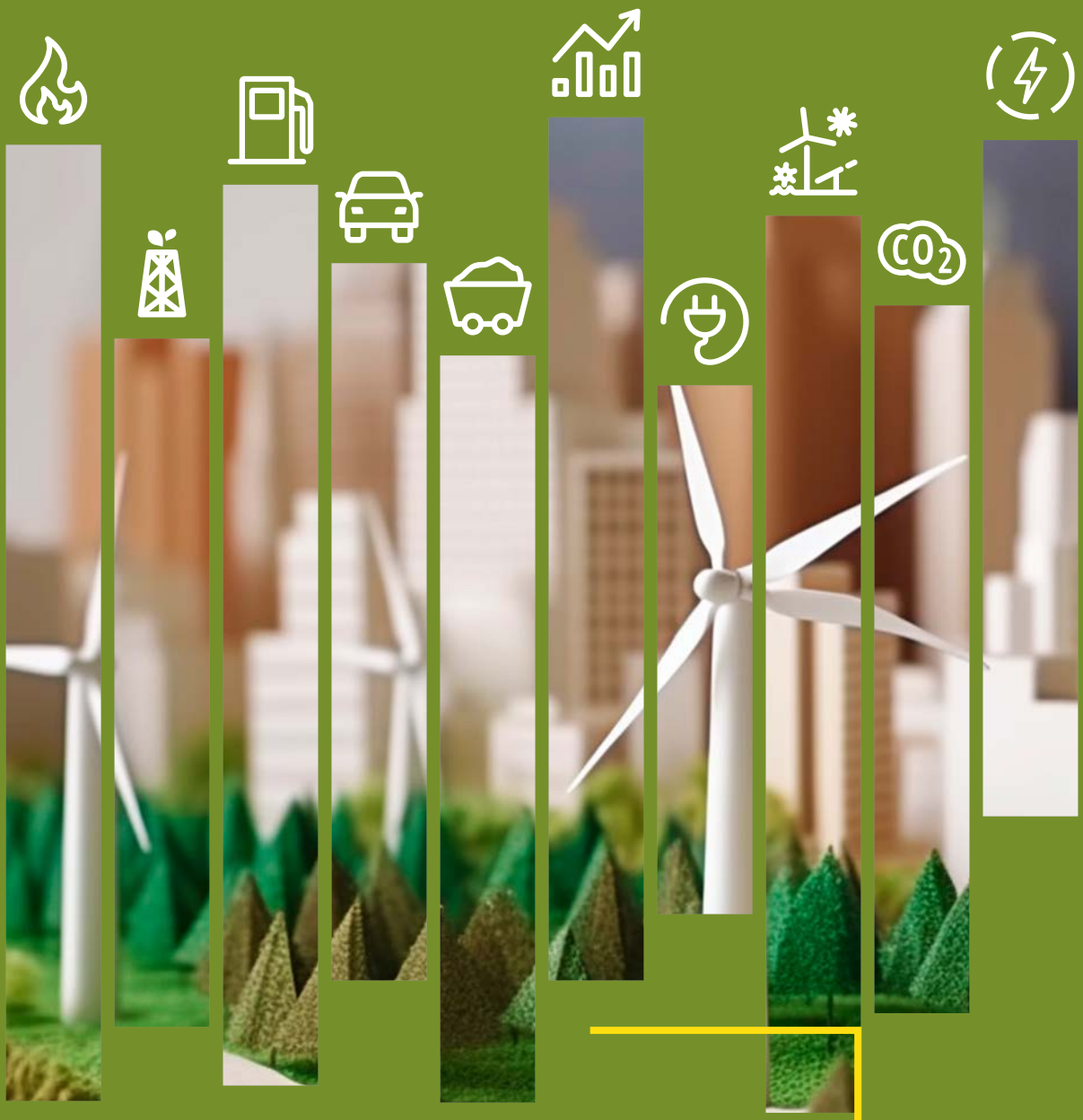

2024

GLOBAL ENERGY TRENDS

Edition

2030 TARGETS

Renewables & energy efficiency

Enerdata
intelligence + consulting

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Chapter 1

2022 & 2023 DATA BENCHMARKS

- Key energy & climate figures for G20
- Trends by energy for G20
- Summary

Key energy & climate figures for G20*

ECONOMIC GROWTH

returns to its historical trend

2023 **+3%**

2022 **+3.2%**

2021

2010-19 **+3.4%** /year

Source: Enerdata – www.enerdata.net

***G20 countries** represent approximately **80% of global energy consumption.**

ENERGY CONSUMPTION

grows faster than its historical pace

2023

+2.3%
12.2 Gtoe

2022

+1.2%

2021

2010-19 +1.3% /year

CO_2 EMISSIONS**

continue to grow

2023

+1.7%
30.1 $GtCO_2$

2022

+1.4%

2021

2010-19 +1.2% /year

** CO_2 emissions from energy combustion (> 80% of all CO_2 emissions)

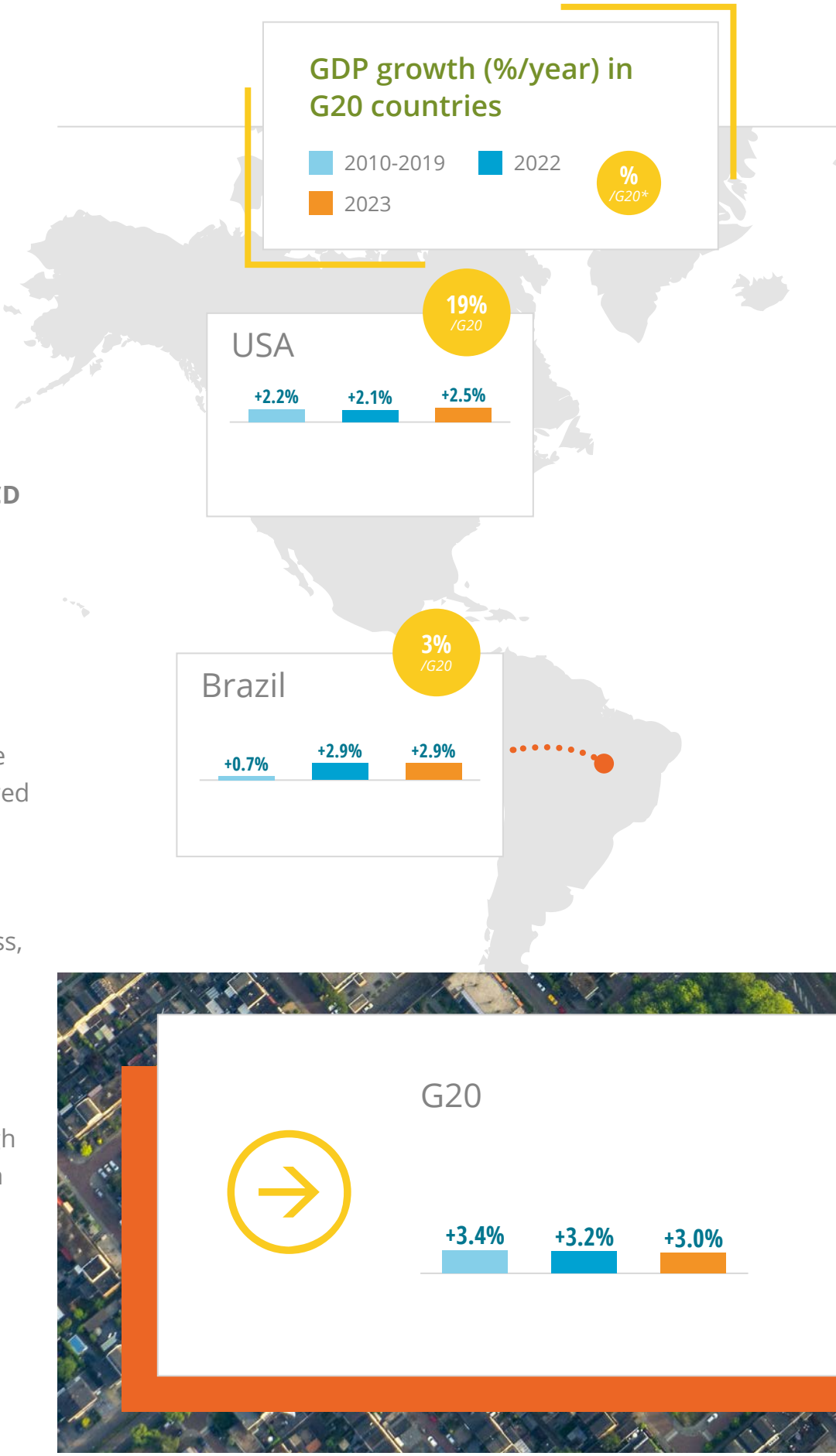
Source: Enerdata – www.enerdata.net

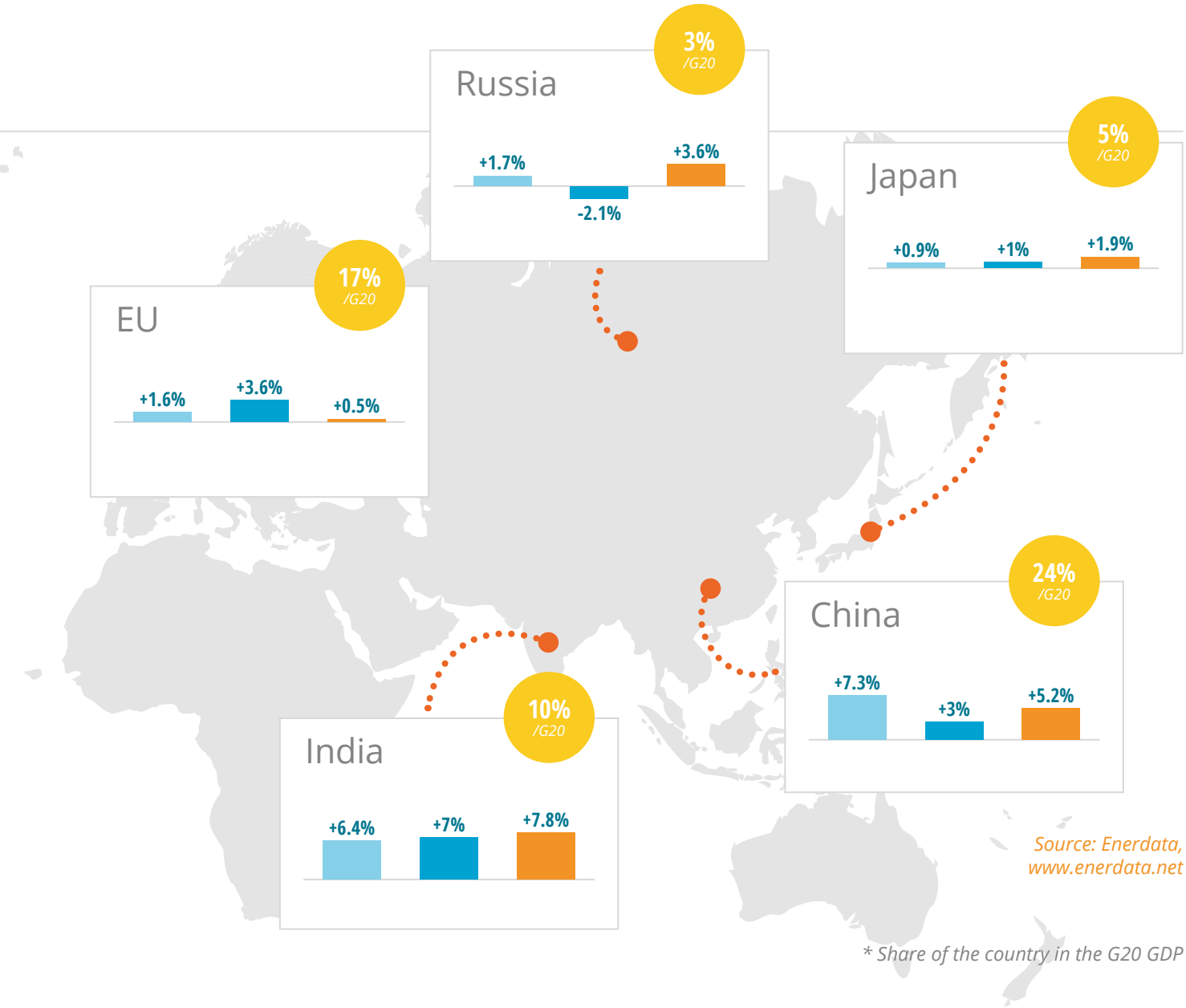
ECONOMIC GROWTH

The G20's GDP surged by 3% annually in 2023

Rapid growth in non-OECD countries, notably driven by China (+5.2%), and was fueled by post-COVID-19 recovery. India and Indonesia also saw strong expansion. Russia maintained growth despite Western sanctions, bolstered by substantial fiscal measures and increased military spending. Brazil showed significant progress, especially in agriculture.

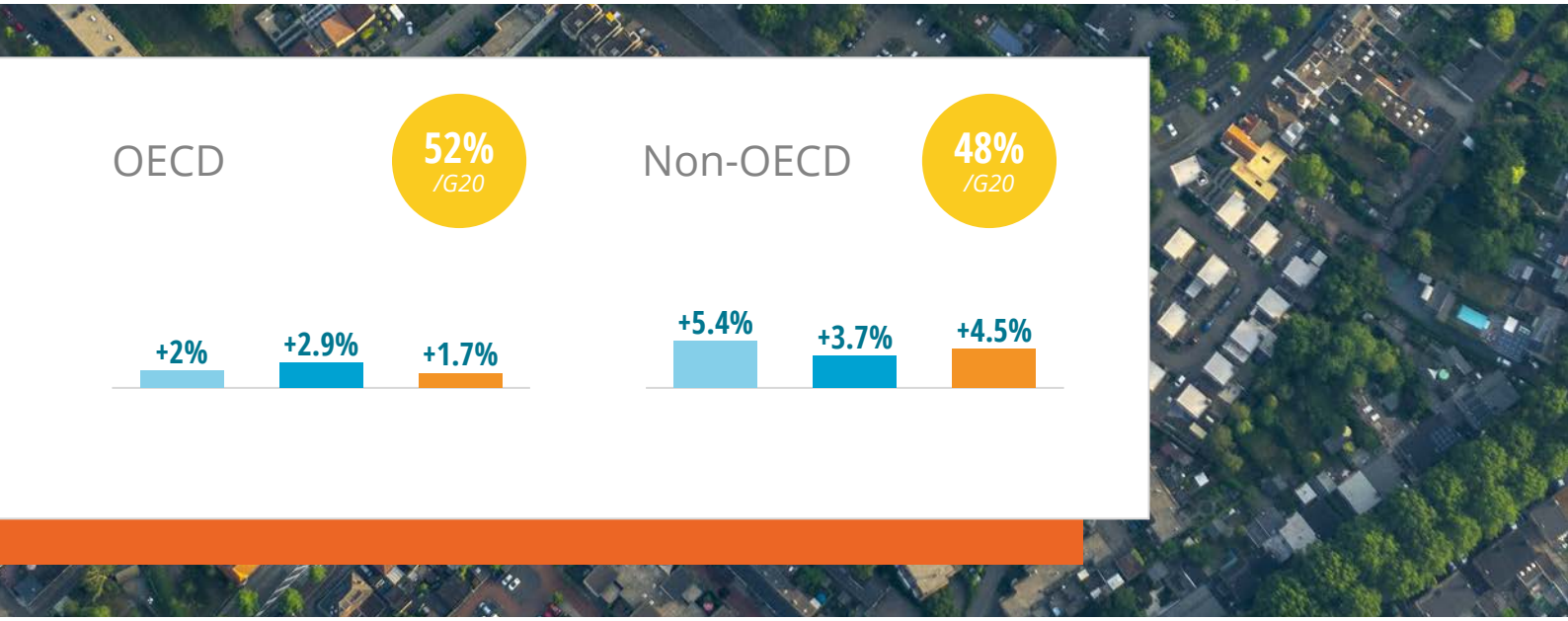
OECD slowdown. The EU GDP grew by 0.5% in 2023 amid geopolitical uncertainties, inflation, high interest rates. GDP grew in the US (+2.5% over steady consumer spendings), in Japan and South Korea (3rd year of growth), in Türkiye and Mexico (both due to strong construction activities).





Source: Enerdata, www.enerdata.net

** Share of the country in the G20 GDP*

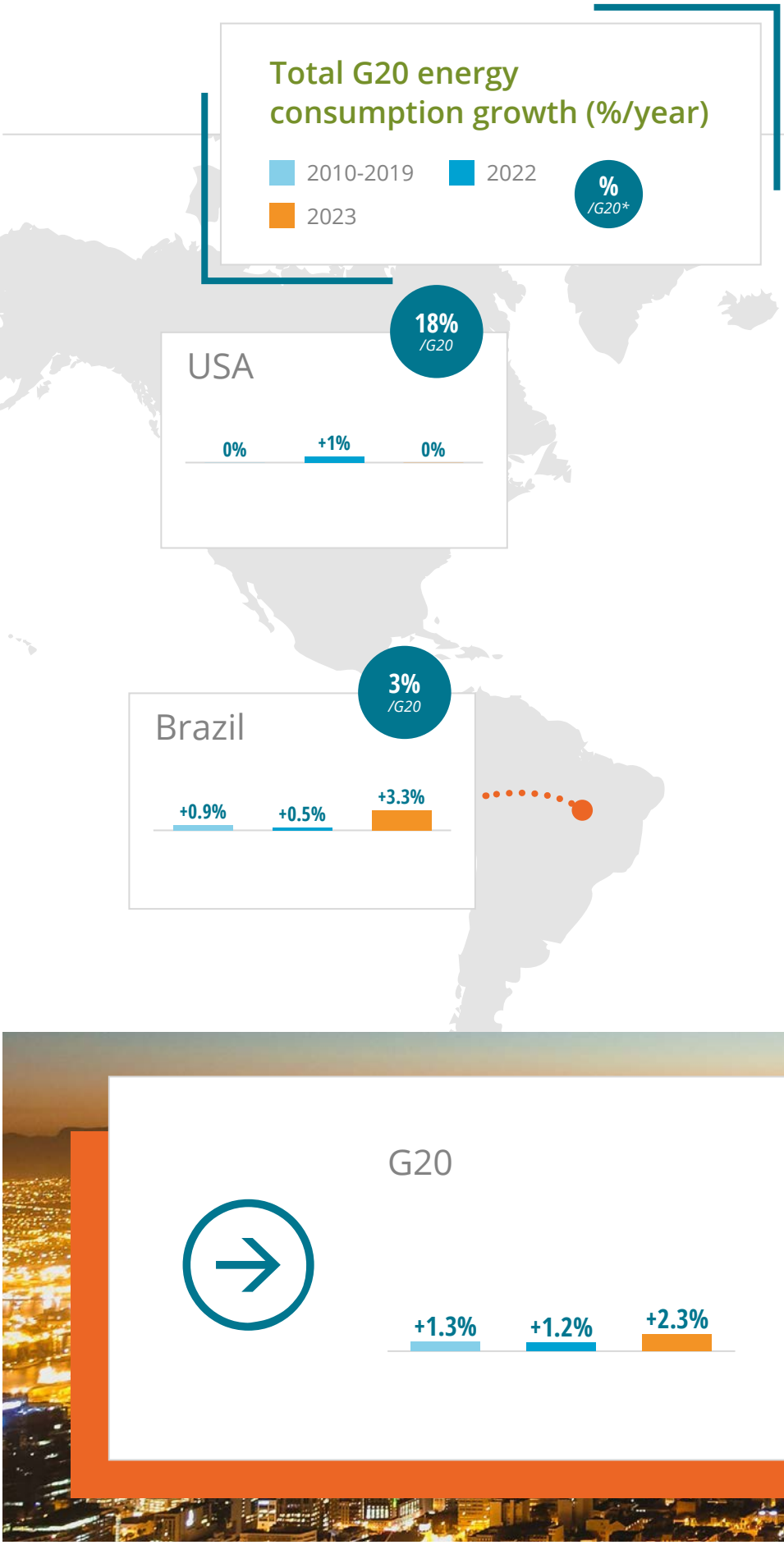


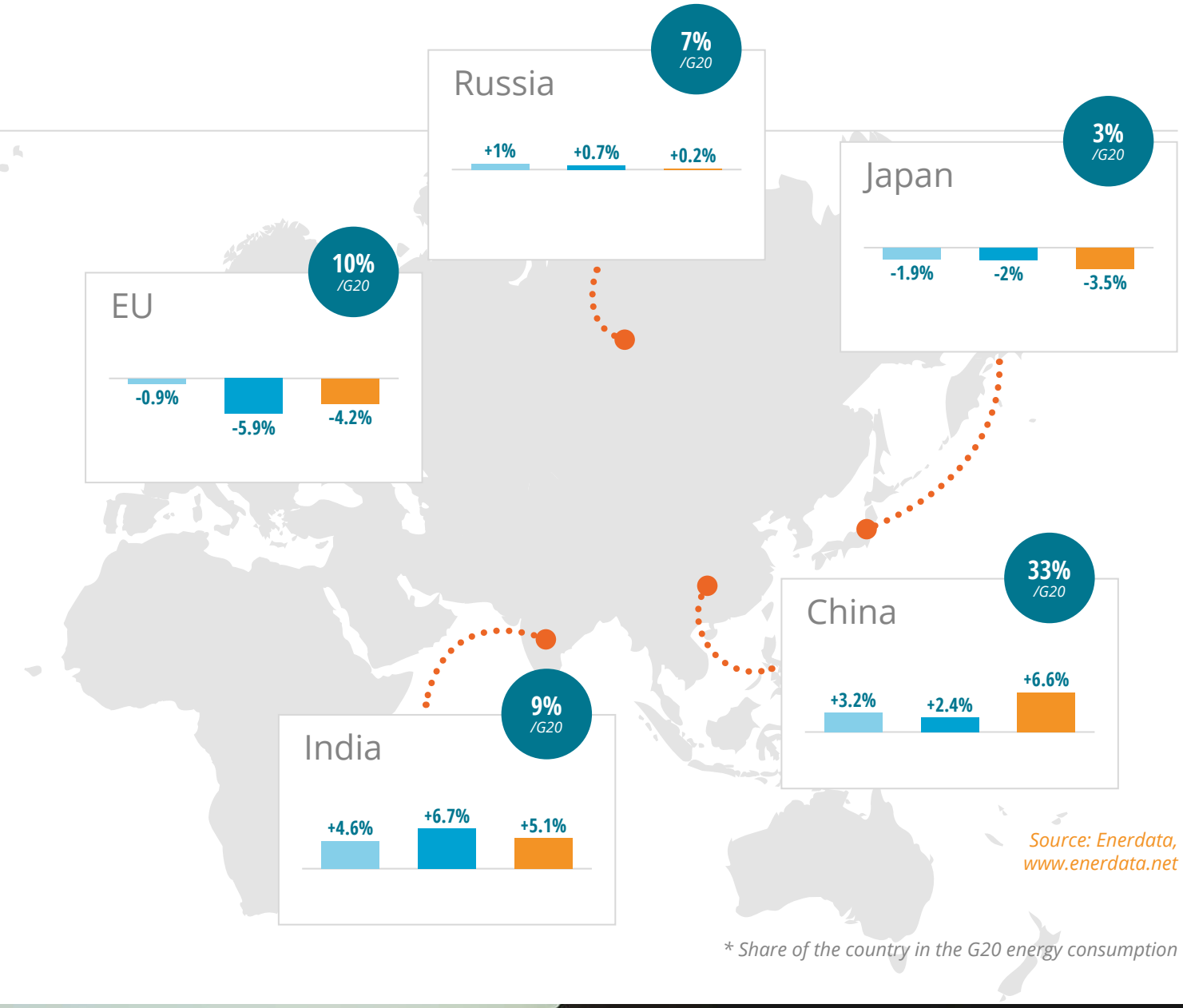
ENERGY CONSUMPTION

Rose at a steady pace in 2023

The G20's energy consumption grew faster than its historical trend (+2.3% in 2023), **spurred by non-OECD countries**, and more specifically, by China (+7%) and India (+5%). Economic growth also fueled energy consumption in Brazil (+3%) but it stagnated in Russia and declined in Argentina (-2%), South Africa (-1%) and Saudi Arabia.

