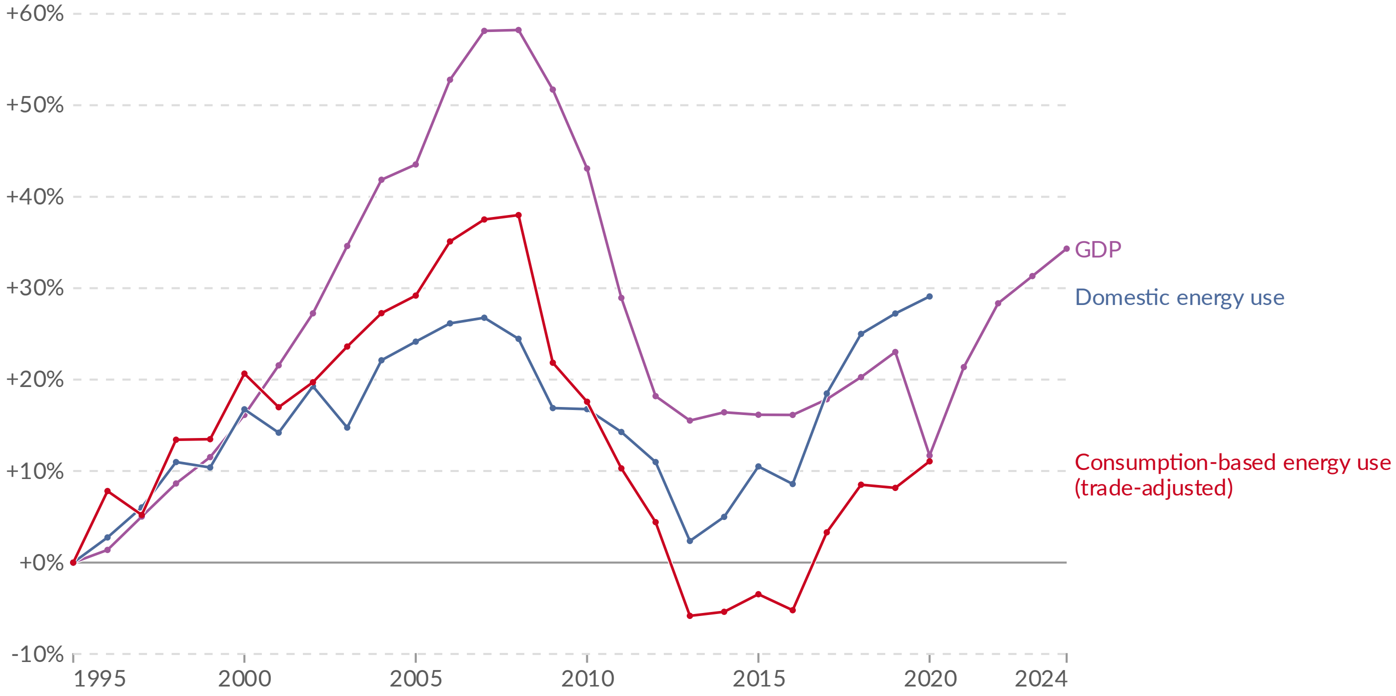
Across countries, **higher income per person goes hand-in-hand with higher energy use** per person. Households and companies consume more energy as they become richer; demand for energy services such as mobility, heated and cooled space, appliances, digital activities and industrial output increase.

The chart on the right illustrates this pattern clearly, with energy consumption climbing alongside GDP and only limited cases of absolute decoupling.

Changes in energy use vs. changes in GDP, Greece

Our World in Data

Consumption-based (trade-adjusted) primary energy[1] use measures domestic energy use minus energy used to produce exported goods, plus energy used to produce imported goods. Gross domestic product (GDP) is adjusted for inflation and differences in living costs between countries.



Data source: Calculated by Viktoras Kulionis, based on the EXIOBASE v3.8.2 database; Eurostat, OECD, IMF, and World Bank (2025)

Note: GDP is expressed in international-$[2] at 2021 prices.

Link to source: https://ourworldindata.org/grapher/energy-use-gdp-decoupling?country=~GRC

1. **Primary energy** Primary energy is the energy available as resources – such as the fuels burnt in power plants – before it has been transformed. This relates to the coal before it has been burned, the uranium, or the barrels of oil.
Primary energy includes energy that the end user needs, in the form of electricity, transport and heating, plus inefficiencies and energy that is lost when raw resources are transformed into a usable form.
You can read more on the different ways of measuring energy in our article.

2. **International dollars** International dollars are a hypothetical currency that is used to make meaningful comparisons of monetary indicators of living standards.
Figures expressed in constant international dollars are adjusted for inflation within countries over time, and for differences in the cost of living between countries.
The goal of such adjustments is to provide a unit whose purchasing power is held fixed over time and across countries, such that one international dollar can buy the same quantity and quality of goods and services no matter where or when it is spent.
Read more in our article: What are international dollars?

Growth constraints resulting from the current energy consumption target

The EU faces a substantial headroom gap: final energy consumption in 2024 exceeds the 2030 cap by more than one thousand TWh, even before accounting for new electrification-driven demand. As sectors such as hydrogen, transport and digital services shift from fossil fuels to electricity, measured final energy use rises despite significant efficiency measures.

The absolute-consumption target forces clean growth sectors to compete for limited energy “space”, even when they replace fossil alternatives. It also risks slowing investments needed for decarbonisation, including grids, storage and energy-intensive clean-tech industries.

Economic growth continues to correlate with higher total energy use across Europe. In an expanding and electrifying economy, achieving large absolute consumption cuts becomes increasingly unrealistic without suppressing activity or delaying the transition.

Price risks

Threats toward the cost of energy in the EU that arise from the current 11.7% energy reduction target

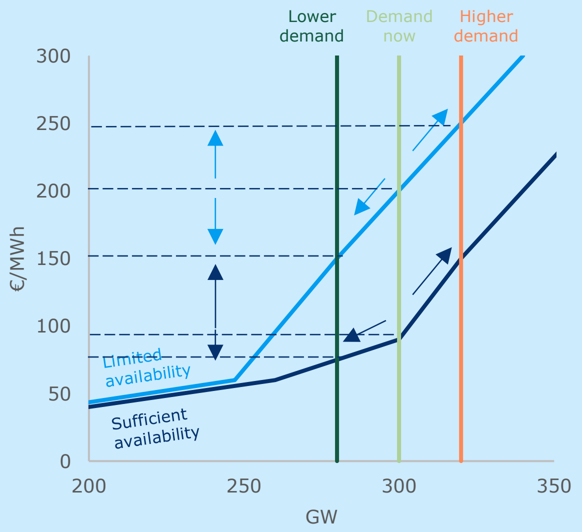
Energy Efficiency Directive has **price implications** – and not always to a favorable direction

The EED aims to reduce prices through efficiency, but the structure of the binding caps, accelerating energy-savings obligations, and the interaction with rapid electrification can create system-wide price pressure if nothing changes. The directive addresses distributional effects – energy poverty, vulnerable consumers – but does not eliminate macro-level price risks.

The Directive addresses fairness, not systemic price stability. The EED affects demand, which interacts with supply availability.

Figure on the right is stylized electricity supply-demand interactions under the EED.

Energy demand is relatively price-inelastic.