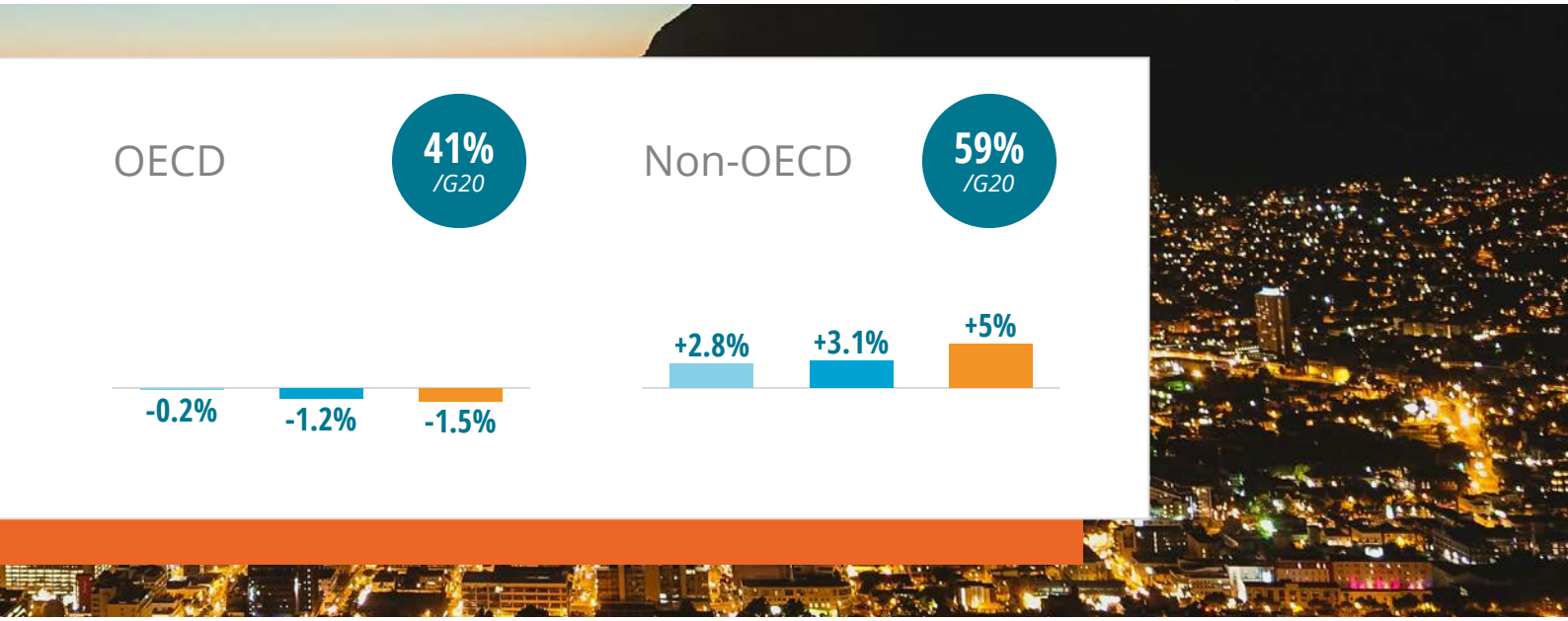
On the contrary, energy consumption declined for the 2nd year in a row in OECD countries (-1.5%), with a 4% drop in the EU, a 3% drop in Japan and South Korea, and a stable consumption in the US (higher oil consumption for transport but lower electricity consumption for cooling).





Source: Enerdata, www.enerdata.net

** Share of the country in the G20 energy consumption*

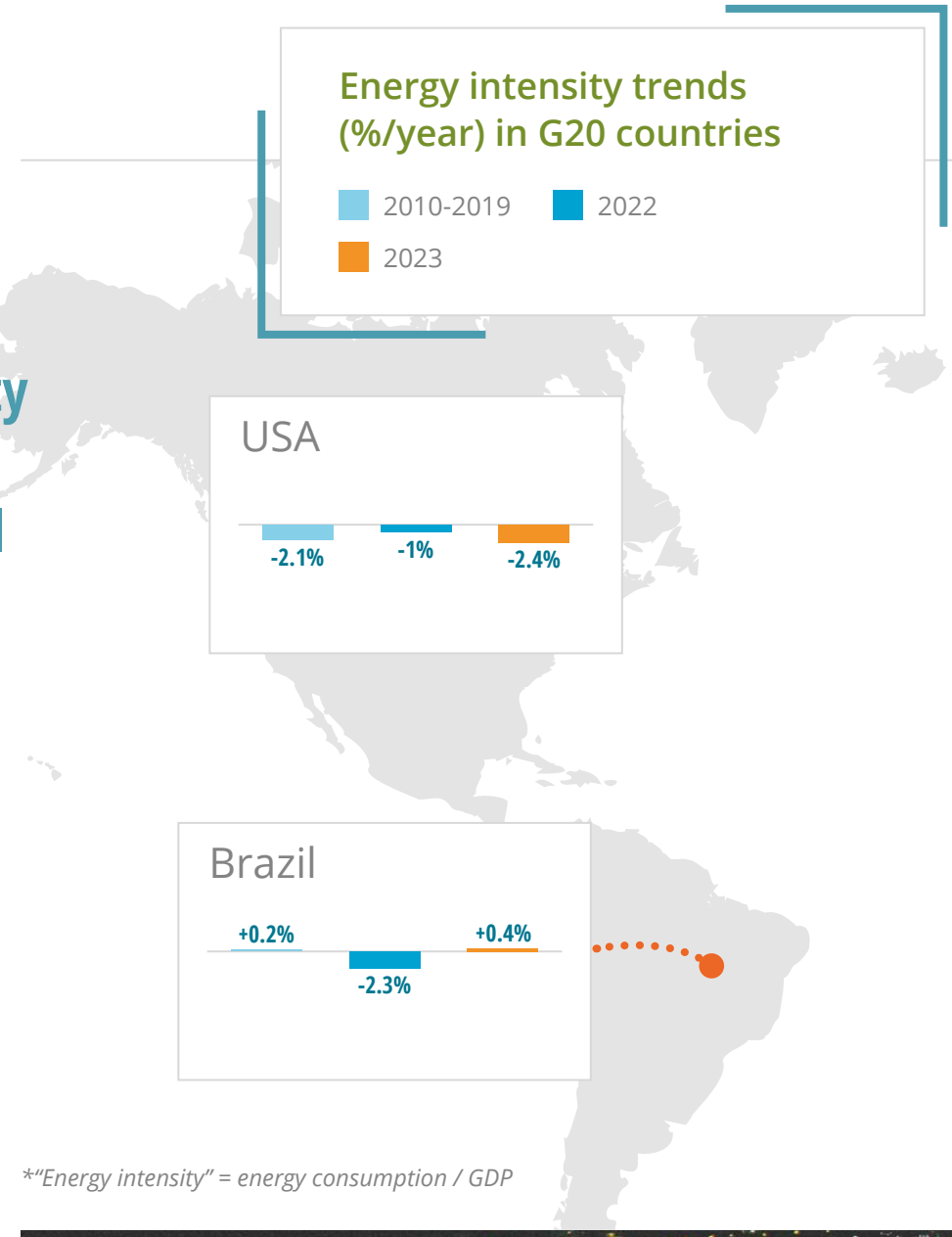


ENERGY INTENSITY*

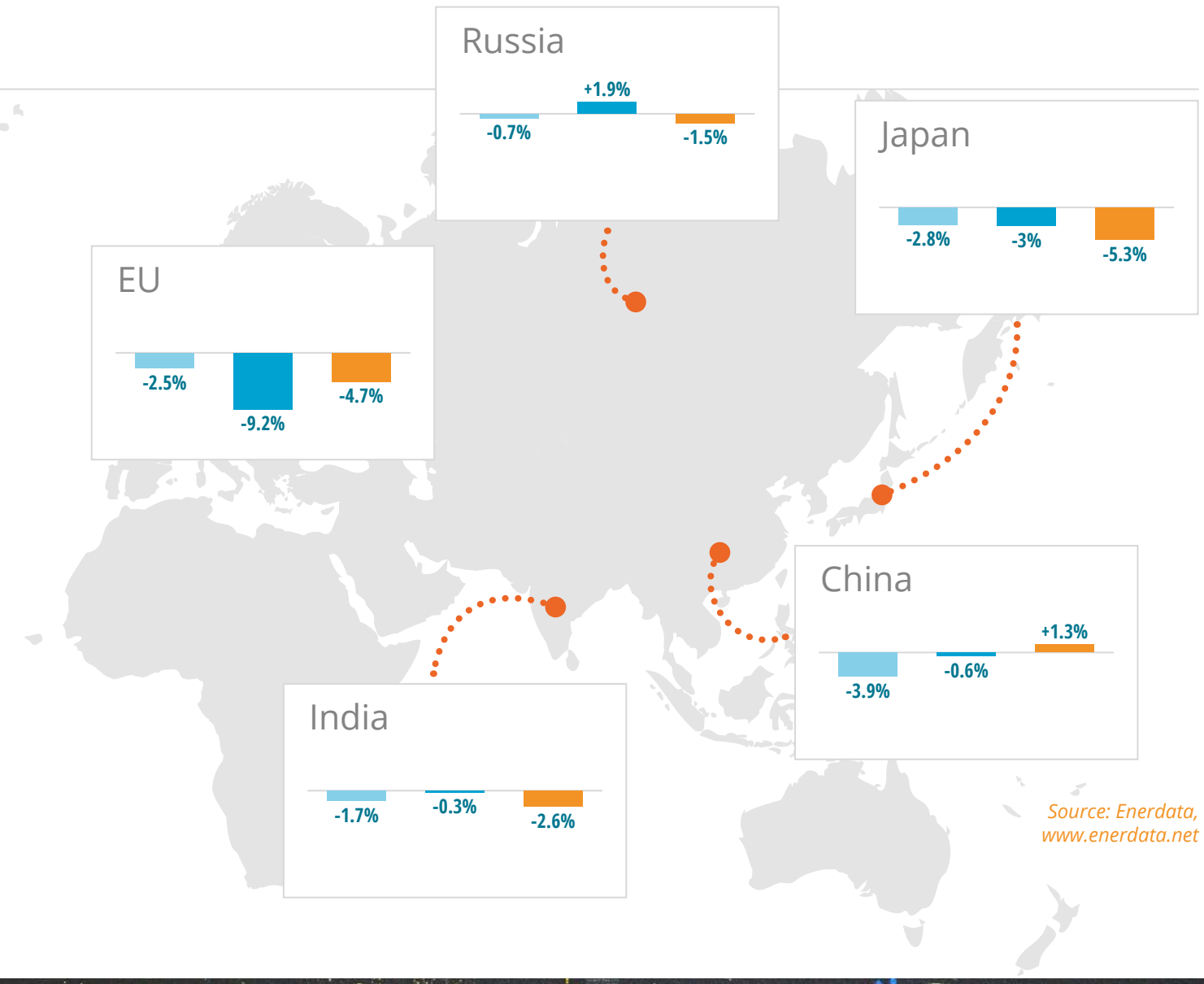
Few energy intensity improvements in 2023 yet, the global economy remains energy-intensive

In **2023**, **energy intensity** saw a **modest reduction** of **-0.7%**, marking a **slower decline than the historical trend**. This **rate of improvement** is **incompatible** with **the 2 °C objective** (which would require a 3.3%/year reduction in energy intensity).

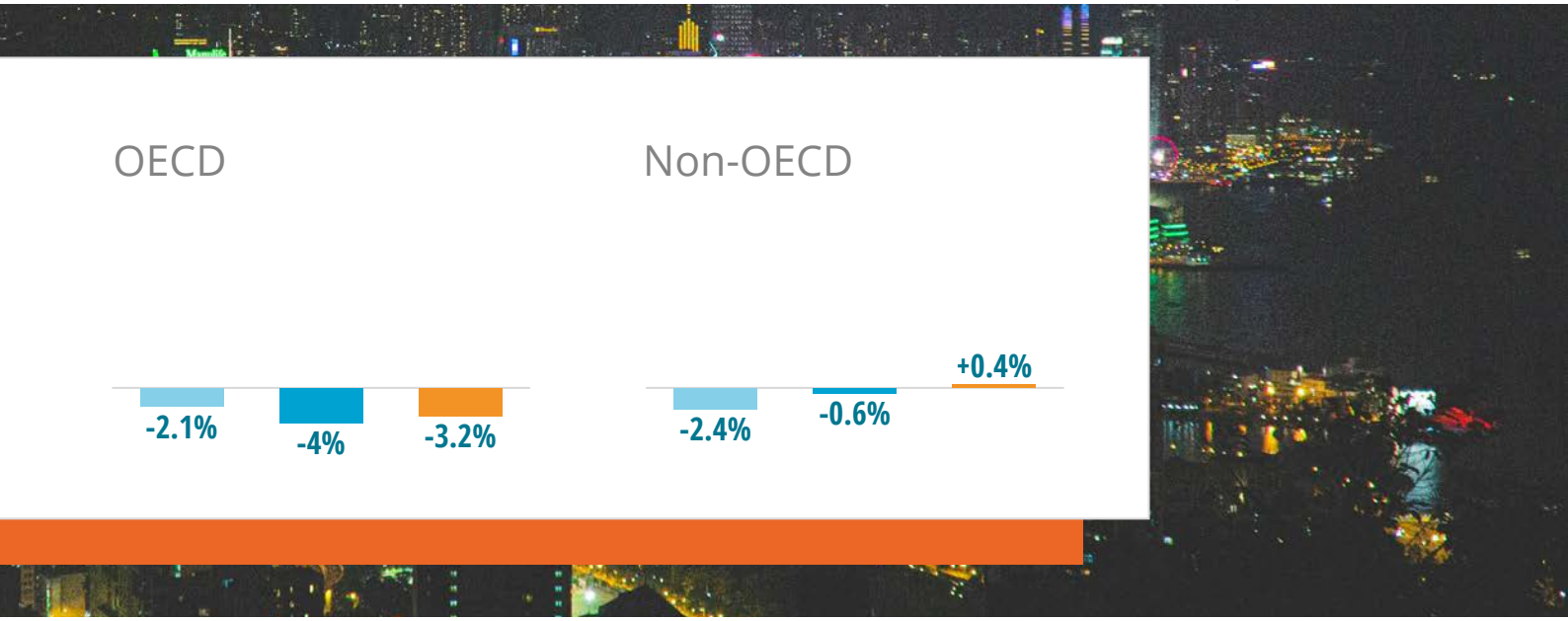
In **OECD countries**, the **higher renewable power generation** and the **weak industrial activity** in the **EU**, **US** and **Japan** contributed to **cut intensity by 3.2%**, but it **remained stable** for the second year in a row in **non-OECD countries** (slight increases in China and Brazil).



*"Energy intensity" = energy consumption / GDP



Source: Enerdata, www.enerdata.net

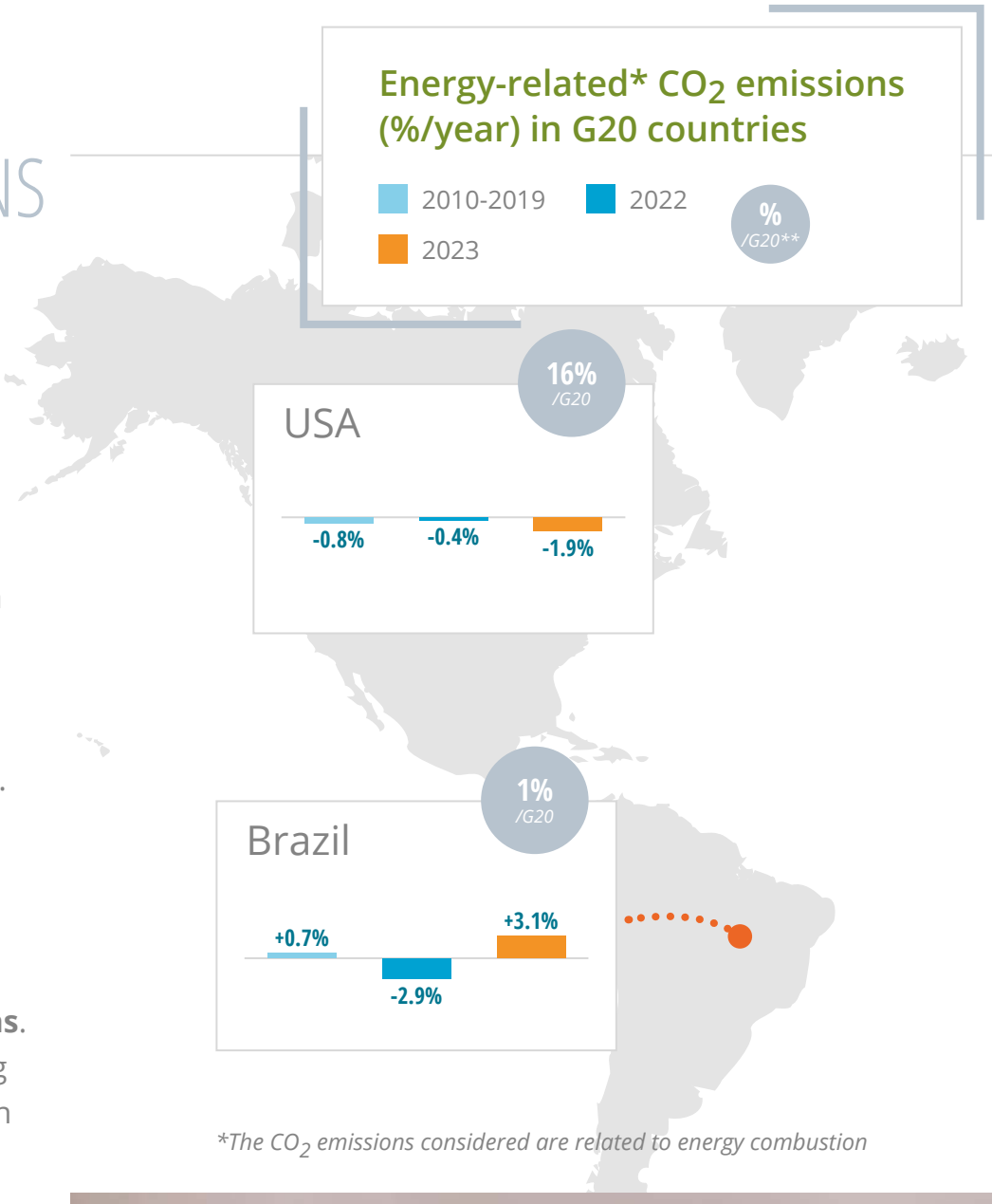


CO_2 EMISSIONS

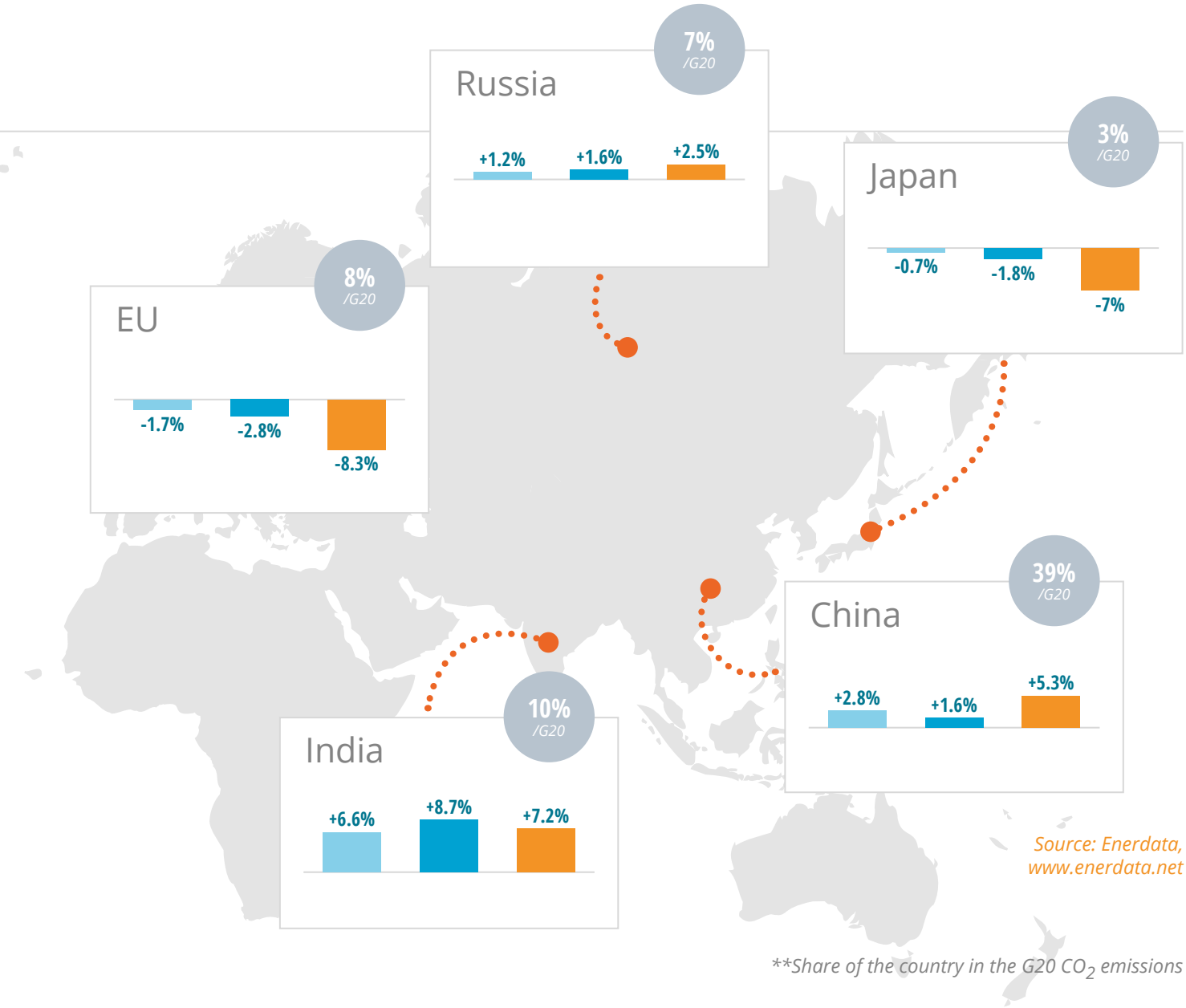
New increase in 2023, spurred by China and India

CO_2 emissions reached a new record in 2023 (+1.7%), **spurred by China** (+5% to 39% of the G20's total CO_2 emissions) and **India** (+7% to 10% of the G20's total CO_2 emissions).

Reduced hydropower availability in **China** and **India** led to **increased coal consumption**, **affecting global emissions**. Additionally, the reopening of transportation sectors in China and global aviation further contributed to the rise in emissions. This impact was **partially offset by milder temperatures reducing energy demand in the US**, **weaker energy-intensive industrial activity** in the **EU**, **Japan**, and **South Korea**, and a **rise in renewable power generation**.

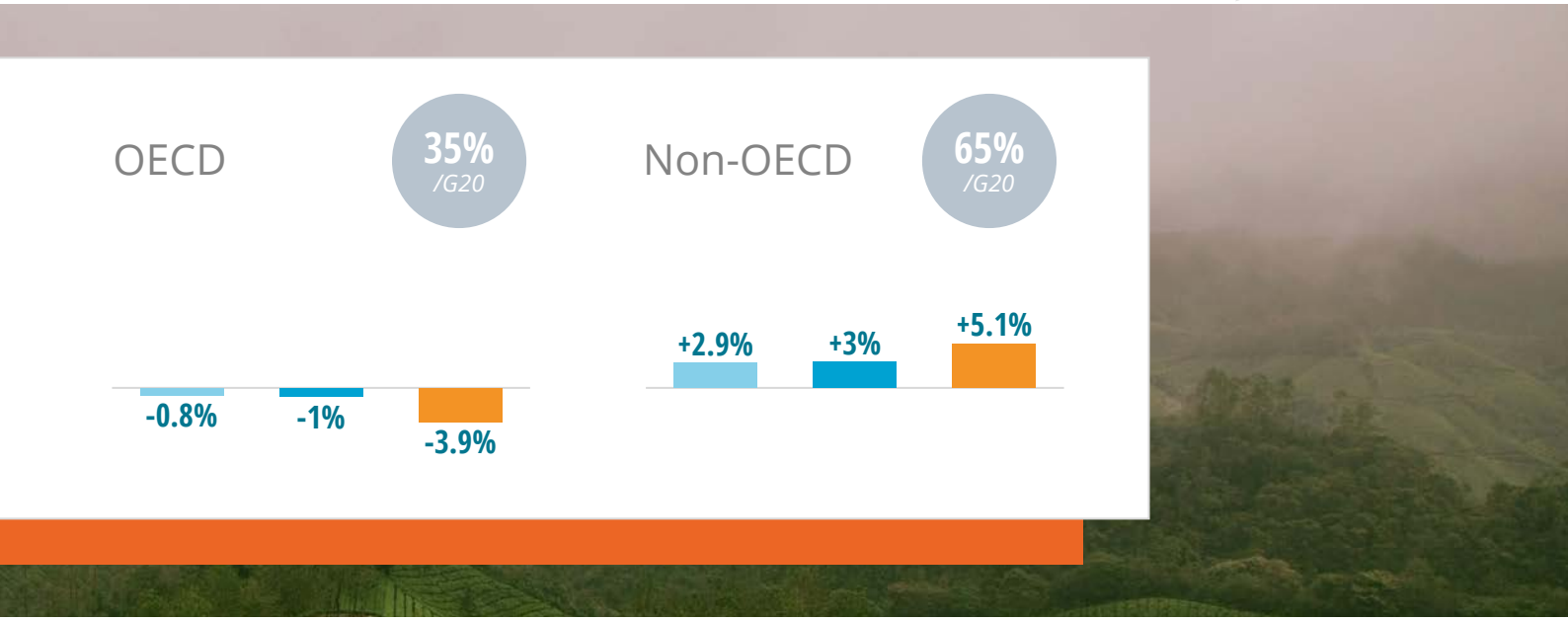


*The CO_2 emissions considered are related to energy combustion



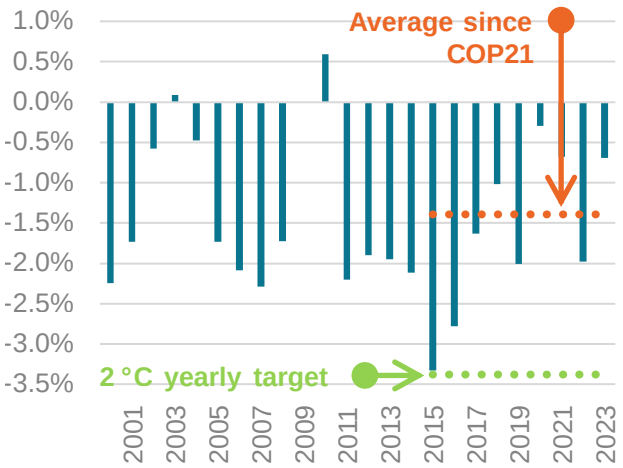
Source: Enerdata, www.enerdata.net

***Share of the country in the G20 CO_2 emissions*

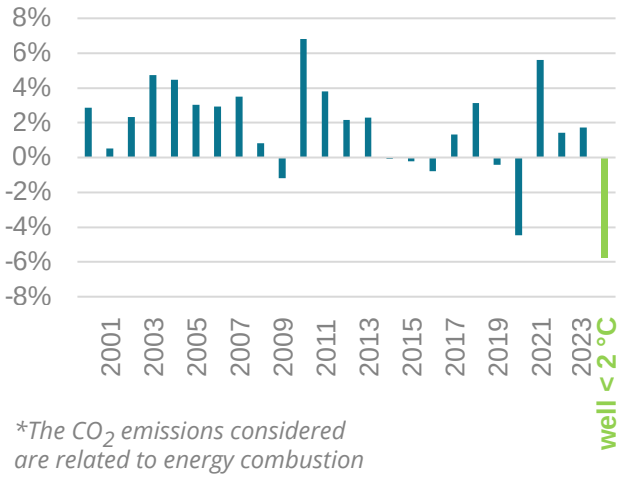


DECARBONISATION EVOLUTION

Energy intensity: G20

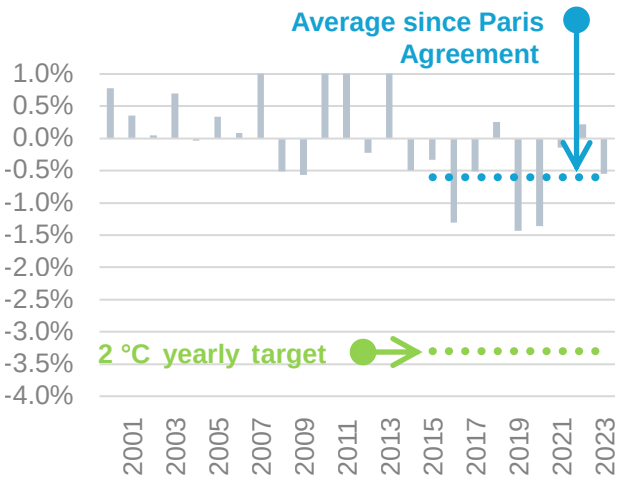


Energy-related* CO_2 emissions (combustion): G20

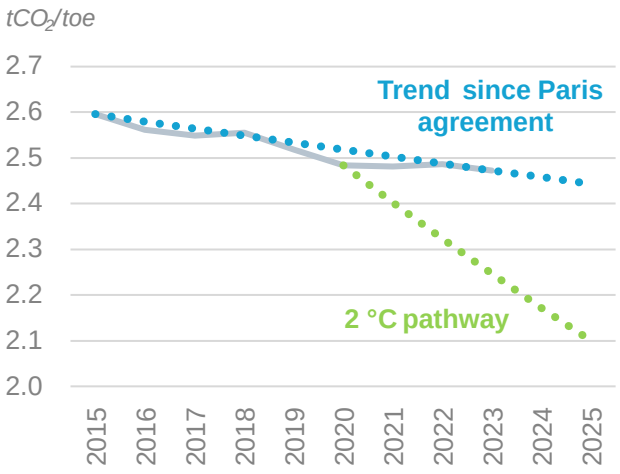


**The CO_2 emissions considered are related to energy combustion*

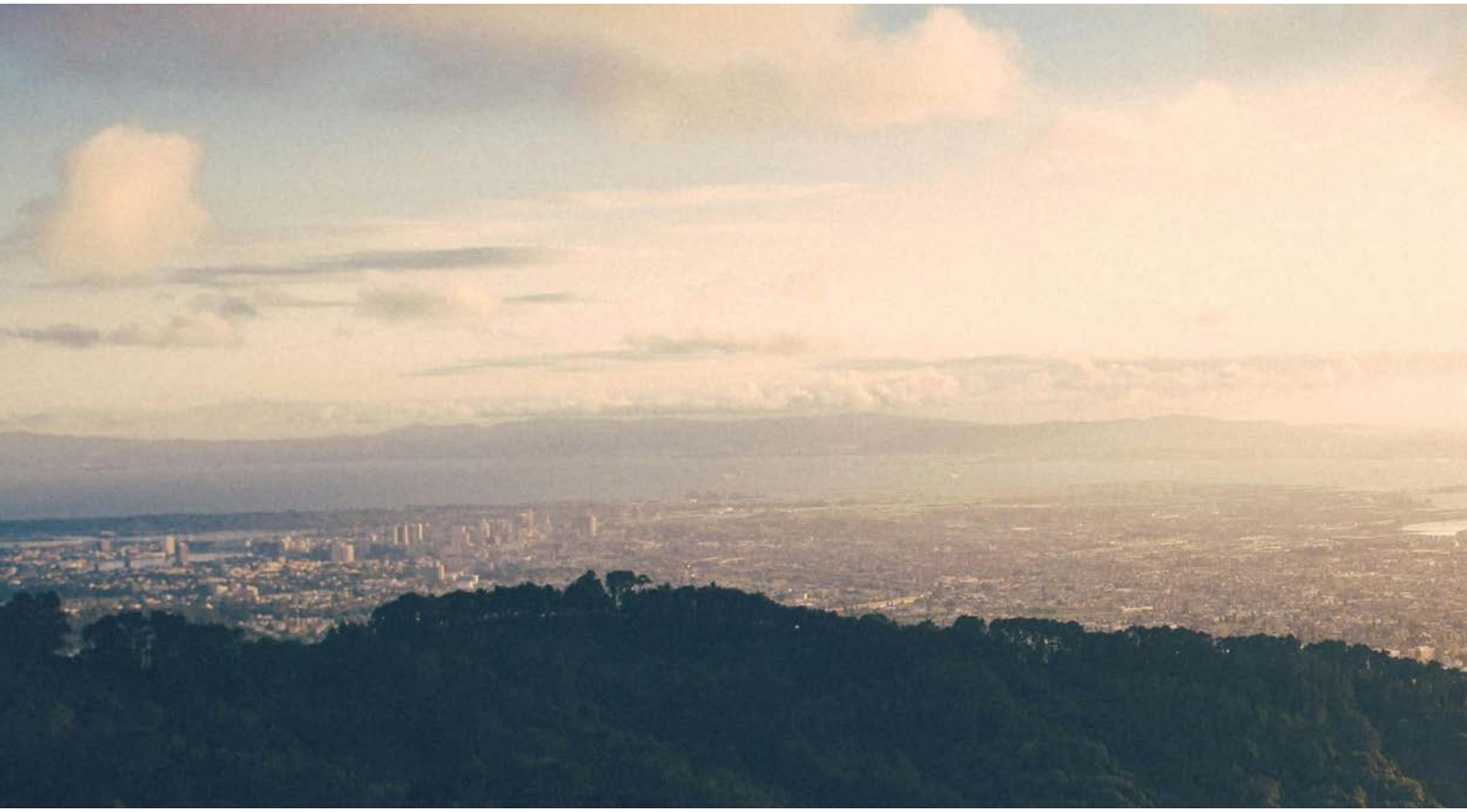
Carbon factor growth: G20



Carbon factor: G20



Source: Enerdata – www.enerdata.net



G20 energy mix remains CO_2 intensive, far from a 2 °C pathway

- **The carbon factor was broadly stable** (-0.5%), **further away from the 2 °C pathway**, **with improvements** in **large OECD countries being offset by a higher carbon content in non-OECD countries** (China, India, Russia). The power mix remains highly carbon-intensive with approximately 60% of fossil fuels.
- In **2023**, **economic growth returned to its average trend from 2010 to 2019**; however, **energy consumption outpaced this historical trend significantly**: the **G20 failed to decouple energy consumption from economic growth and reduce energy intensity enough to meet the 2 °C pathway**; these trends vary depending on the country, its GDP, the structure of its economy and energy mix changes.
- **Despite a rise in wind and solar power generation**, **the share of renewables in energy and power mixes only slightly increased and CO_2 emissions grew again by 1.7%**. The pace of carbon factor reduction **remains insufficient to meet the 2 °C target**.

Trends by energy for G20

ECONOMIC GROWTH

returns to its historical trend

2023

+3%

2022

+3.2%

2021

2010-19 +3.4% /year

ENERGY CONSUMPTION

accelerates beyond historical trends

2023

+2.3%

12.2 Gtoe

2022

+1.2%

2021

2010-19 +1.3% /year

Source: Enerdata – www.enerdata.net

COAL – 33%

The share of coal in the G20's primary energy consumption

2021 → 2022 (+4%) → 2023 (+2.5%)

2010-19 ▶ +0.5% /year

OIL – 28%

The share of oil in the G20's primary energy consumption

2021 → 2022 (+0.6%) → 2023 (+2.6%)

2010-19 ▶ +1% /year

GAS – 21%

The share of gas in the G20's primary energy consumption

2021 → 2022 (-1.8%) → 2023 (+0.9%)

2010-19 ▶ +2.4% /year

Source: Enerdata
www.enerdata.net

ELECTRICITY – 23%

The share of electricity in the G20's final energy consumption

2021 → 2022 (+2.4%) → 2023 (+2.5%)

2010-19 ▶ +2.6% /year

COAL

Consumption continues rising, pulled by non-OECD countries

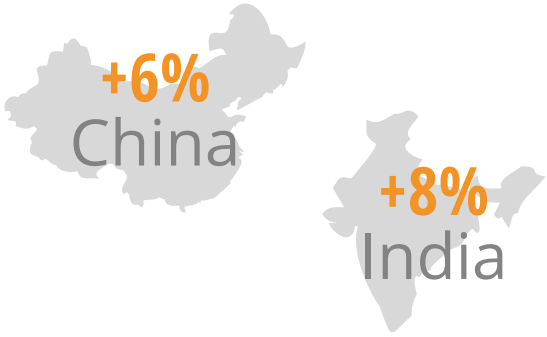
New growth in 2023, despite some noticeable drops.

The growth in coal consumption (+2.5%) **is triggered by non-OECD countries, particularly major producers** such as **China** and **India**, **which consumed more coal to sustain their strong economic growth**. Together, they accounted for nearly **3/4** of the **G20's coal consumption**. **Low hydro availability** also contributed to **increased coal consumption** for power generation in **China**, **India** and **Mexico**.

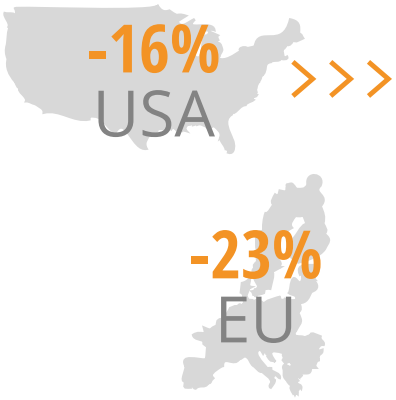
On the other hand, **coal consumption** continued to **decline in the OECD countries**. The **coal-to-gas switch** and **renewable developments** in the US power sector **cut its coal consumption by 16%**. **Higher nuclear** and **renewable power generation** contributed to a **decline** in the **EU** (-23%), **Japan** (-9%) and **South Korea** (-3%). It also declined in Australia (competition from renewables) and in South Africa (supply issues).

Key data

Strong increase in Asian coal producers.

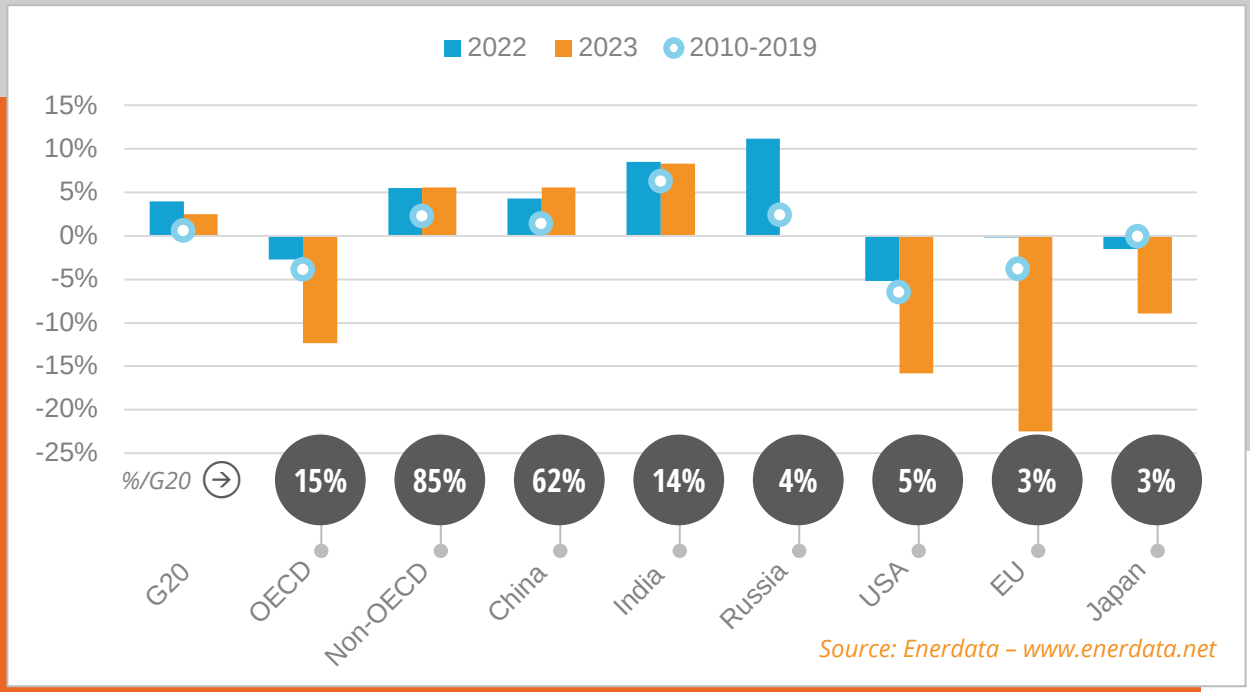


Noticeable falls in the OECD.

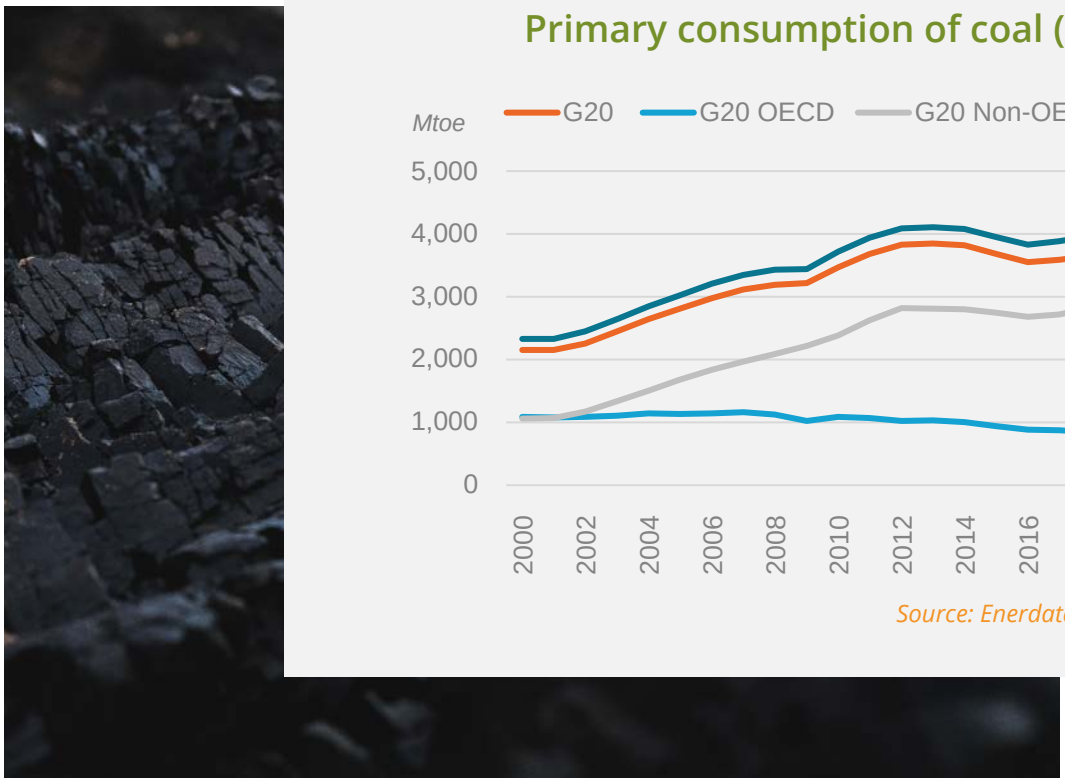


Noticeable decline due to **the coal-to-gas switch** and **renewable developments.**

Trends in coal consumption in G20 countries (%/year)



Source: Enerdata – www.enerdata.net

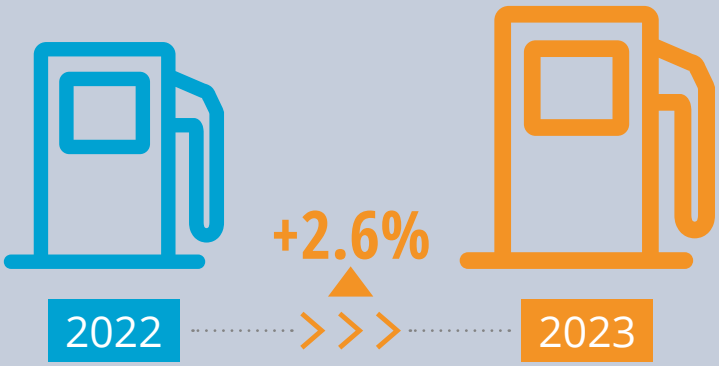


Primary consumption of coal (Mtoe)

Source: Enerdata – www.enerdata.net

OIL

Increased oil consumption in 2023, spurred by China and the USA



In 2023, global oil consumption increased, driven by higher demand in China and the US, although oil prices remained high and volatile.