The EED changes the position of the demand curve by lowering consumption though efficiency but also increasing electricity use through electrification. Higher availability and efficiency push equilibrium prices down, while tight availability or higher electrification demand push prices sharply upward

1 Wholesale electricity price risk from accelerated demand reduction mandates (market shortage or flexibility gaps express themselves as higher prices unless supply and grid investments keep pace)

2 Retail price risk from recovery of energy efficiency obligation schemes (EEOS) costs (regulated obligations placed on energy suppliers tend to translate into consumer prices)

3 Investment risk from ”Energy Efficiency First” interpretation (if efficiency used as a substitute to investment in clean electricity generation or grid capacity causing delays and bottlenecks)

4 Industrial competitiveness price risk (high prices relative to global competitors translates as a disadvantage)

5 Energy-poverty risk despite targeted safeguards (protects *relative burdens,* does not shield from absolute price increases)

Why the current EED framework amplifies price sensitivity – evidence from recent EU analyses

A tighter energy cap under the EED **increases** the system's sensitivity to availability shocks[1]

European energy prices remain structurally sensitive to supply availability

Efficiency alone cannot stabilize prices: supply-side capability and flexibility must grow with electrification[2]

System bottlenecks, not fuel choice alone, drive regional price spikes

EED-driven electrification raises reliance on variable generation, increasing volatility risk unless matched with system upgrades[3]

Higher renewable shares without flexibility increase volatility

[1]The European Commission's Energy Prices & Costs 2025 report shows wholesale prices remain above historical levels, driven by supply constraints and import exposure.
[2]IEA World Energy Investment 2025 shows grid investment is not keeping pace, leading to congestion and blocking cheap renewables from reaching demand centers. Eurelectric 2025 shows negative prices and spikes coexist.
[3]Applied Sciences (2025) finds that high RES penetration raises short-term price volatility when flexibility and interconnection lag.

Same action, different outcomes

A study by Gajdzik et al. (2025) focuses on the effect of industrial energy intensity and its role in energy poverty. Their study and achieved results illustrate an important phenomenon: **the same energy-efficiency action can lead to very different results across different Member States.**

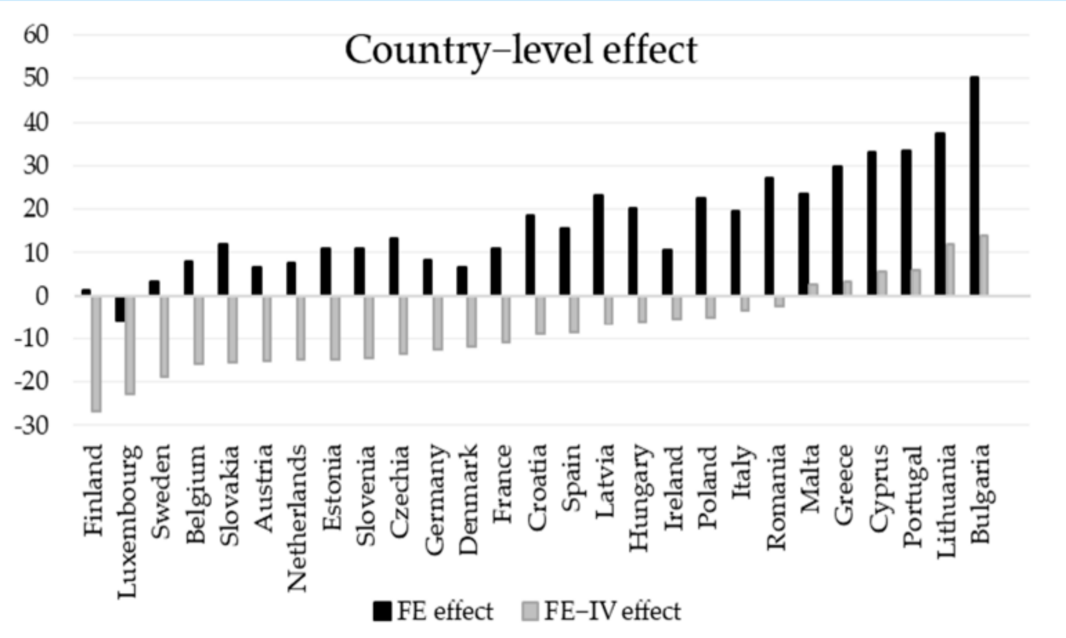
Even though industrial energy-efficiency improvements *can* reduce household energy poverty, the chart on the right shows that the impact varies widely depending on the country and the method used. In some places the effect is strong, in others almost non-existent. **Given the differences between countries, policies must be tailored to local conditions.**

For example, climate change and regular heat waves are making summertime energy poverty an urgent and growing issue in Europe. In the meanwhile, in northern Europe winters can be either very cold or very mild. Both scenarios and the unpredictability cause stress to the local energy systems.

Key takeaway:

Energy-efficiency outcomes are **never black-and-white**. They depend heavily on local structures, prices, industry profiles and social conditions. This means that "one-size-fits-all" policies or single metrics cannot capture the full picture. **Measures and indicators must be adapted to national contexts** to reflect what is actually happening in that country.

Same efficiency measures do not affect all countries equally and results can also vary based on measurement method



Country-level effects across the EU countries based on the models created (Gajdzik et al., 2025)
FE effect = country fixed effects, FE-IV effect is country fixed effect with endogeneity correction

Price risks that may arise from the current energy consumption target

The current consumption cap heightens price volatility, as the system becomes more exposed to supply constraints, grid bottlenecks and limited flexibility. This makes both households and industry more vulnerable to sudden shifts in availability and weather-driven renewable output.