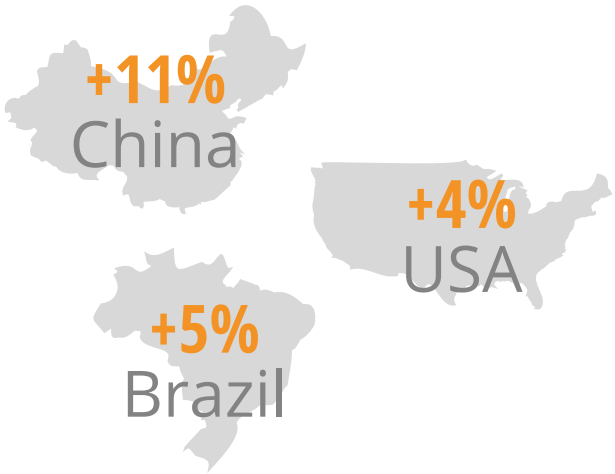
Oil consumption rose by 2.6% in 2023, spurred by China (+11%) and the US (+4%). China, where the end of COVID-19 restrictions fuelled road transport and domestic aviation, has nearly caught up with the US in terms of oil consumption.

Oil consumption grew by 5% in Brazil, but slowed down in India (+1%), and remained stable in Russia. It declined in the EU (-3%), Japan and South Korea (-6%).

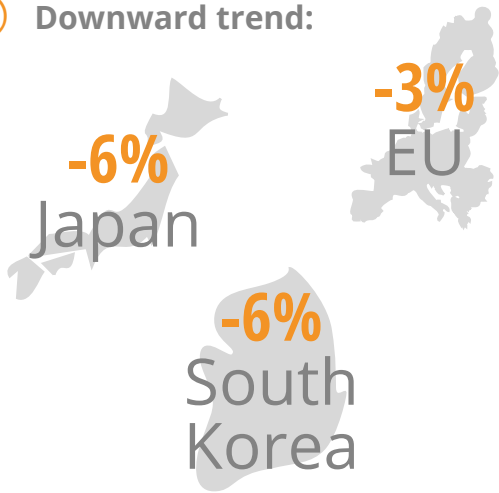
Despite geopolitical uncertainty, global oil prices remain over 30% higher than their pre-COVID levels and exhibit significant volatility.

Key data

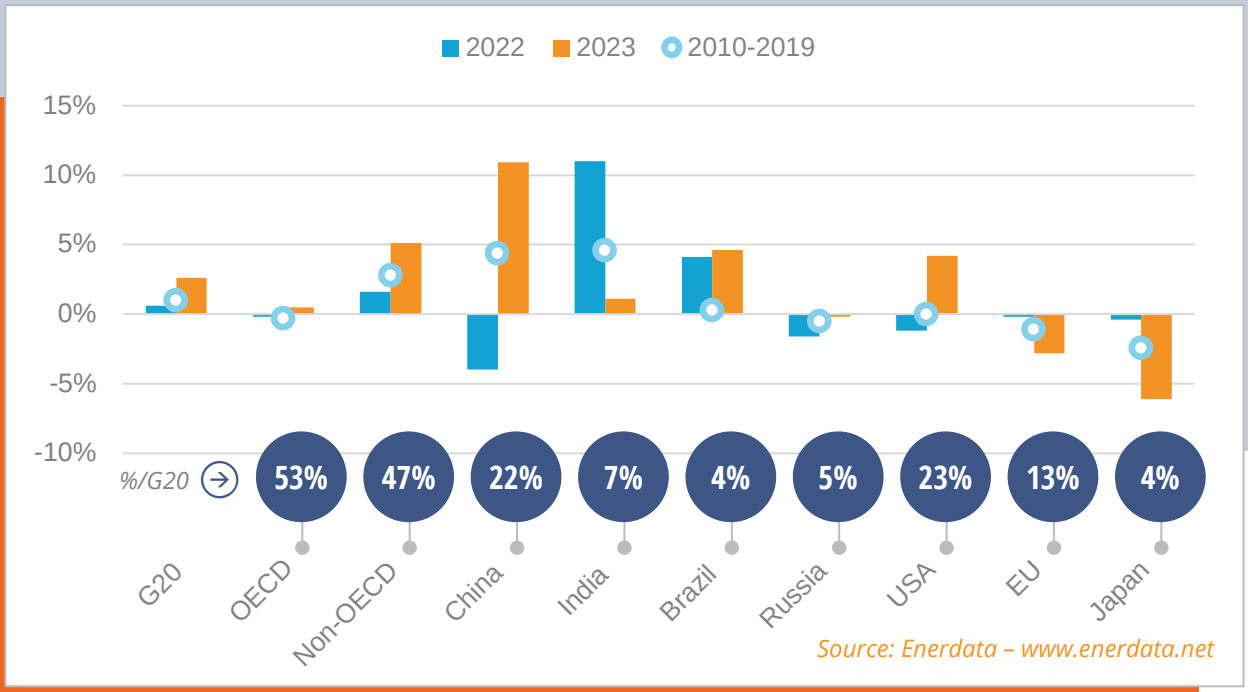
Rising trend:



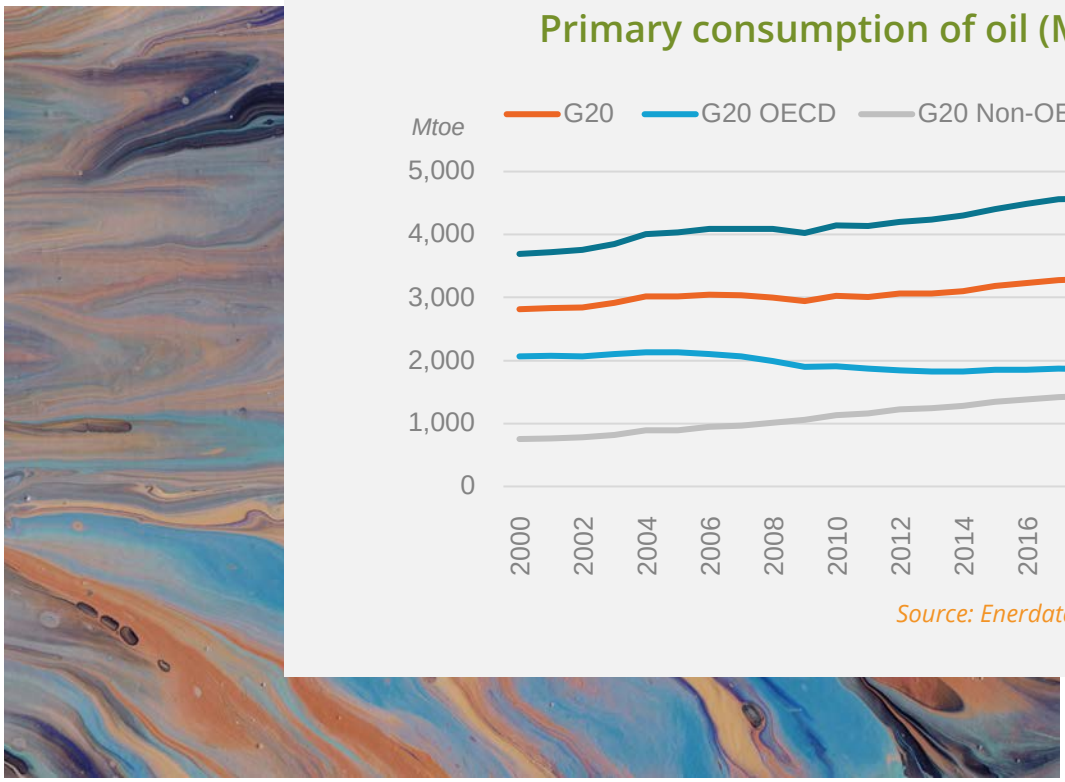
Downward trend:



Trends in oil consumption in G20 countries (%/year)



Source: Enerdata – www.enerdata.net

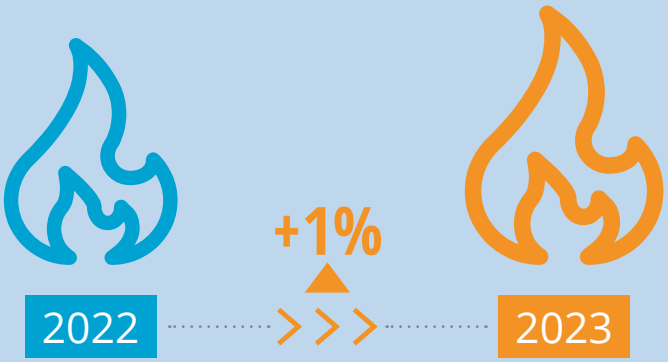


Primary consumption of oil (Mtoe)

Source: Enerdata – www.enerdata.net

GAS

Slight rebound in gas consumption in 2023, amid lower but still high gas prices



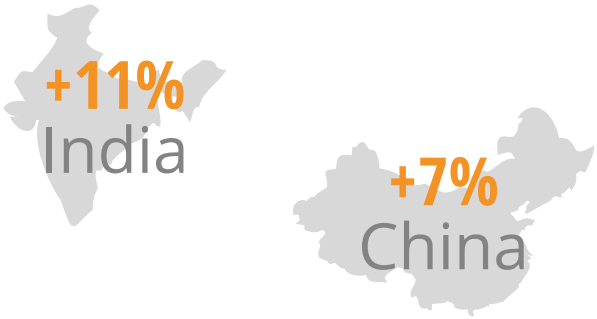
Strong rebound in non-OECD countries, and a slight decline in the OECD.

After a **2% drop linked to record-high gas prices in 2022**, **gas consumption recovered in 2023** (+1%). It **rebounded** in **India as Asian LNG prices returned to more affordable levels** (+11% after the 7% drop in 2022) and in **China** (+7%). Overall, gas consumption grew by **4%** in **non-OECD countries**.

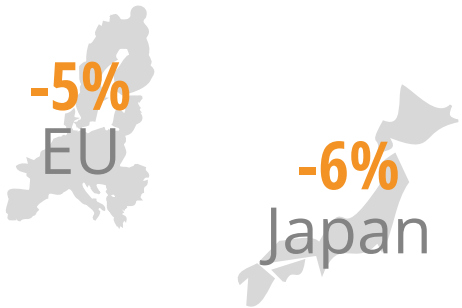
On the contrary, it **declined by 1.3% in 2023** (second year in a row) **in the OECD**, **due to** a **lower consumption** in the power sector (due to higher nuclear and renewable power generation) in the **EU** (-5% for gas consumption), **Japan** and **South Korea**. **New gas-fired power capacities in the US** (+9 GW) **contributed to raise the US gas consumption** (+1%).

Key data

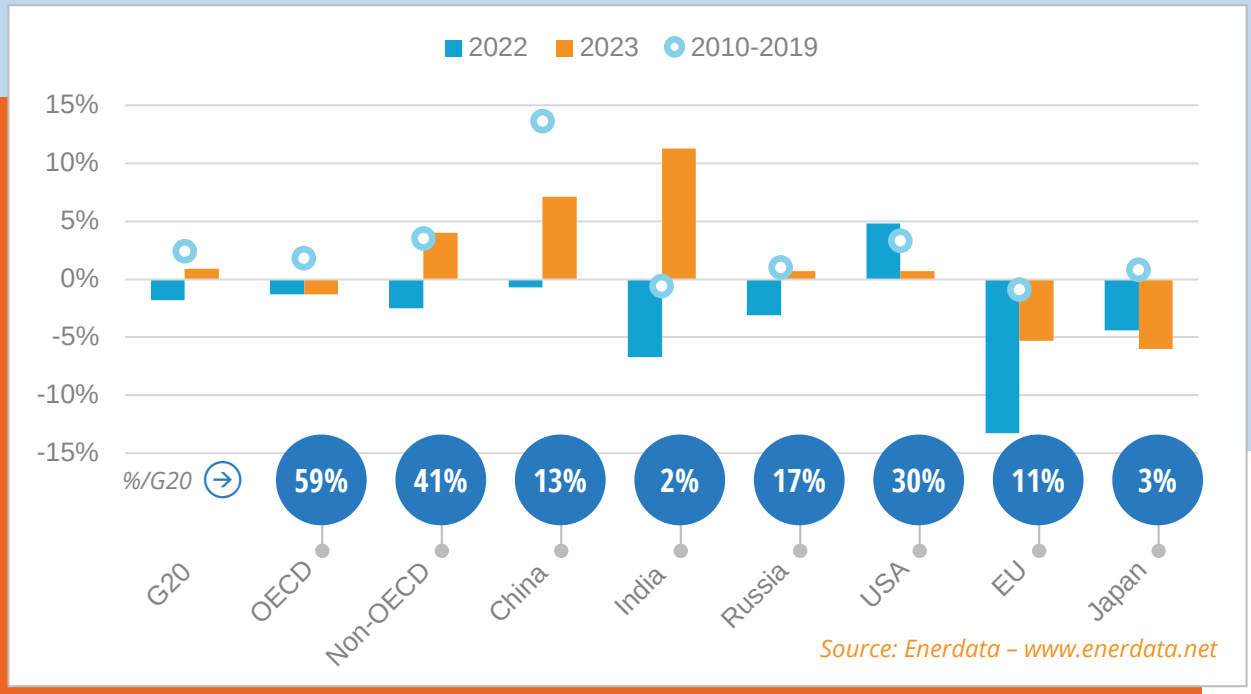
- **Strong growth in non-OECD countries.**



- **Decline in the OECD**, **due to** a **lower consumption** driven by increased nuclear and renewable power generation.



Trends in gas consumption in G20 countries (%/year)



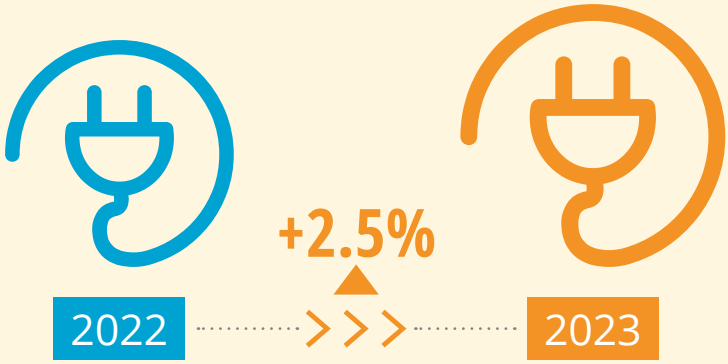
Source: Enerdata – www.enerdata.net

Consumption of natural gas (Mtoe)

Source: Enerdata – www.enerdata.net

ELECTRICITY

Electricity consumption rises but market shares left unchanged



Regular growth but far from a 2 °C pathway.

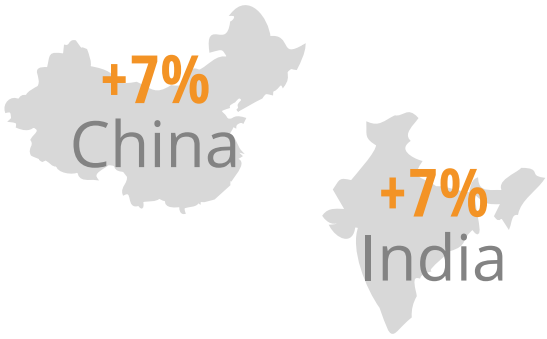
Electricity consumption returned to its average growth rate (around 2.5%/year) and **surged** in **non-OECD countries** (+6% on average, slightly above the 2010-2019 trend): +7% in **China** (higher demand from the services and manufacturing industries), +7% in **India** and +3% in **Brazil** (both due to steady economic growth and high demand for cooling).

On the other hand, electricity consumption **declined** in the **OECD** (-1.4%), with decreases in the **EU** (-4%), the **US** (-1% over milder temperature and a slowdown in the manufacturing industry), **Japan** (-2%) and **South Korea** (-1%).

Electricity now covers **23% of the G20's final energy consumption**. This regular growth in electrification is yet insufficient to significantly improve the decarbonisation of the G20's energy mix.

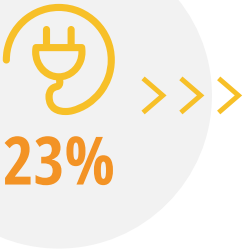
Key data

Surged in non-OECD countries.



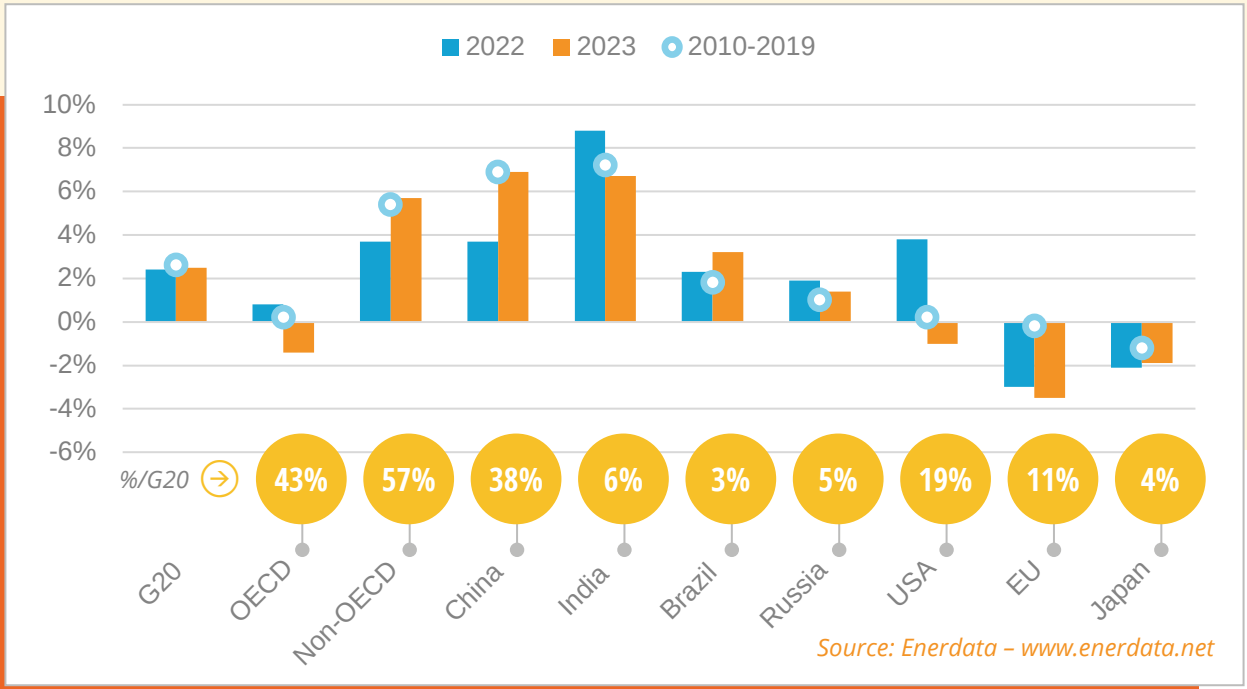
Declined in the OECD.

New drop with still high prices.

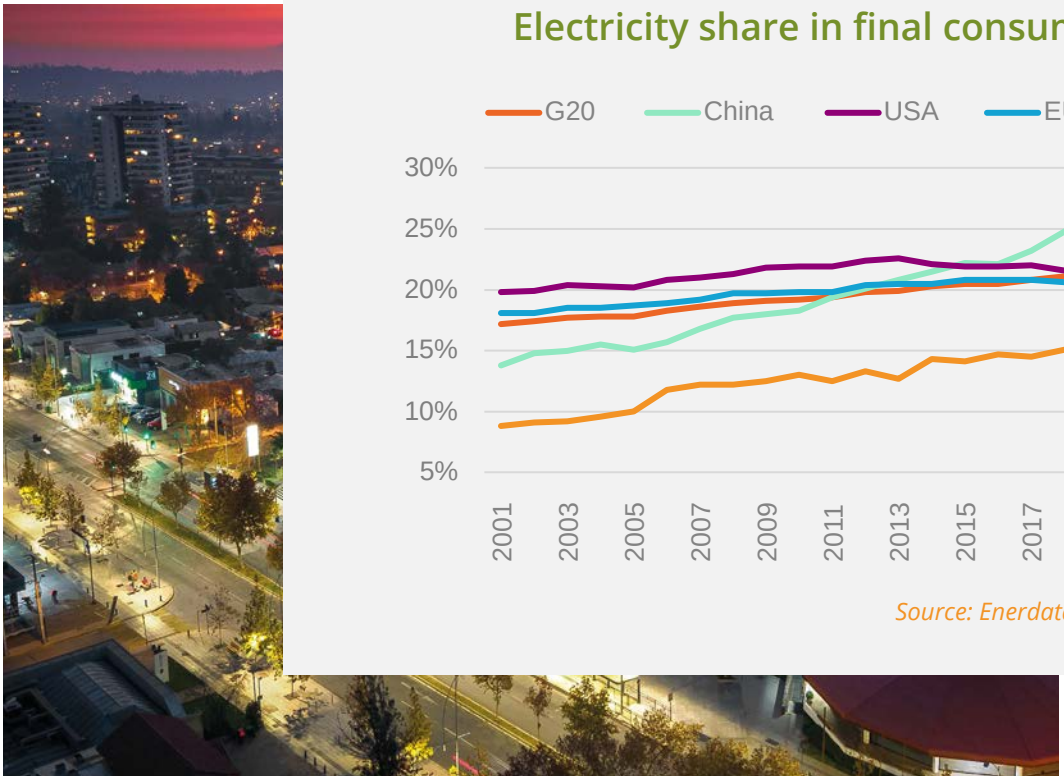


The share of electricity in the G20's final energy consumption (up from 17% in 2010).