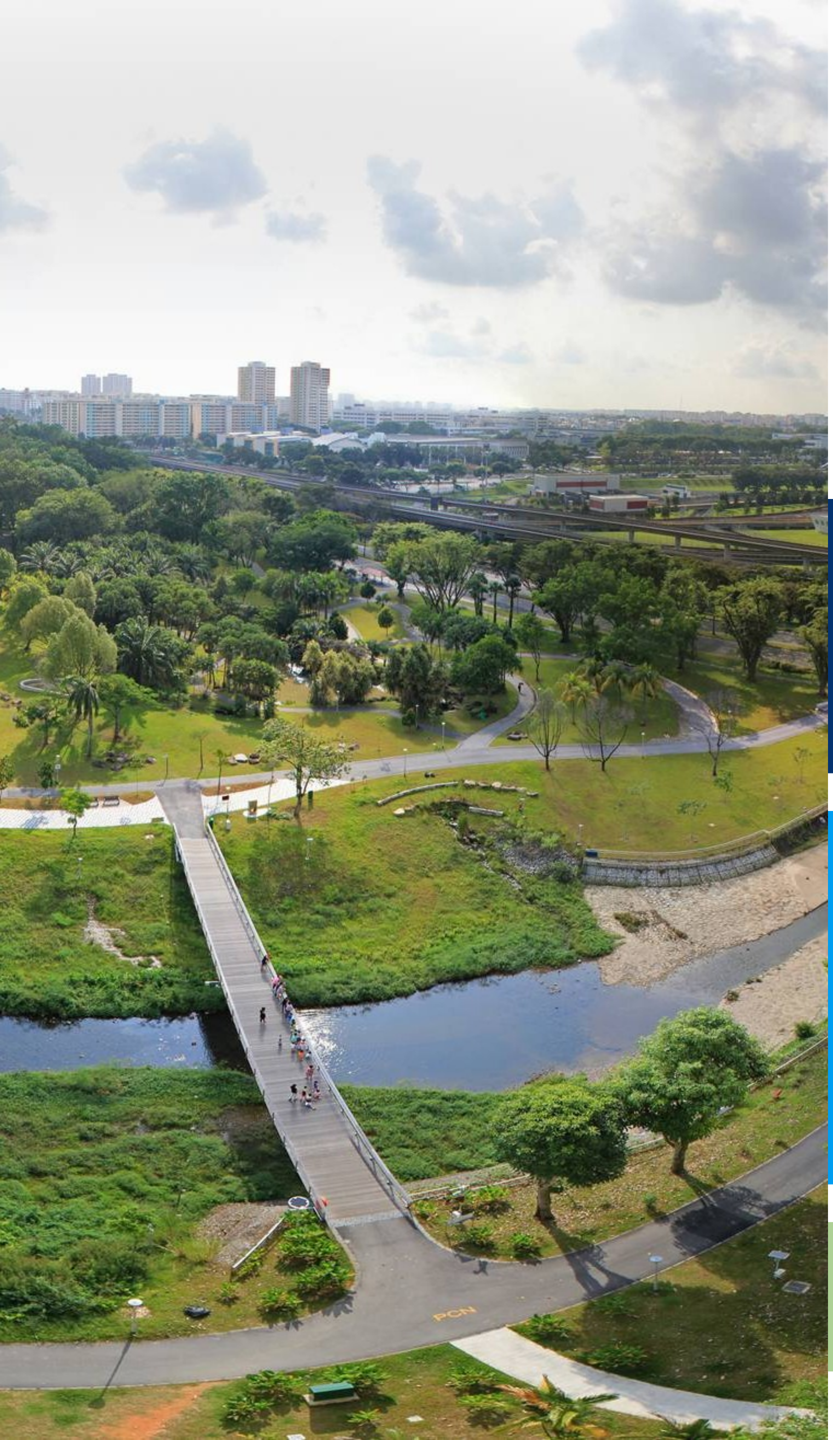
Even with efficiency gains, system-wide constraints and electrification can elevate price volatility when supply or grid capacity tightens. These pressures can cascade to households and smaller businesses, increasing affordability challenges. Investments for flexibility and grid stability are needed.

Investment signals deteriorate in a tightly capped system, as uncertainty around future energy availability and price sensitivity raises the perceived risk of clean-tech and energy-intensive projects. Over time this may slow innovation, reduce competitiveness and shift strategic investments outside the EU.

Alternative metrics

As shown on previous pages, energy efficiency cannot be meaningfully assessed through a single absolute energy consumption number. Especially during the time of energy transition and in an economy that is electrifying, digitalizing and expanding clean-tech production.

In the following pages it will be explained why multi-indicator frameworks, composite scoreboards and balanced evaluation models should be used instead. Keeping in mind that the **aim is to achieve energy efficiency while** increasing energy security and affordability, decreasing emissions from energy production, and enabling economic growth and competitiveness in the EU.



Alternative metrics should widen the perspective

Why use ratios instead of absolute numbers?

Using ratios rather than absolute energy values provides a much clearer and fairer picture of true energy-efficiency progress. Ratios relate energy use to what is being produced or delivered (e.g. GDP, value added, floor area, services provided), which **helps reveal real efficiency gains even if total consumption rises**.

Absolute figures alone can be misleading because they cannot show whether changes come from improved efficiency, structural changes or external shocks. For example, a drop in final consumption might come from industrial shutdowns, unemployment, or households being unable to afford normal heating or cooling, rather than from successful efficiency measures. Likewise, an **increase in final consumption does not necessarily signal failure** if it reflects electrification, renewable integration, increased heat-pump deployment or higher economic activity.

Ratios avoid these distortions by letting us see how efficiently energy is used, **independent of scale**.

Alternative metrics should widen the perspective

How scorecard approach could help?

A scorecard tool approach allows energy consumption to be **evaluated in a broader context**, acknowledging that **higher energy use is not automatically negative**. Consumption may rise because of actions that strengthen energy security, such as replacing imported fossil fuels with domestically produced electricity, or due to climate-positive electrification, such as heat-pump rollouts and electric mobility. It may also reflect improvements in affordability, where households previously unable to heat or cool their homes can finally reach comfortable temperatures, or gains in competitiveness, where industries expand production in Europe rather than relocating elsewhere.

Looking only at total final consumption hides these dynamics and **does not reveal whether reductions result from efficiency improvements** or from economic decline, loss of industrial capacity, or energy deprivation among vulnerable households.

A scorecard view makes it possible to **justify increased consumption when it occurs for the right reasons**, ensuring that efficiency assessment reflects security, climate, social wellbeing and competitiveness, not just energy totals.

Global best practices

The International Energy Agency (IEA) published an annual analysis report *"Energy Efficiency 2025"* showing global energy efficiency developments and recent trends in energy intensity and demand.

IEA's methodology consistently avoids using absolute consumption metrics alone. Instead, it analyses system-wide themes such as emissions, energy security, affordability, and competitiveness.

This demonstrates an international best practice in using integrated efficiency indicators, not single-value targets.

Competitiveness

- **WHAT**: Competitiveness metrics assess how efficiently industries convert energy into economic output.
- **WHY**: They show how efficiency improves companies' resilience to energy-price volatility and boosts long-term productivity.
- **HOW**: By analyzing energy intensity of value added, company-level behavior and management-system performance, the IEA identifies barriers and levers for deeper industrial efficiency.

Sustainability

- **WHAT**: Efficiency metrics capture how much CO_2 emissions are avoided by using less energy for the same services.
- **WHY**: They isolate the efficiency effect from other drivers like economic growth, fuel switching or weather, ensuring emissions progress is correctly attributed.
- **HOW**: By tracking changes in end-use intensities and decomposing CO_2 drivers, the IEA identifies which sectors and policies deliver the largest real-world emission cuts.

Security

- **WHAT**: Energy security metrics measure how efficiency reduces fossil-fuel demand, import dependence and peak-load stress.
- **WHY:** They show how demand-side improvements strengthen resilience to crises by lowering exposure to volatile global fuel markets.
- **HOW:** Using indicators like avoided imports, gas-demand decomposition and demand-response performance, the IEA pinpoints which actions provide the most durable security gains.

Affordability

- **WHAT**: Affordability metrics evaluate how efficiency lowers household energy bills and reduces energy-poverty risks.
- **WHY**: They reveal how persistent high prices affect different income groups and where efficiency provides the greatest financial relief.
- **HOW**: The IEA tracks real energy expenditures, distributional impacts and program-level bill savings to understand which measures most effectively protect consumers.

Competitiveness – for example what to measure?

These metrics help describe how strong and productive a country's industry is and how efficiently it converts energy into economic value.
They focus on two things.

- First (**Metric A**), how much energy is used to create each unit of added value. This reveals whether the economy is becoming more energy-efficient over time.
- Second (**Metric B**), how much the industrial sector contributes to the total Gross Domestic Product (GDP). This shows the scale and importance of industry within the national economy.

Changes in these indicators show whether economic growth is increasing or slowing down, and how effectively energy is being used to support that growth. For example, if industrial value added stays the same but energy used per added value decreases, the same output was achieved with less energy. This would signal an improvement in efficiency.

A. Industrial energy intensity of value added

- **What** Final energy use per unit of manufacturing gross value added
- **Units** MWh / M€ (industry share of GDP*)
- **Why** Tracks productivity and efficiency improvements in the manufacturing industry. Shows how energy is used to produce value to the economy.
- **Sources** Eurostat energy and national accounts; ODYSSEE* macro/industry indicators; IEA Energy Efficiency Indicators for methodology.

**GDP = Gross Domestic Product*
ODYSSEE = Database that contains data about energy consumption and CO_2 indicators

B. Industry share of GDP

- **What** Industry's share and size of a member state's total GDP.
- **Units** Million euros (M€)
- **Why** Shows the economic weight of industry within national GDP. Helps assess macro-level competitiveness, industrial capacity, structural economic changes, and potential impacts of energy prices or efficiency policies on the real economy.
- **Sources** Eurostat National Accounts (GDP by industry/value-added); Eurostat Structural Business Statistics (industry sector output); OECD* National Accounts for cross-checking international comparability

**OECD = The Organization for Economic Co-operation and Development*

Sustainability / Climate – for example what to measure?

These metrics show how energy production and use affect greenhouse-gas emissions and global warming. They matter because carbon neutrality is a key EU goal, and changes in energy use or supply directly influence progress toward that target. They also indicate how dependent a country still is on fossil fuels and how quickly renewable energy is replacing them. When emissions stay high, the metrics underline the importance of reducing energy use, as higher consumption would otherwise lead to higher emissions and faster warming.

- **Metric A** shows the total annual emissions from energy production and reflects the overall climate impact of the energy system.
- **Metric B** shows emissions per unit of final energy consumption and indicates how clean the energy mix is over time.

In the future, sustainability assessments may expand to include wider environmental aspects such as biodiversity, land use and local ecological impacts, providing an even more complete view beyond climate effects.

A. Annual emitted GHG from energy production

- **What** Describes how much CO_{2eq} emissions are being produced annually due to primary energy production and imports.
- **Units** Kilotonnes (kt) of CO_{2eq} -emissions per year
- **Why** Highlights the amount of emissions being produced every year due to energy production and imports.
- **Sources** EEA and UNFCCC* GHG inventories (annual reported emissions); IEA GHG Emissions from Energy (fuel-combustion emissions); Eurostat Emissions Accounts (sector-level emissions)

**UNFCCC = The United Nations Framework Convention on Climate Change*

B. Share of fossil from final energy consumption

- **What** Share of energy produced with fossil-fuels from the final energy consumption.
- **Units** Percentage (%)
- **Why** Shows how big portion of the consumed energy has been produced from fossil-based resources. Also, considering the utilization of waste energy and energy reuse.
- **Sources** Eurostat energy balances; national databases; DG ENER – Energy Union Indicators Webtool; IEA End-Uses and Efficiency Indicators for cross-checks.

Energy Security – for example what to measure?

These metrics describe how energy-independent and self-sufficient a country is. As the global geopolitical situation has become increasingly unstable, the ability to produce and distribute energy domestically has gained importance. Heavy reliance on imported fuels increases vulnerability to supply disruptions and political shifts.

There are many ways to understand internal energy security. These include assessing how balanced the energy mix is (so that not all energy comes from one source), how flexible the system is in responding to weather variations or sudden changes in demand and how stable and resilient the distribution networks are. For this work, the selected metrics focus specifically on energy independence because comparable and reliable data were readily available.

- **Metric A** shows the ratio between imported energy and domestically produced primary energy. A result with the value 1 would mean that the country imports the same amount of energy as it produces domestically. A ratio above 1 means that imports are larger than domestic production, which indicates higher dependency on external sources.
- **Metric B** shows what share of all available energy (before any losses or conversions) comes from imported fossil fuels. This percentage helps illustrate how reliant a country still is on fossil-based imports, and thus how exposed it is to global fuel price changes and supply risks.

A. Import energy / primary energy supply

- **What** Ratio between all imported energy and primary energy supply
- **Units** Dimensionless ratio
- **Why** Shows the ratio between imported energy and domestically produced primary energy. Describes the energy self-sufficiency level of the member state.
- **Sources** Eurostat energy dependency indicator; DG ENER – Energy Union Indicators Webtool.

B. Share of imported fossil energy from all available energy sources

- **What** Share of imported fossil-based energy from all available energy sources (imports + primary + statistical differences and stock draw)
- **Units** percent (%)
- **Why** Shows how big portion of the produced energy (before losses) is from imported fossil sources. Describes the system’s structural exposure to external shocks.
- **Sources** Eurostat energy dependency indicator; DG ENER – Energy Union Indicators Webtool.

Affordability – for example what to measure?

Affordability metrics describe how easily households and consumers can pay for their energy use. This is important because one of the Energy Efficiency Directive's aims is to reduce energy poverty, meaning fewer people should struggle to keep their homes warm, cool or properly powered. Energy prices also influence businesses. If prices rise too high, companies may move their production elsewhere or cut output, which can lead to wider economic consequences.

In this scorecard, two affordability metrics are used. Together, these two indicators give a clearer picture of both absolute prices and their real impact on people's budgets.

- **Metric A** shows the cost of energy for household consumers. It is useful for comparing prices between countries or evaluating how prices change over time.
- **Metric B** measures how large a share of an individual's disposable income is spent on energy, such as heating, cooling and electricity. This helps indicate whether affordability is improving or worsening, and whether the risk of energy poverty is increasing.

A. Cost of energy to household consumers

- **What** Average cost of energy for households and other non-industrial, non-transport users, covering electricity and gas retail prices paid by typical consumers.
- **Units** EUR / MWh
- **Why** Presents a comparable number of energy cost to normal (non-industry or transport) users. If the cost rises significantly, there is a risk of increased energy poverty.
- **Sources** Eurostat Electricity and Gas Price Statistics for household consumers; ACER Household Energy Price Dashboard; European Commission Energy Prices & Costs Report (retail energy cost trends)

B. Household energy expenditure and share of disposable income

- **What** Average annual household spend on residential energy and its share of disposable income.
- **Units** Percentage (%) of disposable income.
- **Why** Evaluates persistent affordability pressure and the risk for energy poverty is percentage rises too high.
- **Sources** Eurostat Household Budget Survey HBS and Energy Prices datasets; experimental ICW income-consumption-wealth overlaps.

Effect Analysis

By using the scorecard metrics introduced earlier, you can track energy consumption trends and their effects on:

- Competitiveness
- Sustainability / Climate
- Energy Security
- Affordability

This helps **justify energy use that benefits** these areas.

The key idea is that energy should be utilized efficiently and not wasted, but energy consumption in itself is not inherently negative.

CASE EXAMPLE:

How the metrics could be applied in practice?

Finland’s energy balance and two scenarios

We use Finland’s 2024 energy balance as a baseline case example to illustrate how the previously introduced metrics can help visualize changes in energy production and consumption over time. To make this comparison meaningful, we created two forward-looking scenarios that demonstrate how Finland’s energy system could evolve under different conditions.

In **Scenario 1**, Finland develops its energy-intensive economy by 2040. This assumes significant growth in green hydrogen production and datacenter activity, supported by a large expansion of renewable electricity generation. Final energy consumption rises compared with 2024, fossil imports—particularly natural gas—are partially replaced by domestically produced hydrogen, and waste heat from datacenters and electrolyzers is utilized in district heating.

In **Scenario 2**, Finland reaches the Energy Efficiency Directive target by 2030 by reducing final energy consumption. Here the energy balance shrinks across all sectors and fuel types in proportion to their current shares, lowering total production and use of energy according to the EU EED target levels.