Trends in electricity consumption in G20 countries (%/year)



Source: Enerdata – www.enerdata.net

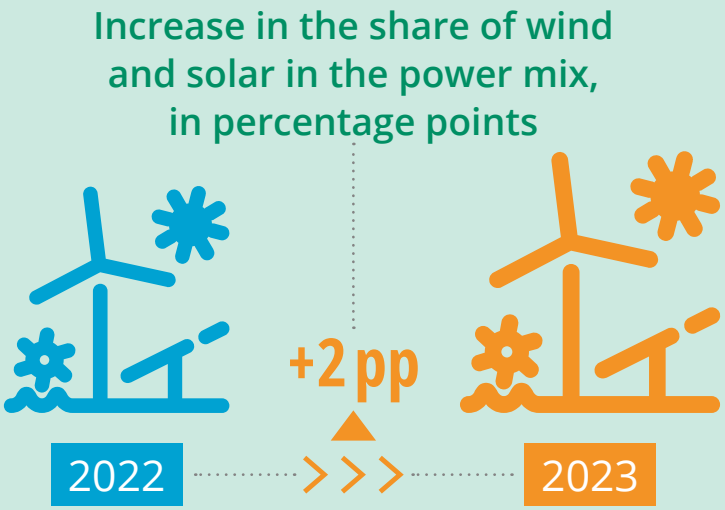


Electricity share in final consumption

Source: Enerdata – www.enerdata.net

POWER MIX

Renewable growth but fossil fuels remain dominant



Thermal power generation grows again, though slower than wind and solar power generation.

Thermal power generation continued to increase in 2023, though at a **slower rate than renewable power generation** as its share dipped **below 60% of the power mix**.

Solar and **wind power generation continued to surge** (+25% and +10%), now covering **15% of the power mix**.

Climate change and **El Niño** contributed to cut **hydropower generation** (-3%) in many **G20 countries** (including China, India, the US and Argentina) **except** for the **EU**, while **nuclear power generation rebounded** (+2%), especially in **Japan**, **South Korea** and the **EU**.

Key data

Steady growth in renewable power generation in 2023, to **30% of the power mix** (vs 19 % in 2010).

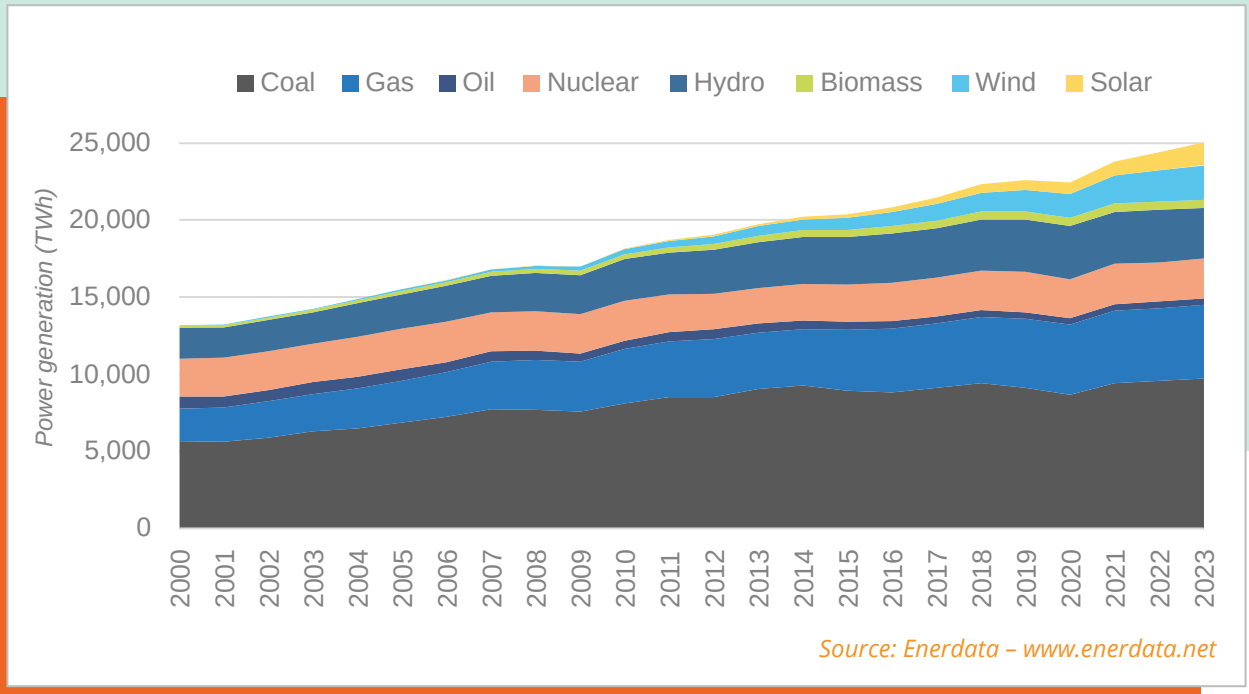
+10%
For Wind

Accounts for **9% of the power mix** (2% in 2010)

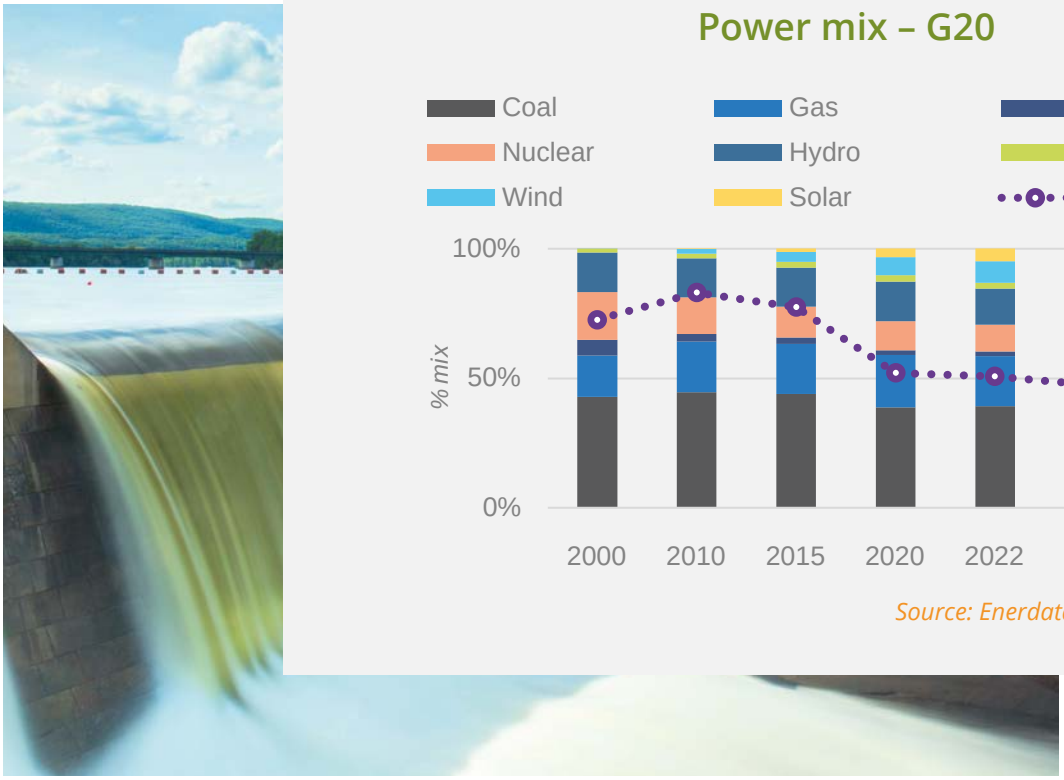
+25%
For Solar

Accounts for **6% of the power mix** (0% in 2010)

Evolution of power generation by source in G20 countries



Source: Enerdata – www.enerdata.net

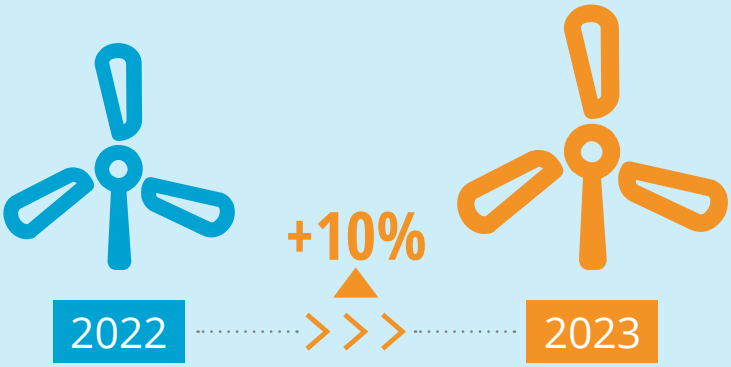


Power mix – G20

Source: Enerdata – www.enerdata.net

WIND

Wind power generation continues to grow, driven by China



In 2023, China and the EU accounted for the majority of the increase in wind power generation.

Global wind installation reached a **new record** (+113 GW), **thanks to China** (+76 GW, i.e. as much as the global wind installations in 2022).

G20's wind power generation rose by **10%** in 2023. **China**'s wind power generation rose by **16%** and now accounts for **40% of the G20 wind power generation**. China generates as much wind power as the EU and the US combined (China: 40%, US: 20%, EU: 20%, rest of G20: 20%).

Key data

New record in wind installations.

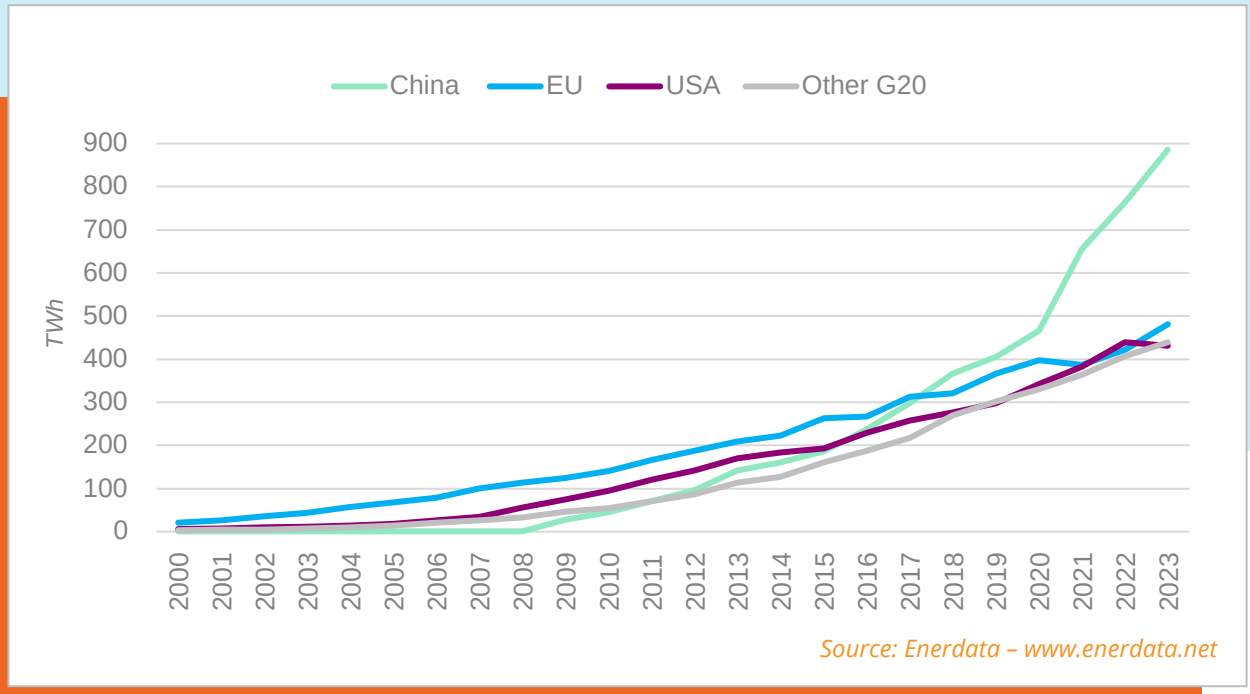
+113 GW
For wind installations

Rebound after +91 GW in 2021 and +74 GW in 2022.

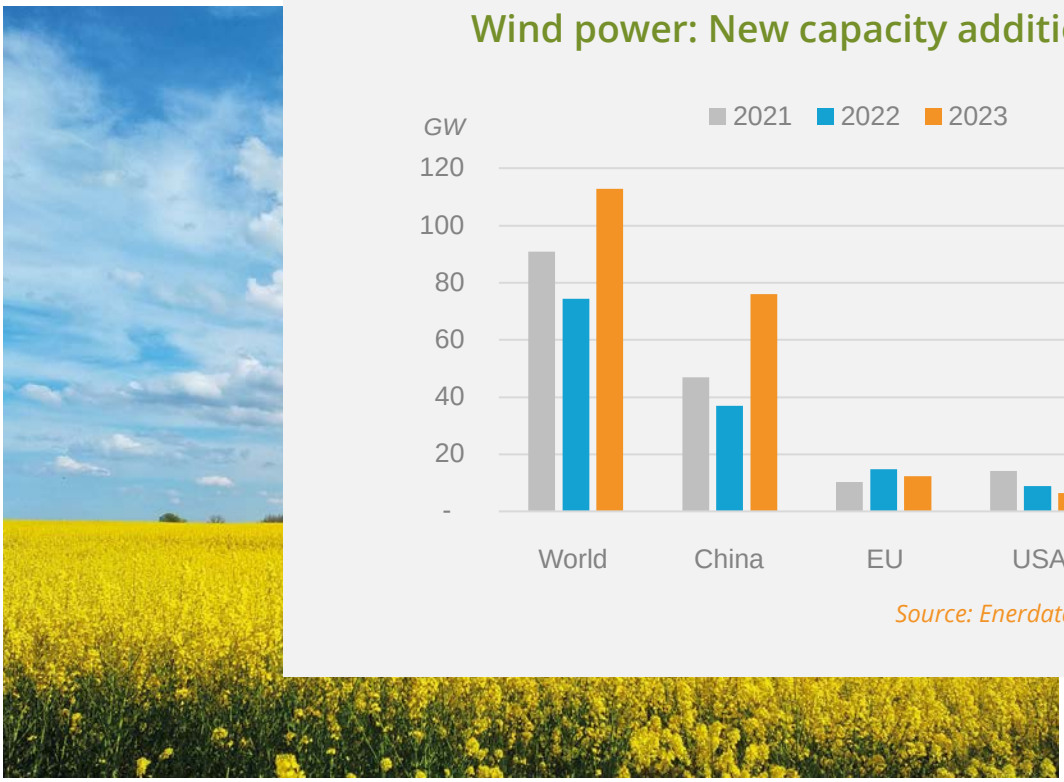
Growth in wind power generation driven by China.

Boom in wind installations with +76 GW. x2 compared with 2022 additions.

Wind power generation in the main G20 countries (TWh)



Source: Enerdata – www.enerdata.net

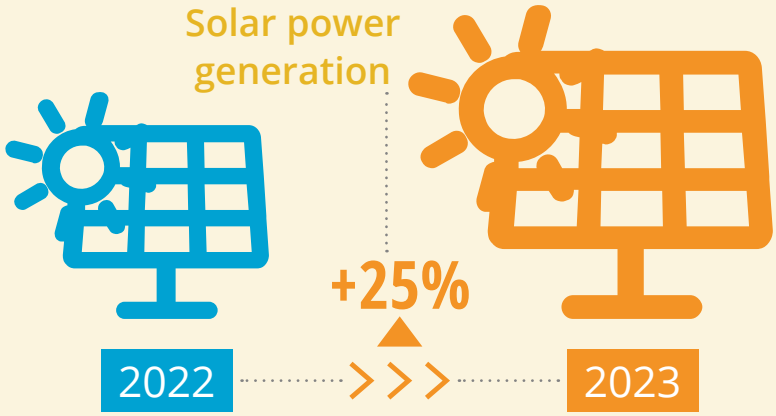


Wind power: New capacity additions (GW)

Source: Enerdata – www.enerdata.net

SOLAR

Solar development: Growth driven by China



China installed more solar in 2023 than the entire world in 2022.

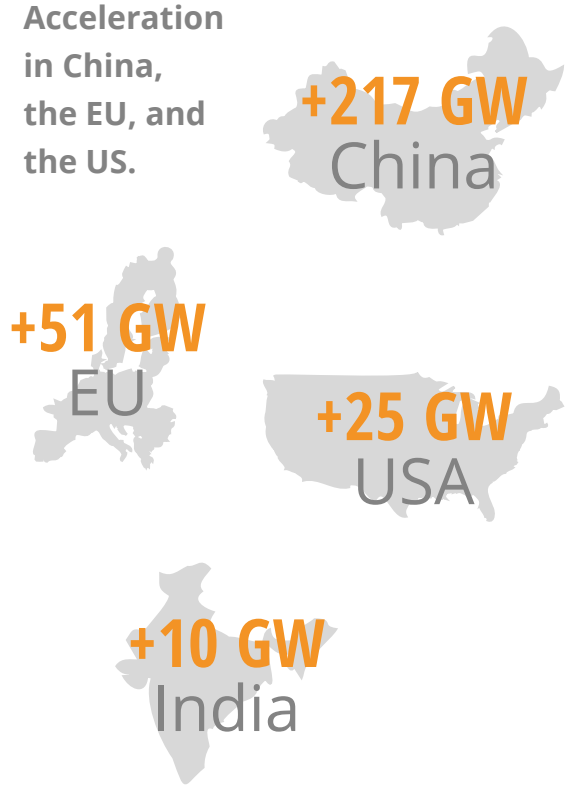
Global solar installations doubled in 2023 (+349 GW), which China installing 217 GW (i.e., more than the entire world in 2022 with 186 GW).

Solar power generation rose in most G20 countries (+25%), **especially in China** (+37%), the **EU** and the **US** (+16% each).

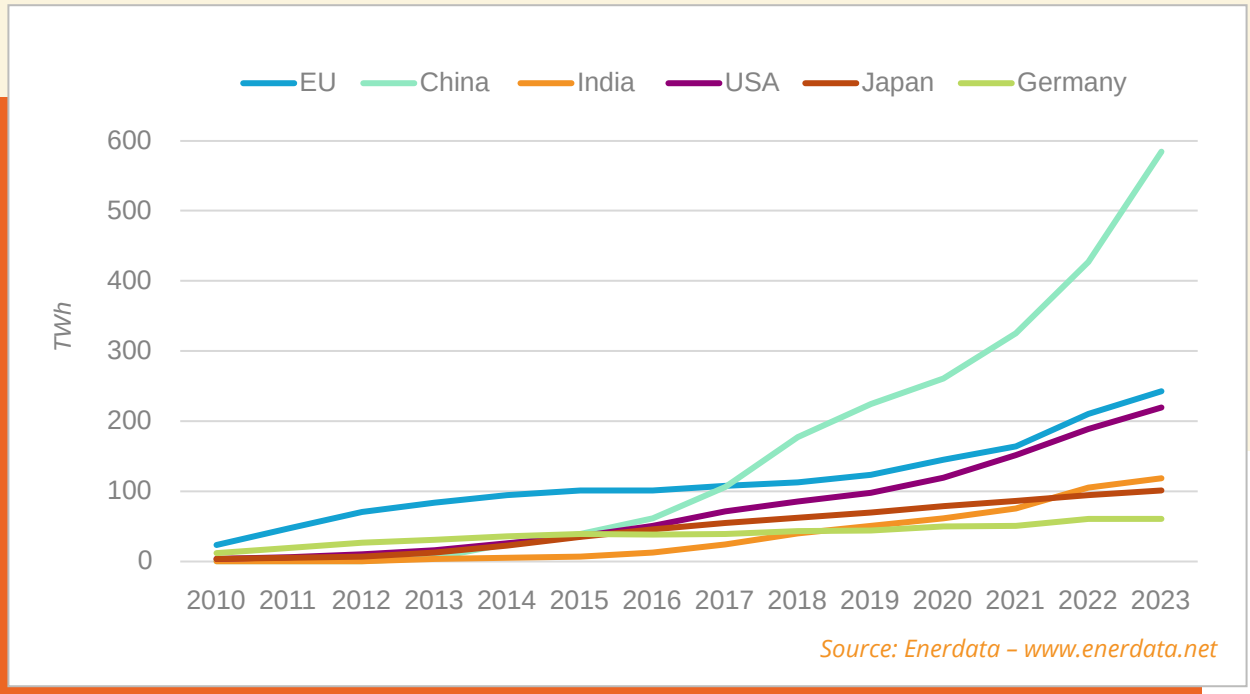
In 2023, **China accounted for 40% of the G20 solar power generation**, i.e., as much as the EU, the US, and India together.