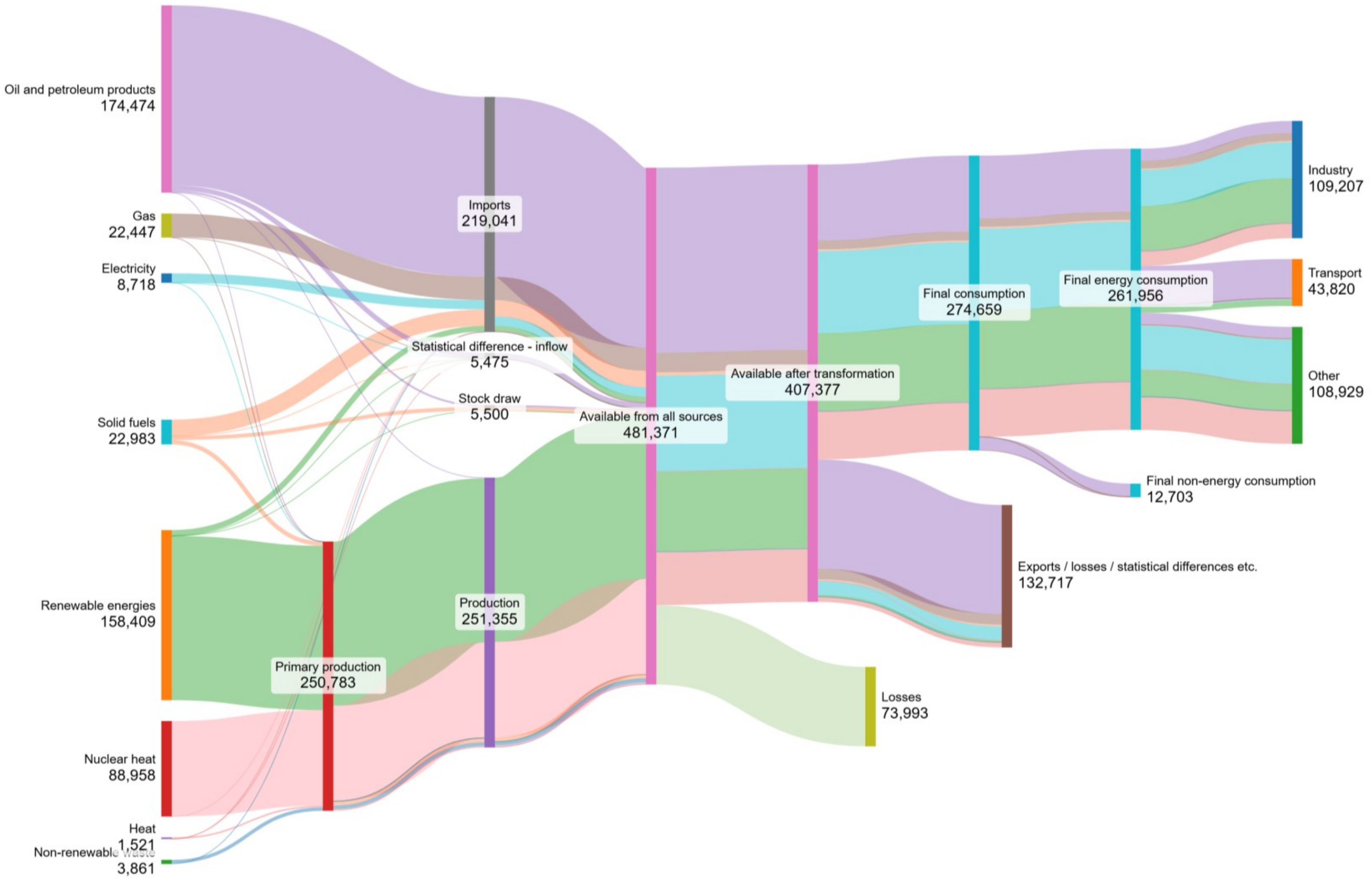
The scenarios are **not predictions** of the future!
Instead, they are simplified estimations built on specific assumptions, designed solely to show how the scorecard metrics behave when the energy balance shifts.

The assumptions behind both scenarios and the resulting modelled energy balances are presented on the following slides. After this, the scorecard-based metrics are applied to each case, highlighting where the most significant changes occur.

The chapter concludes with an analysis of what these differences imply for competitiveness, sustainability / climate, security and affordability.

CASE EXAMPLE:
Energy balance flow chart

Input → Output



Finland energy flow chart (GWh) in 2024

An energy balance flow chart is a Sankey diagram that shows how energy enters an economy, how it is transformed, and where it is ultimately used.

The width of each band represents the amount of energy flowing in a given pathway. Eurostat compiles these charts from national energy balance data, typically using thousand tonnes of oil equivalent as the unit.

The chart lets you see at a glance the relative importance of different energy sources, the scale of conversion losses, and how much energy ends up in sectors like industry, transport, and households.

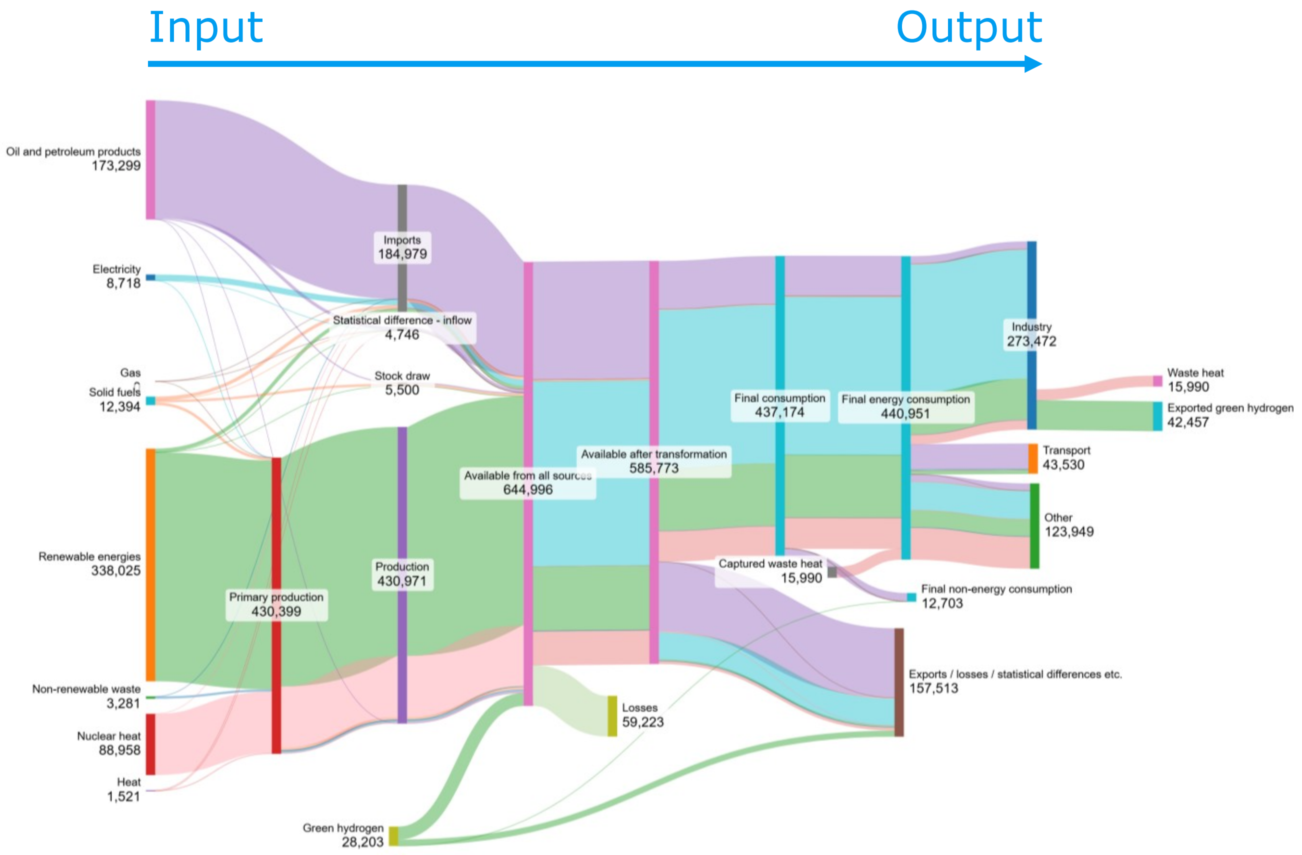
How to read:

1. Start at the left with supply (imports and primary energy production)
2. Follow the colors to track fuel families into final consumption

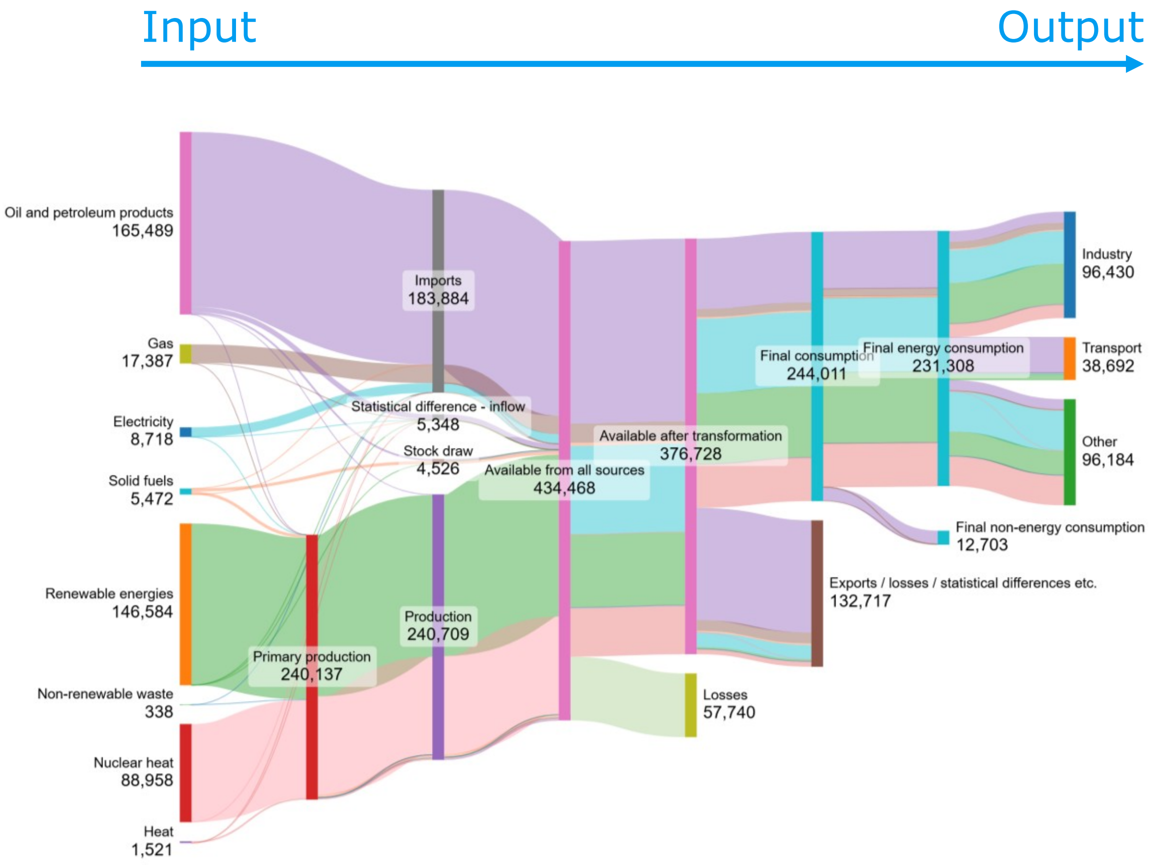
The diagram does not show e.g., how much waste heat is created from industry currently and how that translates into heating.

CASE EXAMPLE:

Considered scenarios



Scenario 1 – Finland with a lot of data centers and hydrogen economy in 2040



Scenario 2 – Finland with EED directive goal reached in 2030

CASE EXAMPLE:

Scenario and calculation assumptions

	Scenario 1	Scenario 2
Final energy consumption – Industry	Based on Finnish TSO's 1 scenario of Finland in 2040. Data centers consume 27 TWh, and hydrogen economy consumes 106 TWh. Other usage remains the same as in 2024.	Each group (industry, transport, other) reduce their FEC in relation to their current share of FEC. Similarly, each fuel in each group is reduced in relation to their share in the group.
Final energy consumption – Other / transport	Remains the same as 2024 values, other than heating fuel usage per waste heat details.	
Waste heat	Data centers and hydrogen economy produces waste heat of which 20 % and 35 % was assumed to be capturable and usable. Captured heat is used to replace fossil/bio/burning based district heating production. It is assumed that this lowers the cost of DH moderately. This shows in the primary energy sources and volumes per fuel type. Reduction in DH fuels is based on 2024 data.	Same as 2024 energy balance (not shown).
Primary energy sources	Industry's new consumption is matched by renewables (wind and solar) in primary energy production. The waste heat affect on DH is shown first by decreasing imported fuels, then from domestic production.	Primary energy sources are reduced based on FEC fuel reductions. First reductions on imported fuels, then from domestic production.
Target year	2040	2030
Energy cost	Same fuel prices as in 2024, other than conservative assumption on electricity and heat price reduction.	Same fuel prices as in 2024, other than conservative assumption on electricity and heat price increase.
GHG avoided emissions	The 106 TWh is assumed to be used entirely for hydrogen production, which provides the largest GHG reduction in comparison to e.g., e-fuels. Avoided GHG from fossil fuels is calculated against 2024 volumes with the same emission factors.	Avoided GHG from fossil fuels is calculated against 2024 volumes with the same emission factors.
Industry value added	Conservative estimates on gross value added for data centers and hydrogen economy. Baseline MWh/GDP remains the same.	Same ratio as 2024, as the industry mix remains the same.
Other category's Energy cost	Fossil fuel usage reduced as per the effects made to energy balance.	The same reduction logic as applied for industry and other categories. The total FEC is reduced, but the households' portion remains 2024 figures.
Households' expenditure/ disposable income	Energy consumption in total remain the same as 2024 figures. Gas usage transferred to heat. Divided by 2024 disposable income	Energy consumption and disposable income in total remain the same as 2024 figures.
Green hydrogen	Assumed that hydrogen economy includes only green hydrogen production which yields highest GHG reductions. Green hydrogen used to replace fossil hydrogen in final non-energy consumption, exports, and available from all sources.	Not considered in the scenario.