Key data

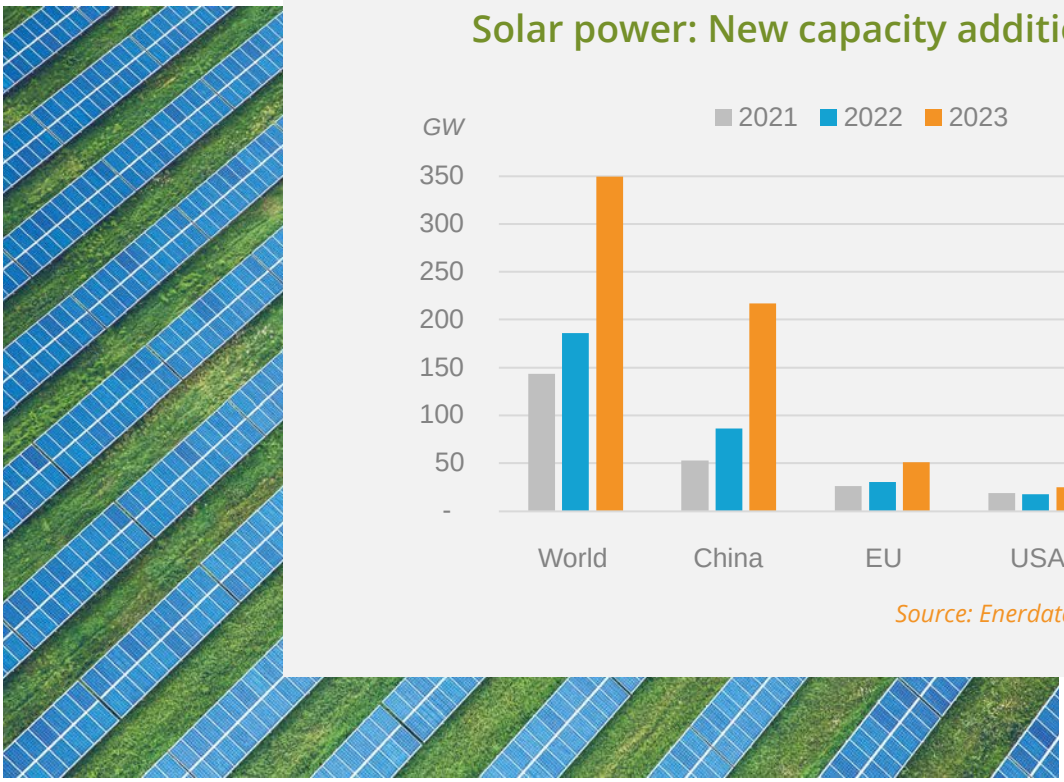
Acceleration in China, the EU, and the US.



Solar power generation in the main G20 countries (TWh)



Source: Enerdata – www.enerdata.net



Solar power: New capacity additions (GW)

Source: Enerdata – www.enerdata.net

Summary

KEY TAKEAWAYS FROM 2023 FIGURES

In 2023, global economic growth and energy consumption returned to pre-COVID-19 levels, driving significant shifts in fossil fuel and renewable energy trends.

In 2023, **economic growth and energy consumption returned to their pre-COVID-19 crisis trend, with a 3% increase in the G20 GDP** (in line with 2022 and the pre-crisis period 2010-2019 average) and a **2.3% rise in energy consumption** (which is faster than over 2010-2019).

CO_2 emissions rose again, at a slower pace than energy consumption (+1.7% in 2023), as fossil fuel consumption continued to increase significantly and faster than over the 2010-2019 period.

The steady economic growth contributed to fuel energy consumption, at a faster rate than over the previous periods (+2.3% vs +1.3%/year). **Electricity consumption** returned to its **historical growth rate (**+2.5%/year), while **gas consumption rebounded** (+0.9%) after its 2022 drop (still below its historical rate).

Oil consumption grew by 2.6% in 2023, much **faster than its historical rate** (compared to +1%/year between 2010 and 2019), as the end of COVID-19 restrictions in China and the resumption of aviation boosted transports and oil demand. **Coal consumption** also continued to grow (+2.5%, **4 times faster than its historical rate**), spurred by the demand of Asian consumers (China and India).

Energy consumption grew faster than over the 2010-2019 period and the trends largely vary between OECD and non-OECD countries. **The share of fossil fuels in the G20 energy mix** almost **remained stable**, as coal and oil consumption continued to increase, spurred by non-OECD countries such as China and India and by the recovery of the transport sector. **Less-CO_2 emitting natural gas consumption increased marginally owing to still high prices in Asia and Europe.**

Renewable power generation is gaining momentum. **New renewable installations reached record high levels, thanks to China**, which **installed as many** renewables **in 2023 as the entire world in 2022**. Overall, wind and solar generation rose rapidly (+10% and +25%, respectively) to reach 15% of the G20 power mix.

Chapter 2

THE COP28 PLEDGE: RENEWABLES & ENERGY EFFICIENCY

- Over 120 states pledge to accelerate renewable energy at COP28
- Tripling renewable capacity by 2030
- Doubling energy efficiency improvement by 2030
- The COP28 objectives in the perspective of long-term decarbonisation pathways
- Summary

Over 120 states pledge to accelerate renewable energy at COP28

During COP28, over 120 countries pledged to speed up the deployment of renewable energy* in a collective agreement aimed at limiting global warming to "well below 2 °C".

COP28 AGREEMENT

"We, heads of state and governments as the participants in the COP28 global renewables and energy efficiency pledge [...] declare our intent to work collaboratively and expeditiously to pursue the following objective:

- *Commit to work together to **triple the world's installed renewable energy generation capacity** to at least 11,000 GW by 2030, taking into consideration different starting points and national circumstances.*
- *Commit to work together in order to collectively **double the global average annual rate of energy efficiency improvements** from around 2% to over 4% every year until 2030."*

Source: www.cop28.com/en/global-renewables-and-energy-efficiency-pledge

** NB: Renewable Energy Sources (RES) include solar, wind, hydropower, geothermal, bioenergy and marine energie*

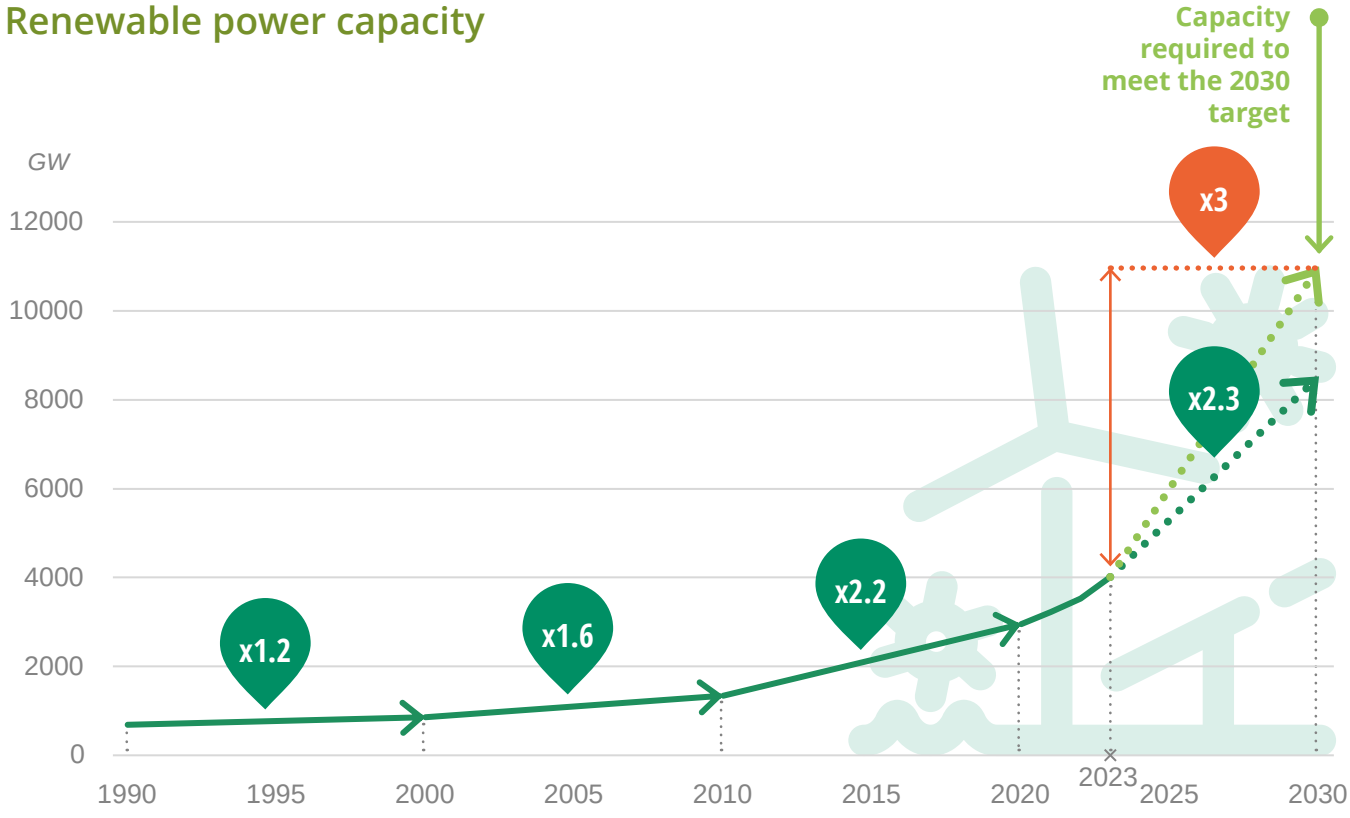
Tripling renewable capacity by 2030

A MAJOR BOOST IS NEEDED TO TRIPLE RENEWABLE CAPACITY

Renewables are clearly on an upward trend, but not enough to reach this objective.

The upward trend in **renewable energy development** is evident, with **significant acceleration**, **especially since 2010**. The early 2020s have experienced a modest increase in growth rates, with an **annual growth** of **11%**, compared to **8% per year from 2010 to 2020**. However, **tripling** the current **renewable energy capacity** will **require an annual growth rate of 16% on average by 2030**.

Renewable power capacity

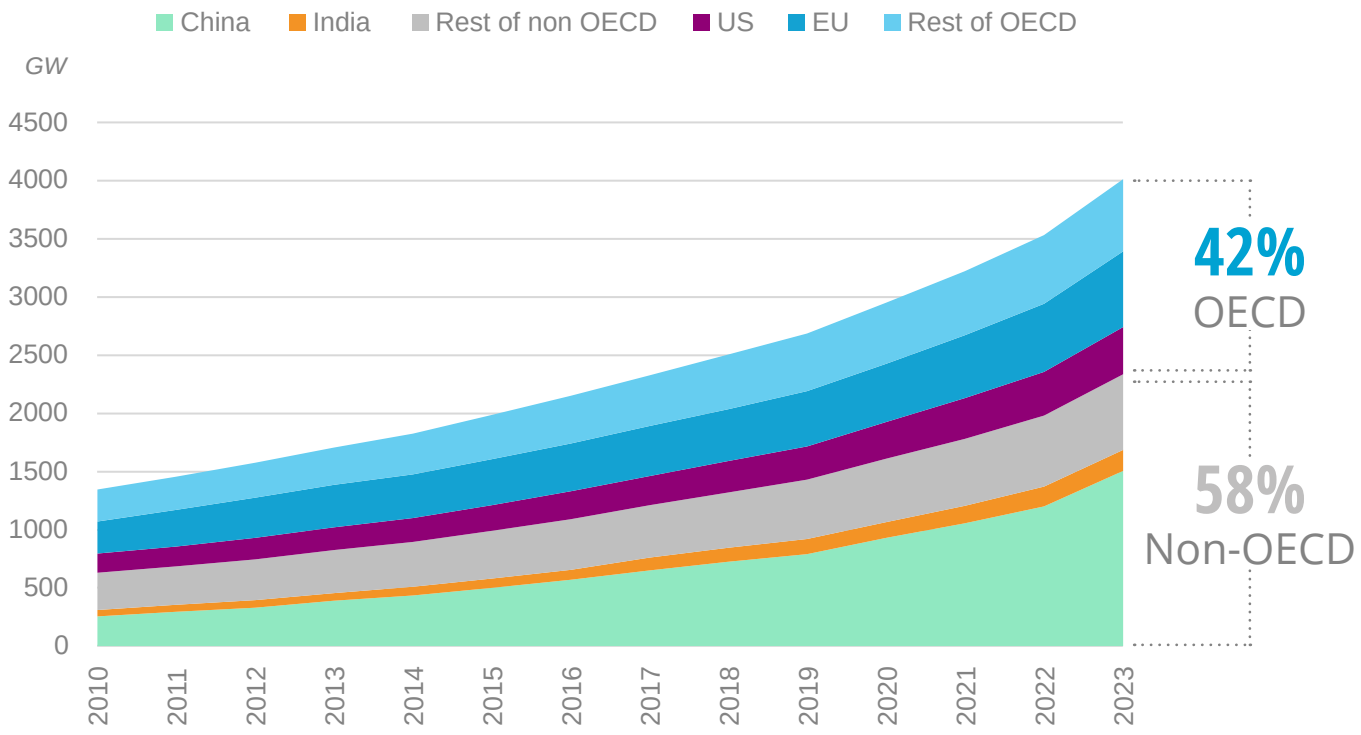


Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

CHINA LEADING THE PATH FOR RENEWABLE CAPACITY GROWTH

China is currently outpacing the 3x objective, while other countries are lagging behind.

Renewable power capacity



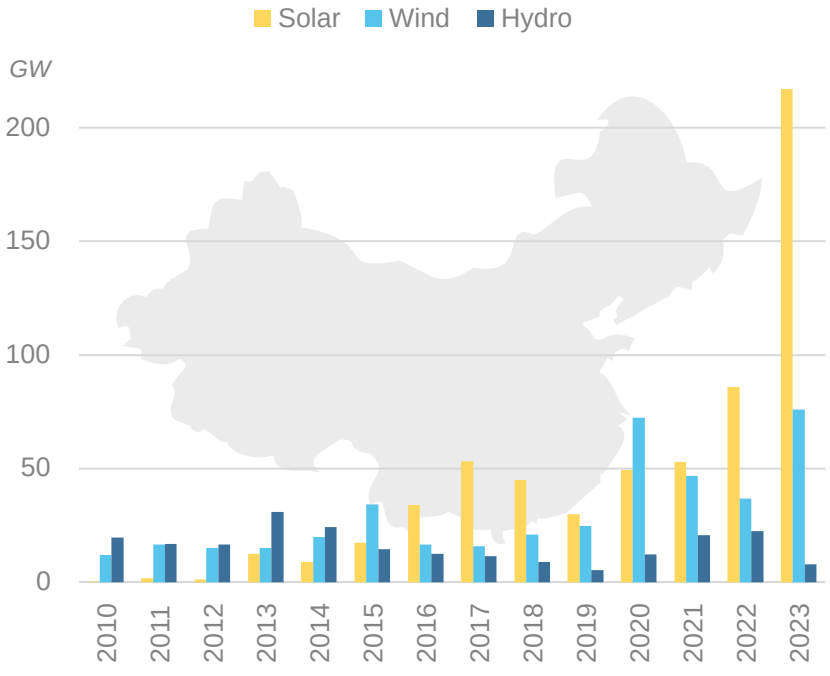
Shares of renewables in power capacity in 2023 >>>

50% OECD

44% Non-OECD

Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

Renewable capacity additions in China



Source: Power Plant Tracker, Global Energy & CO_2 Data, China National Energy Administration – Enerdata – www.enerdata.net

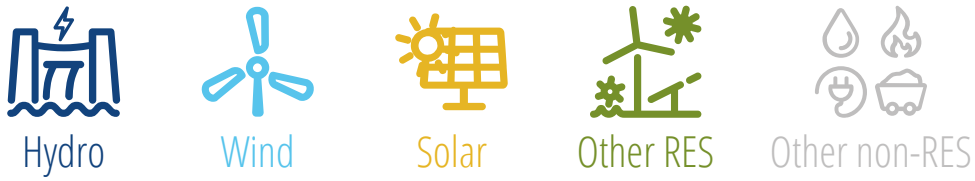
2023 marked a remarkable year for China in renewable energy deployment, with the country **installing more renewable capacity than** the rest of **the world** globally.

As a result, **non-OECD countries** now account for **more renewable capacity than OECD countries**, although this is in large part driven by China.

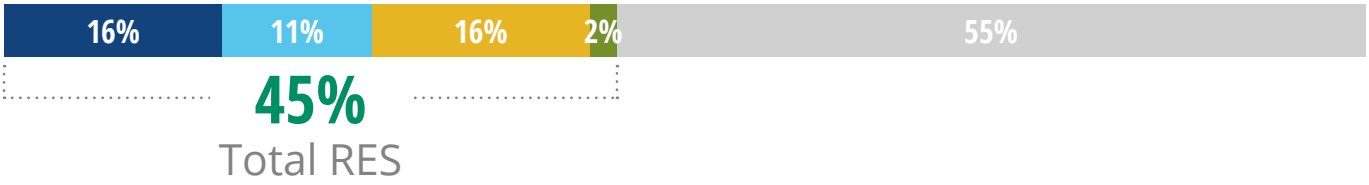
RENEWABLES GROW, FOSSILS PERSIST

The shift to renewables is real but underwhelming.

Renewable power capacity, operational & projects

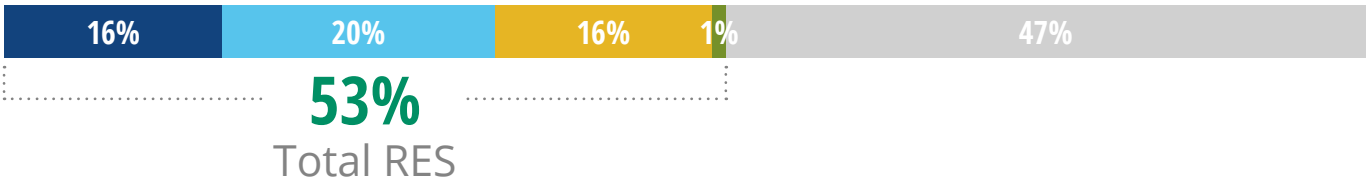


Operational — TOTAL – **9 TW**



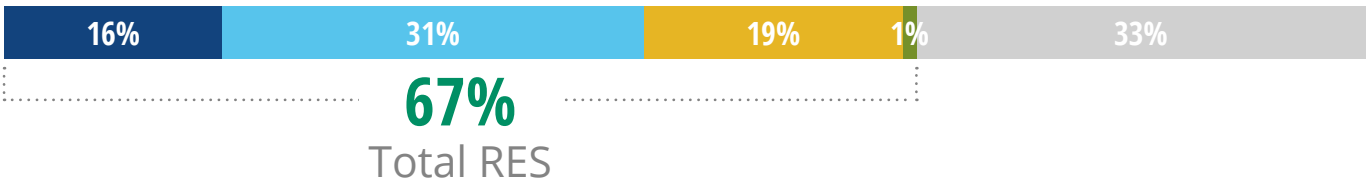
Under construction — TOTAL – **0.8 TW**

A **slim majority** of projects under construction.



Under development* — TOTAL – **4 TW**

2/3 of less advanced planned projects.



** Projects at various stages of development, from just announced to financial closing done.*

Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

- Out of 9 TW of installed capacity globally, **RES account for 45%**.
- RES respectively accounts for **53%** and **67%** of **under construction projects and other projects** currently at **less advanced stages of development**.
- There is a **switch towards renewables** but it is underwhelming, **fossil fuels** will **remain significant** in the **future capacity mix.**

This confirms an **accelerating trend**, **but** significant **fossil-based capacities are still being constructed and planned**.

THE CURRENT PROJECT PIPELINE FAR FROM SUFFICIENT TO MEET THE TARGET

The full implementation of the project pipeline has the potential to nearly double the existing renewable energy capacity.

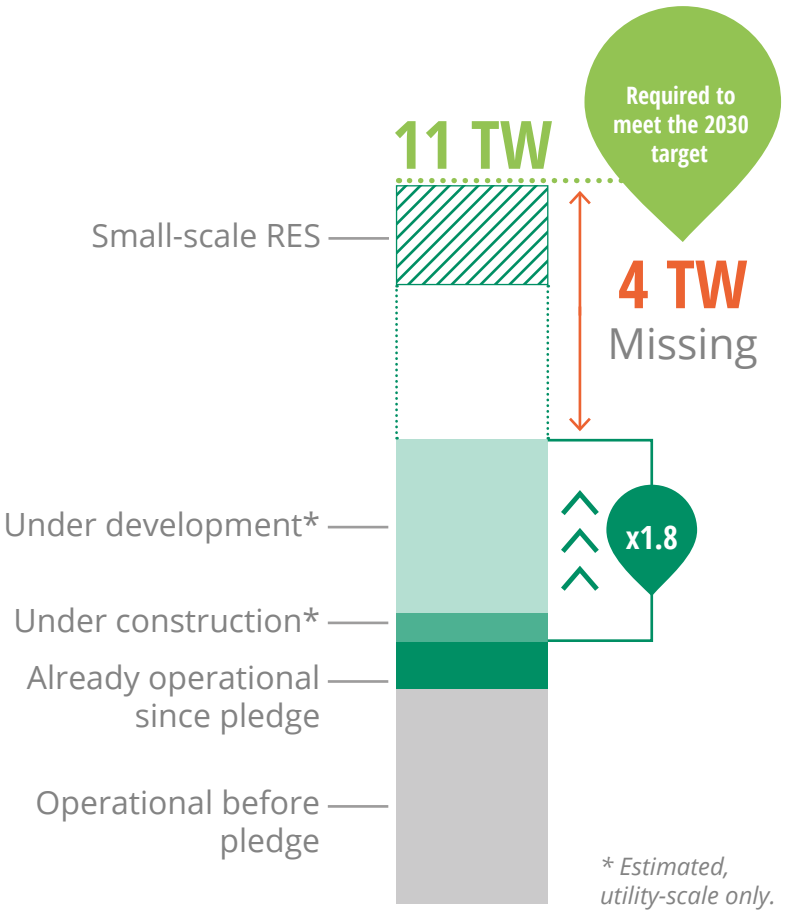
Current renewable power projects amount to a total of **3 TW**.

If all announced projects proceed as planned and are completed by 2030, the **renewable energy capacity** could see an **80% increase**, but this is an **optimistic view** as not all announced projects go through completion.

However, **to achieve the goal of tripling** the renewable energy capacity by 2030, a significant **number of additional projects will need to be initiated**.

A portion of this objective **can be met through small-scale, decentralised power sources**, such as rooftop photovoltaic (PV) systems, which are not included in the current project pipeline.

Renewable power capacity project pipeline



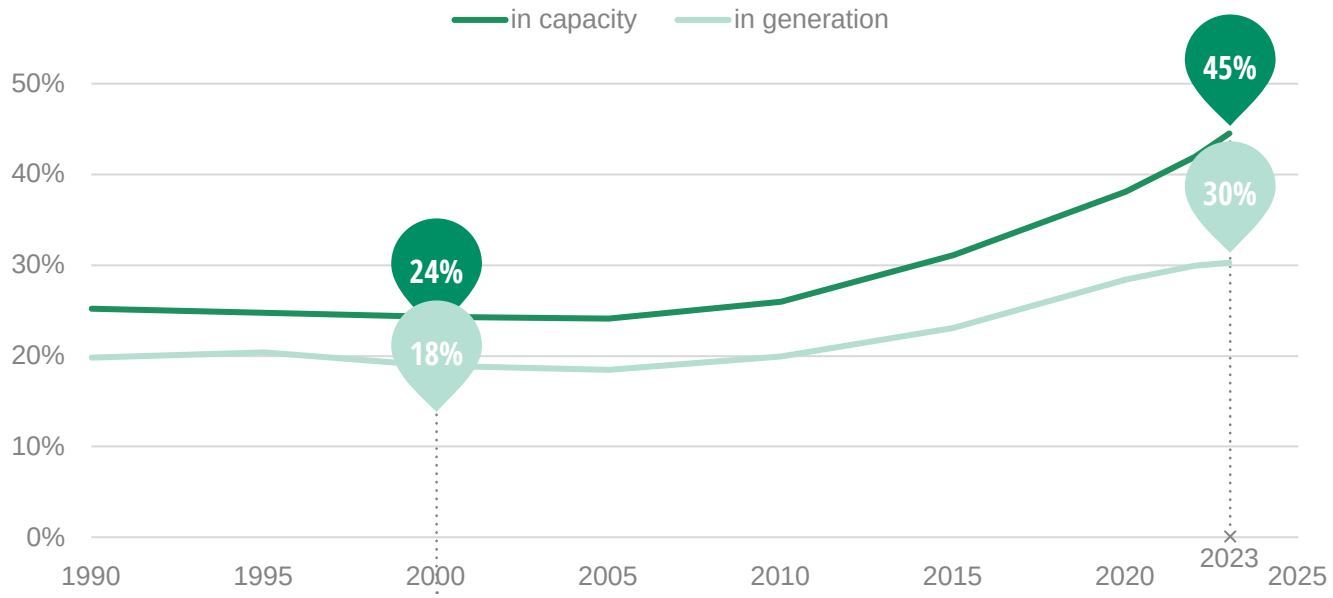
Source: Global Energy & CO_2 database, Power Plant Tracker Enerdata – www.enerdata.net

RENEWABLE CAPACITY GOALS IN PERSPECTIVE

Despite significant growth in renewable energy capacity, rising from 24% of total electrical capacity in 2000 to 45% in 2023, the contribution of renewables to primary energy consumption has only modestly increased.

Although the **share of electricity production from renewables grew from 18% in 2000 to 30% in 2023**, lower capacity factors limited the impact on overall electricity generation and, consequently, on emissions reduction. Indeed, this expansion has **contributed to a mere decrease of 7% in total emissions** between 2000 and 2023.
Moreover, the contribution of renewables to primary energy consumption reached only 15% in 2022, reflecting a modest rise of 3 percentage points from the 1990-2010 average. It thus appears that **fossil fuels are not significantly being replaced by renewable energy**, despite its capacity growth.

Share of renewables in power



Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

Doubling energy efficiency improvement by 2030

HOW TO DEFINE AND MEASURE ENERGY EFFICIENCY?

Energy efficiency relates to the level of energy consumed for a given output.

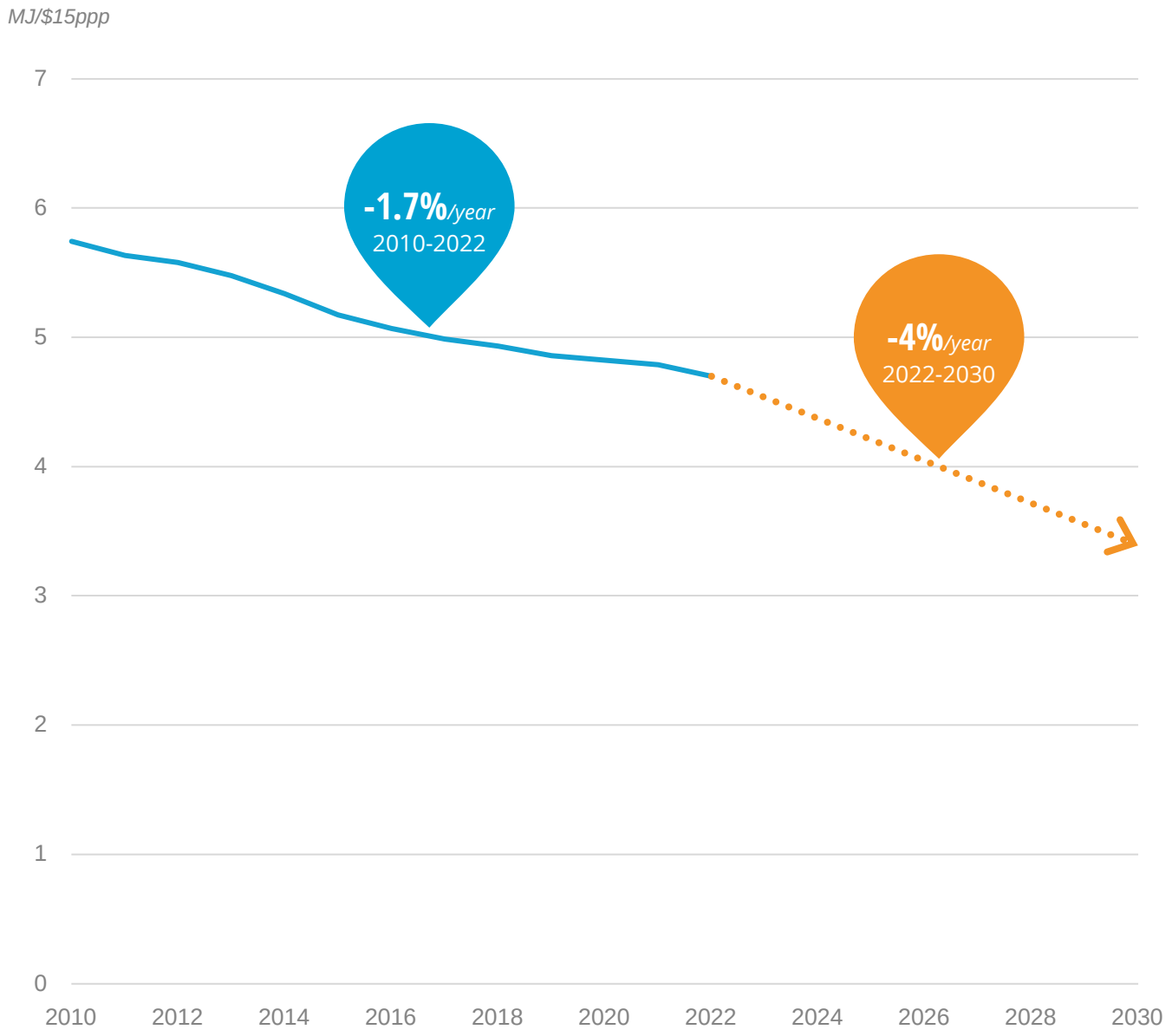
This output may refer to an energy service provided, such as the distance travelled in transportation, or the quantity of goods produced in an industrial setting.

In practice, especially at a **macroeconomic level**, **energy intensity** is often used as **a proxy for energy efficiency**. **Energy intensity measures** the amount of **energy consumed relative to** a wider and more comprehensive **activity indicator**. This indicator is typically **a proxy for overall economic output**, such as the **Gross Domestic Product** (GDP).

While this approach provides a wider scope and is suitable for evaluating diverse outputs across an entire economy, it may lack the precision of directly measuring specific industrial outputs or energy services. As a result, **energy intensity reflects not only energy efficiency progress, but also potential structural effects that impact the relation between activity and energy consumption**.

Since the adoption of the **Paris Agreement**, there **hasn't been a shift in terms of global evolution of energy intensity**.

Global energy intensity



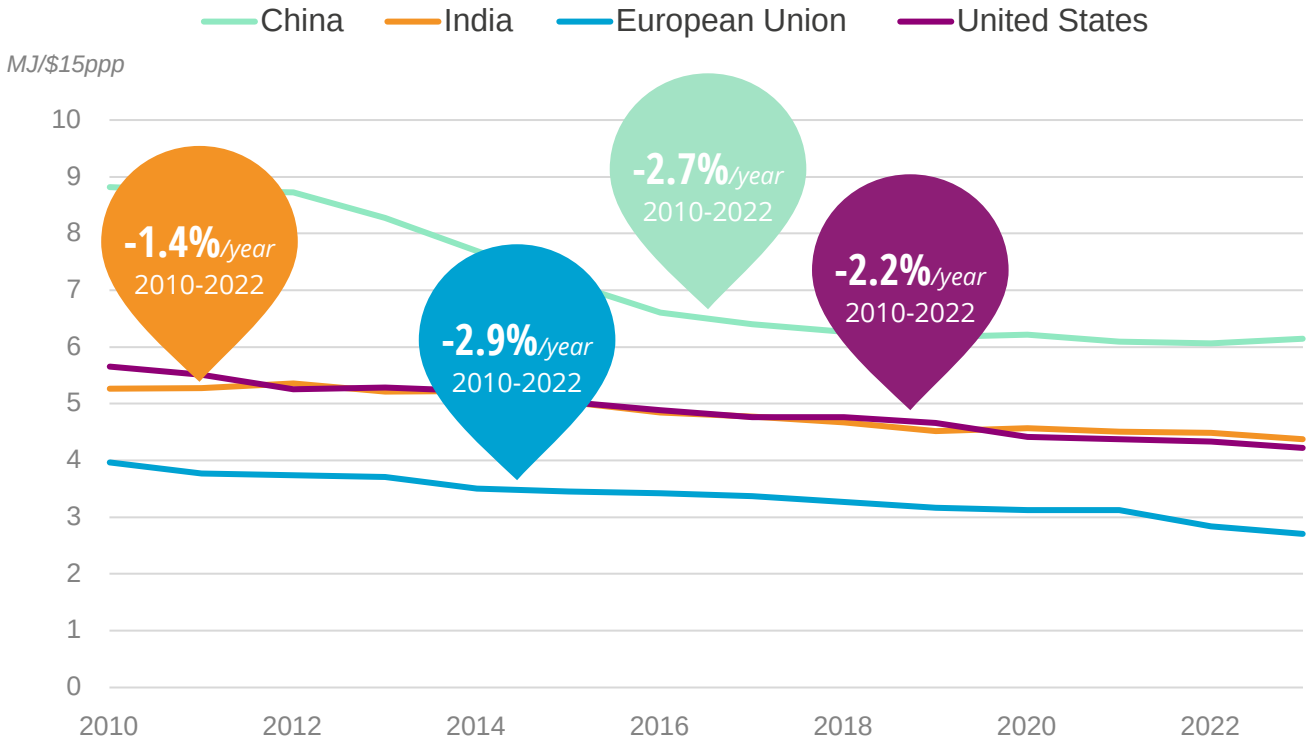
Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

DOUBLING ENERGY INTENSITY BY 2030 IN A CONTEXT OF STAGNATION

How to double energy intensity's pace by 2030 when trends are not showing signs of improvement?

Current trends indicate **slow progress in reducing energy intensity**, with **China**'s annual reduction rate **stagnating at 1% since 2016**, and **no significant improvements** in countries like **India**, the **US**, or the **EU**. However, the expected **adoption of disruptive energy-efficient technologies** such as electric vehicles, heat pumps, and improved dwelling insulation could **play a role in increasing the pace of energy intensity reduction by 2030**.

Energy intensity for major countries / regions



Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net

STRUCTURAL EFFECTS PLAY A KEY ROLE IN INDUSTRY

Since 2015, global manufacturing activity has outpaced energy consumption, reducing energy intensity through efficiency gains and structural changes, notably in China.

Indeed, since 2015, **global manufacturing activity** has **increased by 32%**, while **energy consumption** has **risen by only 11%**. This indicates that **energy consumption** has grown at a **slower pace than manufacturing activity**, resulting in a 16% reduction in energy intensity. This improvement suggests **advancements in energy efficiency within the manufacturing sector**.

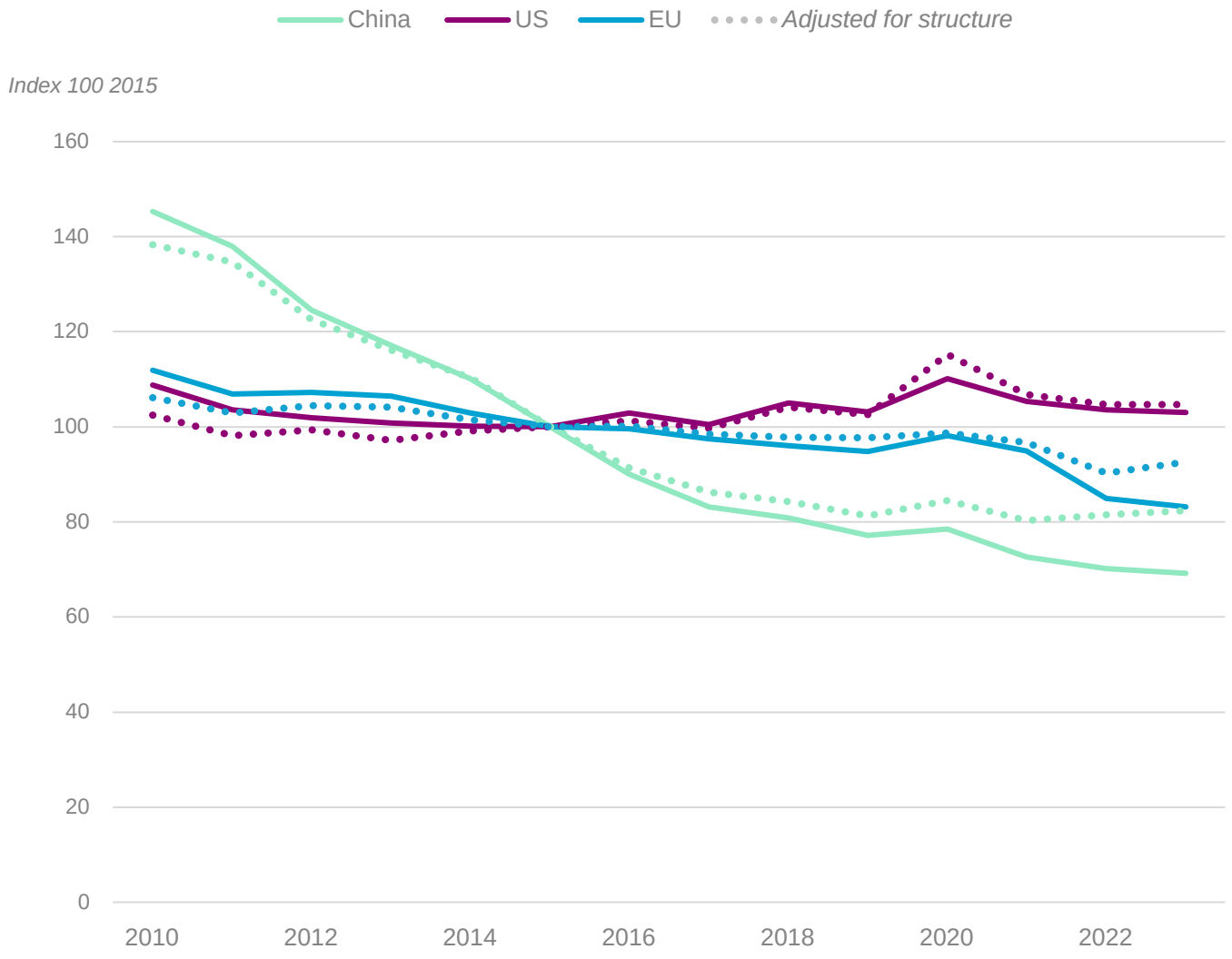
China has demonstrated **significant reductions in energy intensity**, driven by the development of new industrial processes and the adoption of Best Available Technologies (BAT).

This trend is typical in rapidly developing or booming industries where modern technologies and processes are more energy efficient. However, **in developed economies**, **the progress in reducing energy intensity** has been **less pronounced**, with minimal improvements **compared to emerging markets like China**.

The **global reduction in energy intensity is also influenced by structural changes in the industry**, such as the decreasing share of energy-intensive sectors. In the European Union, recent declines in energy intensity are largely attributed to the decline in certain manufacturing activities that require heavy amounts of energy, while increasing manufacturing activities that require lesser amounts of energy, in a context of high energy prices.

Structural changes have led to reduced energy intensity, with **significant impacts** observed in **China since 2016** and in **Europe since 2021**.

Energy intensity of manufacturing industry



Source: Global Energy & CO_2 database – Enerdata – www.enerdata.net & UNIDO Statistics – UN

TRANSPORT ENERGY INTENSITY DECLINES SLOWLY: EV IMPACT IS LIMITED

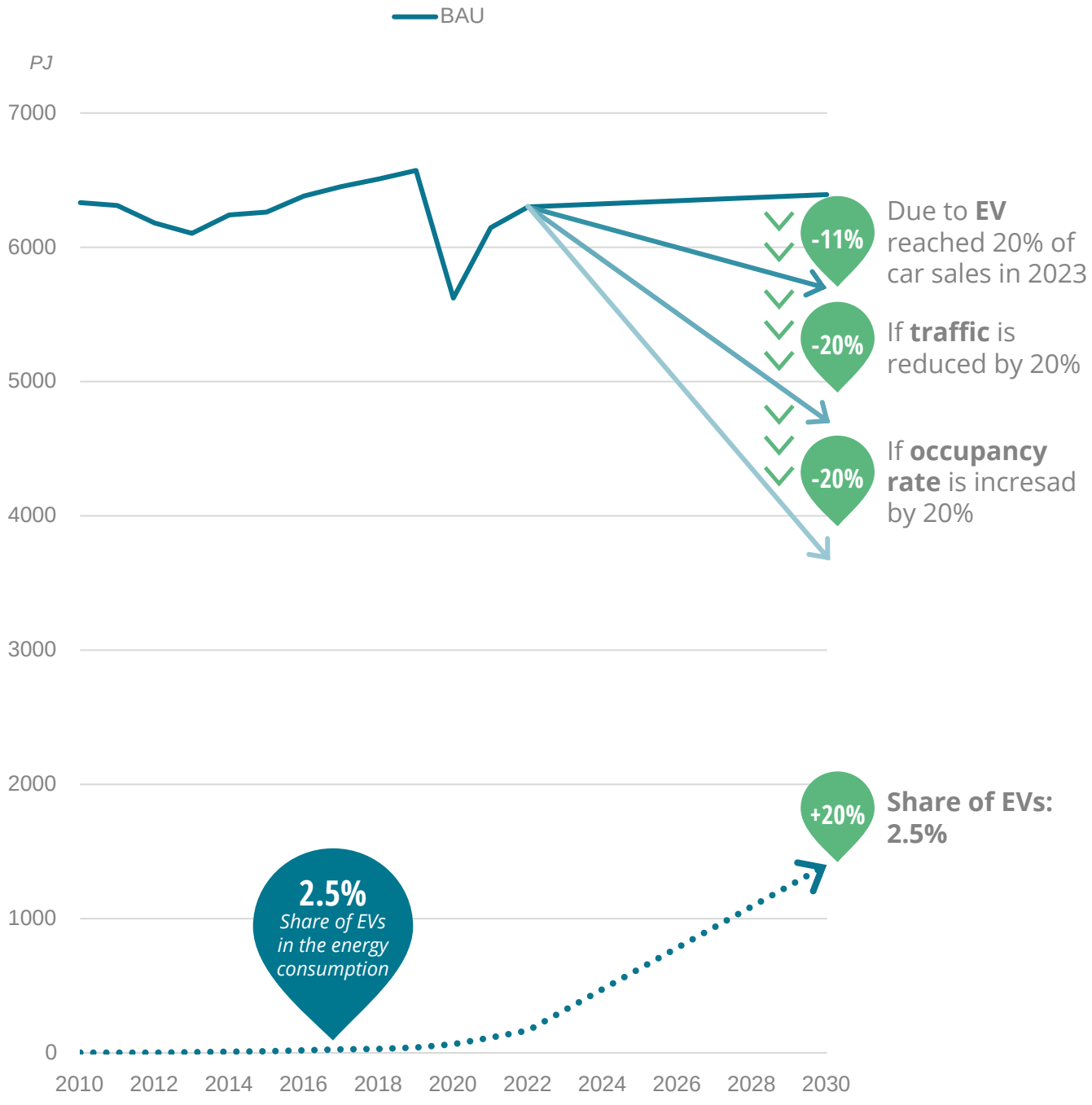
Despite rapid growth, EVs remain a small part of the car fleet with limited impact on transport emissions, highlighting the need to address traffic more broadly.

Since 2015, **Battery Electric Vehicles** (BEVs) have experienced a **40-fold increase**, and **BEVs plus Plug-in Hybrid Electric Vehicles** (PHEVs) **made up 20% of car sales in 2023**. Despite, this rapid growth, EVs have not yet significantly impacted the transport sector as a whole.

In 2023, **EVs** constituted **only 3.2% of the total car fleet**, and **electricity consumption in transport rose** modestly **from 0.9% in 2015 to 1.4% in 2023**.

In the meantime, traffic continues to rise. Passenger **traffic is approaching pre-pandemic levels**, and **goods traffic is increasing globally**. Modal shifts in transportation are negligible or counterproductive. Therefore **implementing measures to reduce traffic volumes** could be **more effective in decreasing energy consumption and CO_2 emissions than relying on the current growth in EV adoption**.

Energy consumption from cars in the EU



Source: Enerdata – www.enerdata.net

DISPARATE ENERGY INTENSITY TRENDS

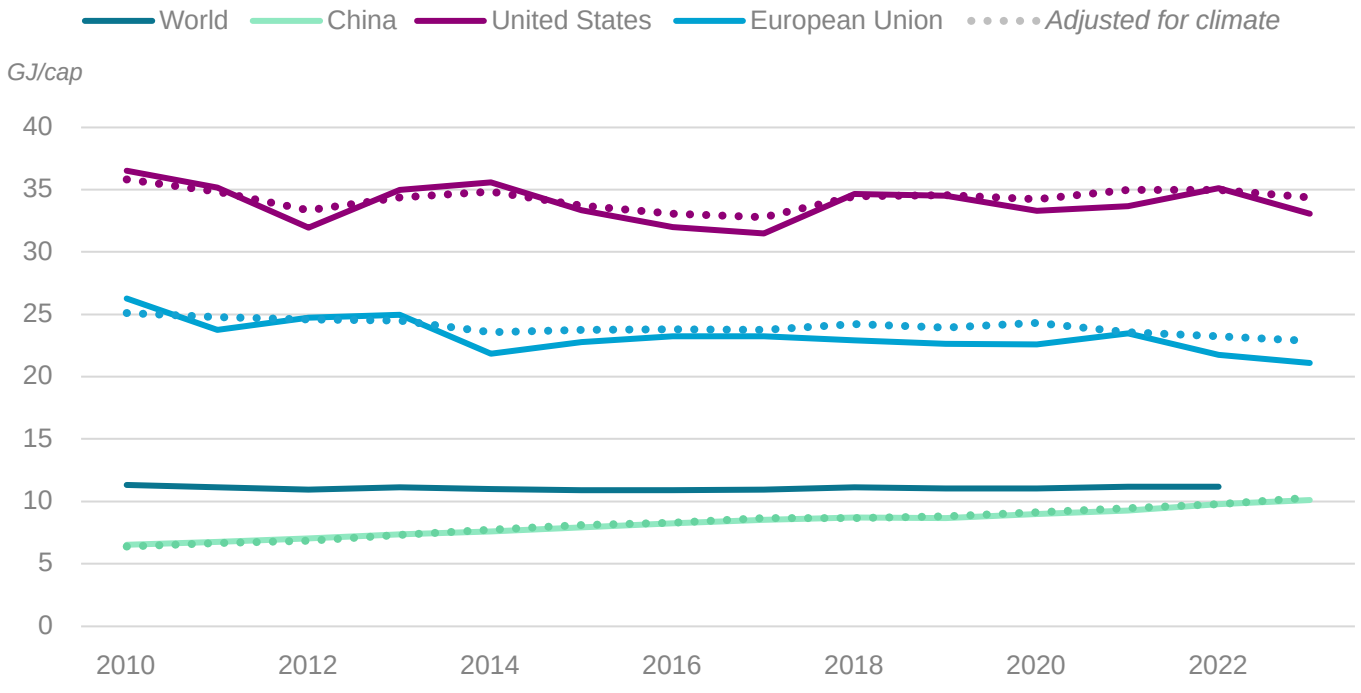
Energy intensity in households is not declining in developed economies, and increasing in emerging countries.