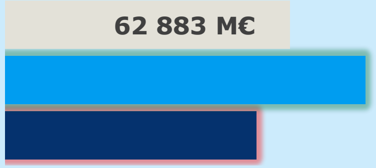
Scorecard

Competitiveness

Baseline
Scenario1
Scenario2

A. Industrial energy intensity of value added

B. Industrial GDP



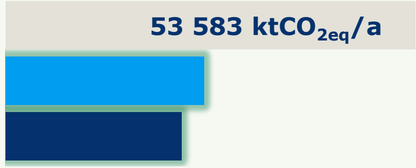
It is expected that meeting the EED targets will involve decreasing activities in sectors such as industry and transport. This reduction results in a lower overall GDP and a decline in industrial output.

Scenario 1 increases both energy consumption and added value.

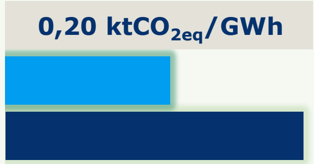
Sustainability

Baseline
Scenario1
Scenario2

A. Annual emitted GHG from energy production



B. Emitted GHG / final energy consumption



Lowering total energy consumption leads to a significant decrease in yearly emissions. However, since the energy production mix does not change, the emission intensity per unit of energy consumed remains high. This can be improved by incorporating cleaner energy sources, as demonstrated in Scenario 1.

Scenario 2 decreases annual GHG emissions a lot but not emitted GHG's per used unit of energy

Energy Security

Baseline
Scenario1
Scenario2

A. Import energy / primary energy supply

B. Import fossil energy / available energy from all sources

Looking at how much of that total is imported fossil fuel helps reveal the country's vulnerability. Scenario 1 improves this percentage through new domestic renewables and reduced gas imports. Scenario 2 keeps it nearly unchanged because the entire system shrinks proportionally like cutting everything with the same "cheese grater".

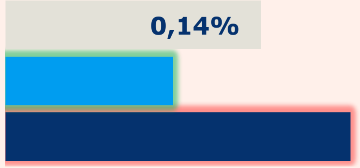
Scenario 1 reduced the reliance on imported energy the most.

Affordability

Baseline
Scenario1
Scenario2

A. Cost of energy to household consumers

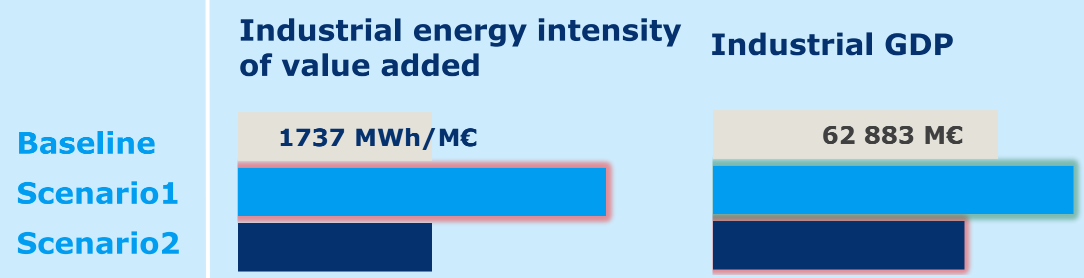
B. Households' expenditure/ disposable income



The law of supply and demand – If we reduce consumption and thus the supply, when the demand (e.g. heating, cooling) remains, the energy cost for household's most likely sees an increase.

Scenario 1 reduced the energy costs, while scenario 2 increases.

Analysis : Competitiveness



It is expected that meeting the EED targets will involve decreasing activities in sectors such as industry and transport. This reduction results in a lower overall GDP and a decline in industrial output.

Scenario 1 increases both energy consumption and added value.

Case example: interpreting the two scenarios

In our Finnish case example, the two scenarios behave very differently.

- **Scenario 1**: Growth in energy-intensive sectors
  Here, new energy-intensive activities such as datacenters and green hydrogen production were added.
  - Because these sectors consume large amounts of energy, energy intensity increases, meaning more energy is needed for each unit of industrial value added.
  - At the same time, industrial GDP grows, because new industries bring more output and value into the economy.

  → This results in one metric showing a negative change (higher energy per M€) while the other shows a positive change (higher industrial GDP).
- **Scenario 2**: Achieving the EED consumption target
  In this scenario, all sectors reduce their final energy consumption evenly. The structure of the economy does not change.
  - The ratio in the energy-intensity metric stays roughly the same, because both the energy use and industrial output shrink proportionally.
  - However, industrial GDP decreases, as reduced activity leads to less production and therefore less added value.

  → This scenario produces a neutral result in one metric and a negative result in the other.

Why a single metric is not enough

These two examples illustrate why energy-efficiency performance should not rely on a single measurement.

Scenario 1: Growth in energy-intensive sectors

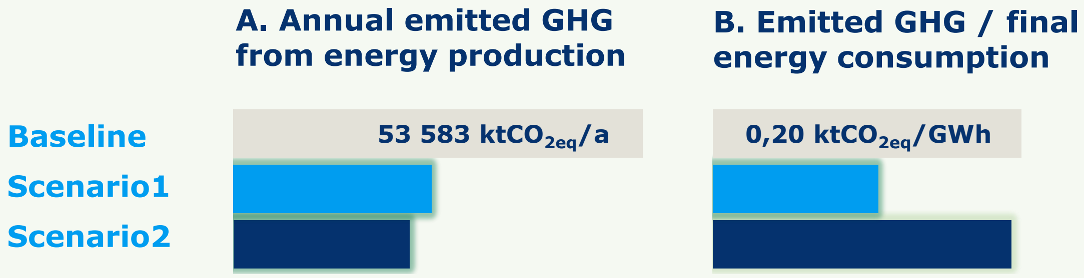
- The energy-intensity metric looks worse even though economic growth, renewable electricity use and waste-heat recovery bring several positive effects.

Scenario 2: Achieving the EED target

- The energy-intensity metric looks stable but the overall economy contracts, and industrial competitiveness weakens.

→ Looking at only one metric could lead to a misleading conclusion. A scorecard-approach makes the interpretation more realistic, showing both the gains and the trade-offs.

Analysis : Sustainability / Climate



Lowering total energy consumption leads to a significant decrease in yearly emissions. However, since the energy production mix does not change, the emission intensity per unit of energy consumed remains high. This can be improved by incorporating cleaner energy sources, as demonstrated in Scenario 1.

Scenario 2 decreases annual GHG emissions a lot but not emitted GHG's per used unit of energy

Case example: interpreting the two scenarios

- **Scenario 1**: Growth in energy-intensive sectors
  In this scenario, Finland's total energy use increases due to new energy-intensive activities. Although no specific energy-saving actions are assumed, several mechanisms still reduce emissions:
  - Waste heat from data centers and electrolyzers replaces fossil-fuel-based district heating.
  - Domestically produced green hydrogen replaces part of the imported natural gas.
  - A large amount of new renewable electricity is added to the system.

  → Together, these changes already create a significant drop in annual GHG emissions. In addition, because renewables take a larger share of the total energy mix, the emissions per GWh (metric B) decrease noticeably.
- **Scenario 2**: Achieving the EED consumption target
  Scenario 2 produces an even slightly larger reduction in annual emissions than Scenario 1. This happens mainly because:
  - overall energy consumption is lower, which reduces the amount of fossil fuels burned across all sectors.
  - However, the reduction applies evenly to all fuels and all users. This means that the relative share of fossil versus renewable energy remains similar to the baseline.

  → As a result, the emissions-per-GWh metric (B) stays almost unchanged. The system emits less simply because it uses less energy, not because the production mix has become cleaner.

Why a single metric is not enough

These scenarios show why sustainability cannot be assessed through one measure alone.

Scenario 1: Growth in energy-intensive sectors

- Scenario 1 delivers slightly smaller annual savings, yet it achieves them while adding renewable electricity, enabling new industries, replacing fossil imports and strengthening the long-term decarbonization pathway.

Scenario 2: Achieving the EED target

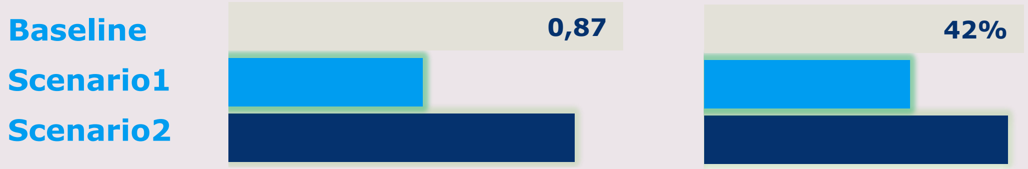
- Scenario 2 delivers larger annual emission savings, but only because activity and consumption are reduced—not because the energy system becomes cleaner.

→ The scorecard approach ensures these important differences are visible and correctly interpreted: Scenario 1 improves the sustainability of the energy mix, whereas Scenario 2 reduces emissions mainly by shrinking the system.

Analysis : Energy Security

A. Import energy / primary energy supply

B. Import fossil energy / available energy from all sources



Looking at how much of that total is imported fossil fuel helps reveal the country’s vulnerability. Scenario 1 improves this percentage through new domestic renewables and reduced gas imports. Scenario 2 keeps it nearly unchanged because the entire system shrinks proportionally like cutting everything with the same “cheese grater”.

Scenario 1 reduced the reliance on imported energy the most.

Case example: interpreting the two scenarios

- **Scenario 1**: Growth in energy-intensive sectors
  In Scenario 1, Finland adds a significant amount of domestic renewable electricity to its system.
  - Hydrogen production and waste-heat recovery also replace part of the fossil-based imports, especially natural gas.
  - The combined effect lowers the ratio between imported energy and domestic primary energy production and reduces the share of imported fossil fuels in the overall energy mix.

  → Both metrics therefore show a clear improvement in energy security.
- **Scenario 2**: Achieving the EED consumption target
  In Scenario 2, all energy consumption and production are reduced evenly across all sectors and fuels.
  - This uniform cut also reduces renewables, which leaves their share small in proportion to total inputs.
  - Because the structure of the energy system remains the same as the baseline, the importance of imports becomes more visible when expressed as ratios.

  → As a result, both metrics show very little improvement. The system becomes smaller, but not structurally more secure.

Why a single metric is not enough

These results show why relying on a single indicator can give a misleading picture.

Scenario 1: Growth in energy-intensive sectors

- Scenario 1 increases total energy use, yet it clearly strengthens self-sufficiency and reduces exposure to fossil imports.

Scenario 2: Achieving the EED target

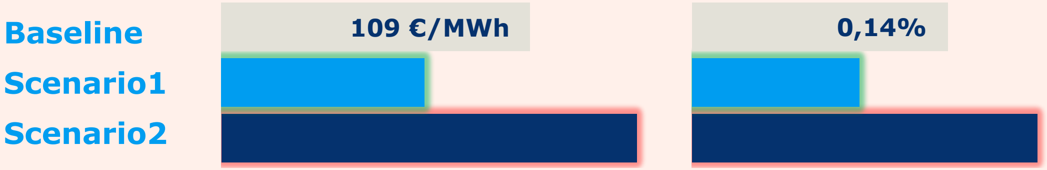
- Scenario 2 appears to improve security slightly because overall consumption is lower.

→ Only by looking at several metrics together can we understand whether changes come from real structural improvements or simply from shrinking the system.

Analysis : Affordability

A. Cost of energy to household consumers

B. Households' expenditure/ disposable income



The law of supply and demand – If we reduce consumption and thus the supply, when the demand (e.g. heating, cooling) remains, the energy cost for household's most likely sees an increase.

Scenario 1 reduced the energy costs, while scenario 2 increases.

Case example: interpreting the two scenarios

- **Scenario 1**: Growth in energy-intensive sectors
  In Scenario 1, consumption is not limited, and new renewable energy is added to supply.
  - Increasing supply tends to reduce price pressure, particularly when this new energy replaces fossil-based imports that may be expensive or volatile.
  - When combined with the assumed growth in industrial activity and GDP, households in Scenario 1 face lower prices and stronger purchasing power.

  → As a result, the share of disposable income spent on energy decreases compared with the baseline. Both metrics therefore move in a favourable direction in Scenario 1.
- **Scenario 2**: Achieving the EED consumption target
  According to basic supply-and-demand logic, if total energy consumption is restricted, as in Scenario 2, then energy supply becomes tighter.
  - Even though total consumption falls at a system level, household needs do not drop significantly—people still require heating, cooling and electricity.
  - With demand remaining relatively firm but available supply shrinking, prices are likely to rise.
  - At the same time, the earlier Competitiveness section notes that GDP does not grow in this scenario.

  → When incomes stagnate but energy prices rise, households end up spending a larger share of their disposable income on energy. This creates conditions where energy poverty is more likely to increase.

Why a single metric is not enough

In the affordability section, both metrics point to similar conclusions, but they reinforce one another:

Scenario 1: Growth in energy-intensive sectors

- Scenario 1 shows lower prices and lower income share spent on energy, indicating improved affordability.

Scenario 2: Achieving the EED target

- Scenario 2 shows higher prices and a higher income share spent on energy, signalling increased affordability risks.

→ However, one element not captured directly in these metrics is price fluctuation. Adding large amounts of renewable energy can also change the variability of electricity prices over time. This is not part of the current scorecard but could be a useful additional metric in future analyses.

Conclusions

Summary

This report demonstrates that assessing energy efficiency through a single number, such as an absolute reduction in final energy consumption, provides only a partial picture of what is happening in a rapidly changing energy system in EU.

Electrification, new industrial activities, increased renewable production and measures that strengthen energy security all influence consumption levels in ways that may be beneficial for climate targets and economic growth, yet these changes are not captured by the one-dimensional metric.

Case example

For this report, a case example from Finland was created solely for illustration. It demonstrates how varying assumptions about future development lead to different sector outcomes, reflected in the four proposed scorecard themes.

Importantly, the metrics here are not final recommendations but examples showing how a broader perspective helps clarify cause-and-effect relationships in the energy system. Different countries or analyses may need additional or alternative indicators, and further refinement is required for practical application.

Two scenarios

Scenario 1 adds energy-intensive activities but improves sustainability and energy security through renewable production, hydrogen and waste-heat utilization.

Scenario 2 reaches the EED target by reducing consumption across all sectors, but without structural changes it shows declines in competitiveness and affordability. These results are not predictions, nor are they an assessment of Finland’s policy choices. They simply highlight how the metrics can help reveal both benefits and trade-offs.

Results

The main conclusion is that a scorecard approach offers a more balanced and realistic way to evaluate energy efficiency. It prevents misleading interpretations from focusing on a single metric and helps decision-makers see how actions in one area affect others.

By eliminating the EED's absolute consumption target and instead tracking a broader set of indicators, policymakers gain a clearer understanding of how efficiency improvements support economic growth, sustainability, energy security, and affordability for households and businesses.

Bright ideas. Sustainable change.

RAMBOLL

This work was carried out by Ramboll between December 2025 and February 2026.
The core project team consisted of Sara Ekman, Siiri Lampela, Jouni Kivirinne and Jukka Kopra.