Energy intensity in households remains **unchanged in developed economies** and is on the **rise in emerging countries**. Globally, **energy consumption** per capita in the **residential sector** has shown relative **stagnation**.

A significant **increase in energy consumption** has been observed in **China**, with an **annual growth rate of 4%**. This trend is **attributed to economic development**, which leads to greater access to energy services. However, China's per capita energy consumption is still far from converging with that of OECD countries, remaining less than half of the EU's and a third of the US's consumption per capita.

In **the European Union**, and to a lesser extent in **the United States**, **climate factors** have been **the primary drivers** of the recent **decline in residential energy consumption**.

Residential energy consumption per capita



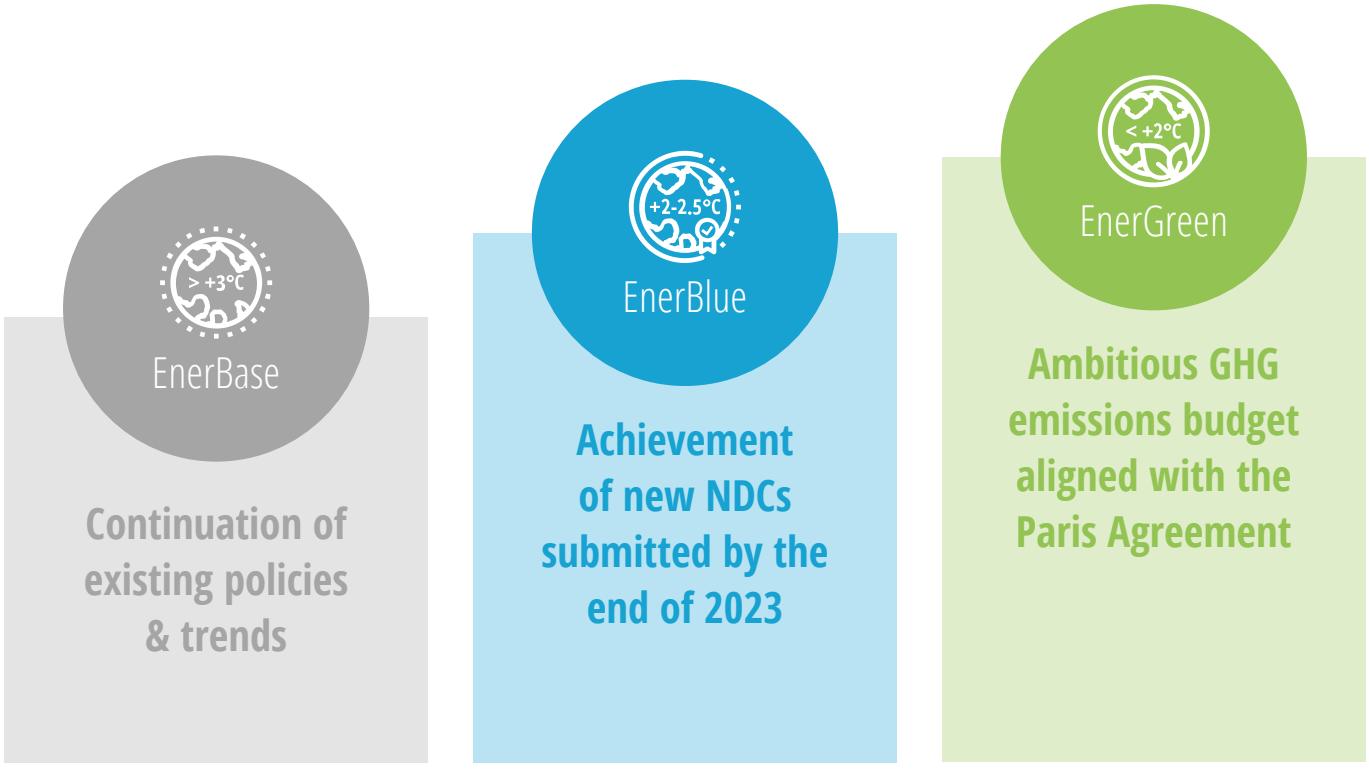
Source: Enerdata – www.enerdata.net


新中关购物中心
CITY MALL

The COP28 objectives in the perspective of long-term decarbonisation pathways

ENERFUTURE: THREE ENERGY-CLIMATE SCENARIOS TO EXPLORE POSSIBLE FUTURES OF GLOBAL ENERGY SYSTEMS

Enerdata has prepared three contrasted energy-climate scenarios up to 2050 to explore possible pathways for the global energy sector.



Source: Enerdata – www.enerdata.net

Enerdata contributes modestly by offering our vision to **complement the official process** and **address its perceived limitations**. Notably, we are working on comparing past trends with reference scenarios. Our goal is to provide a regional and sectoral assessment.

EnerFuture is relying on the recognised POLES-Enerdata model (standing for **P**rospective **O**utlook on **L**ong-term **E**nergy **S**ystems), **an energy-economy-environment model of the global energy system**, covering **66 countries and regions**, with dedicated modelling of the **individual end-use sectors**, **energy supply**, **prices**, and **GHG emissions**.

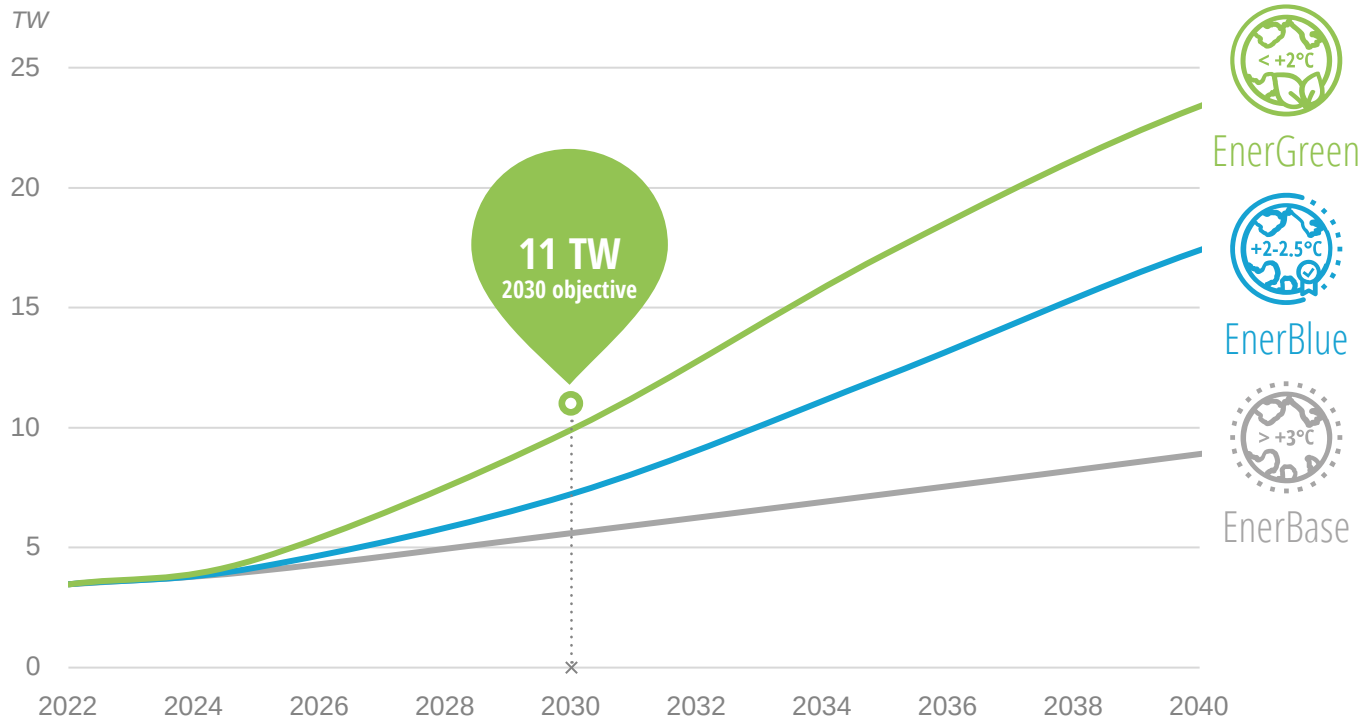
TRIPLING RENEWABLE CAPACITY BY 2030: AN AMBITIOUS OBJECTIVE

Tripling renewable capacity will require additional investments in the short-term, that will become profitable in the long-term.

The goal of tripling global renewable energy capacity by 2030 aligns with the Paris Agreement's objective of limiting global warming to "well below 2 °C".

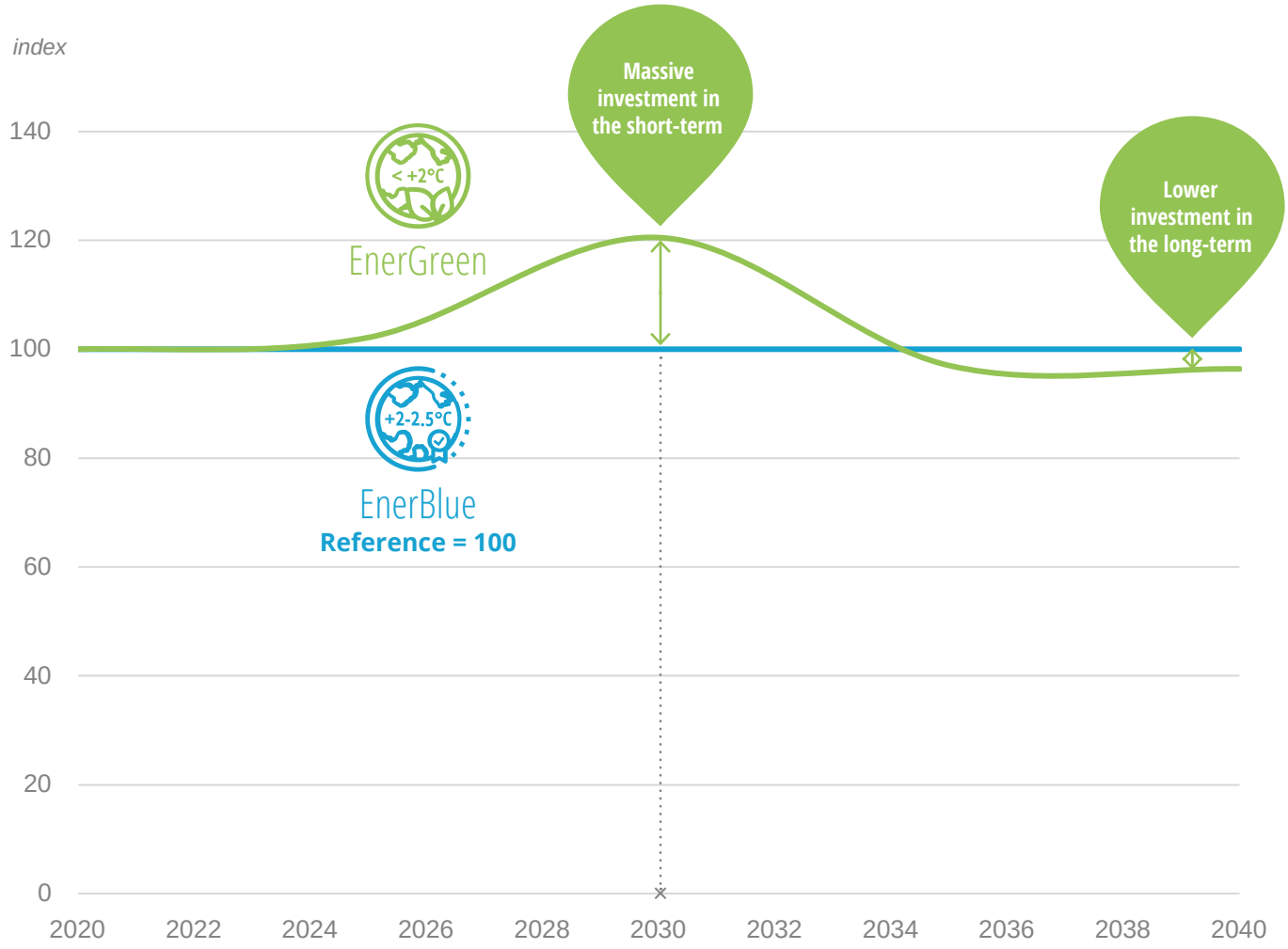
The EnerGreen **scenario**, **aligned with the Paris agreement** by definition, indeed **shows a similar ambition as the 2030 goal**. Even if countries fully honor their commitments, **current policies and Nationally Determined Contributions** (NDCs) **are however insufficient to meet this target**, **as evidenced by the** EnerBlue **scenario**, which indicates that the tripling of renewable capacity will be **delayed until at least 2034**.

Global renewable power capacity



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

Additional costs in the power generation sector



NB: Costs are reported as Net Present Values, not annualised, showing the temporal need for investment.

Source: EnerFuture scenarios – Enerdata – www.enerdata.net

In a **"Well below 2 °C" scenario**, compatible with the goal of tripling renewable capacity by 2030:

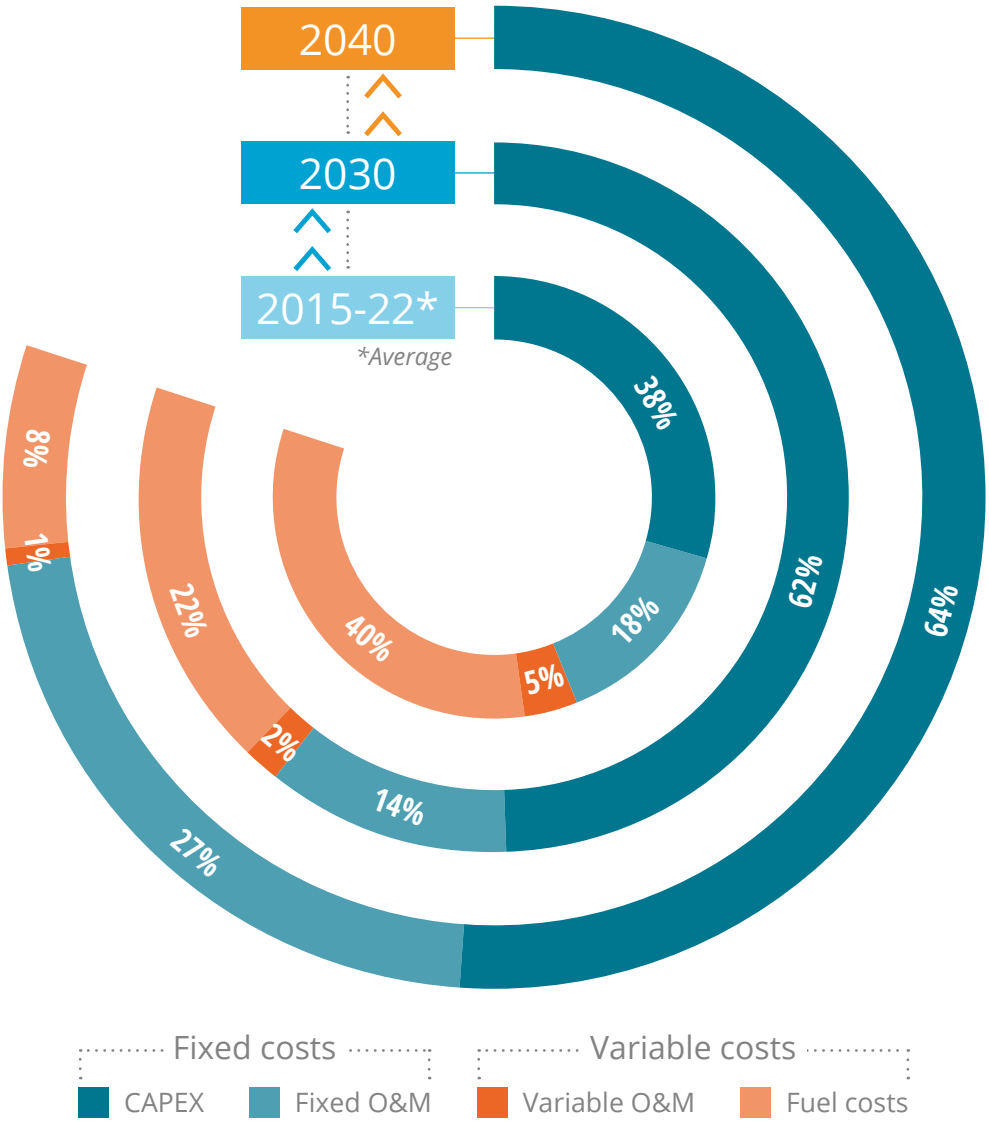
- In the **short-term**, the **total cost of the electricity generation sector** will **significantly increase** compared to a trajectory aligned with the countrie's current ambitions.
- In the **long-term**, beyond 2035, **this additional investment will pay off**, resulting in the **power system costs** declining **below the counterfactual trajectory**.

This is explained by **a massive change in the power sector cost structure**.

A MASSIVE CHANGE IN THE POWER SECTOR COST STRUCTURE

The shift towards renewable energy sources for power generation implies a more CAPEX-oriented system.

Power sector cost structure in %



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

As illustrated above, in a **scenario aimed at tripling renewable capacity by 2030**, the **total costs required** in the **power generation sector** will **rise significantly** over the next decade, with the **need of additional investment in renewables**. However, after 2035, these investments will lead to lower overall power system costs.

The **integration of renewable energy** will indeed **reshape the cost structure of the power sector**, explaining these dynamics. Currently, costs are balanced between fixed and variable expenses, but **by 2030 and beyond**, **fixed costs are expected to dominate**.

Indeed, **renewable energy source are capital expenditure (CAPEX)-intensive technologies**, **unlike thermal power plants** and while they necessitate a significant initial investment, they **benefit from the absence of fuel costs**, as is the case with wind and solar energy.

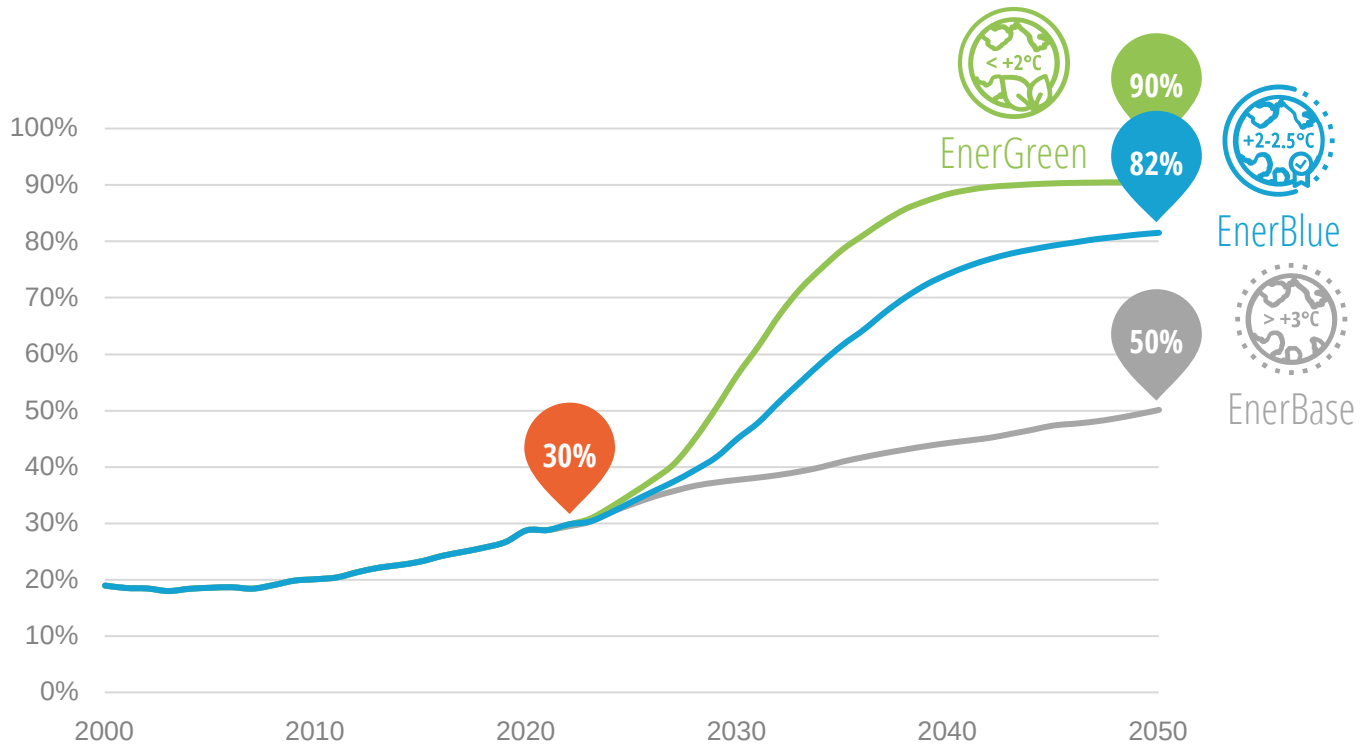
DECARBONISATION OF ELECTRICITY BEYOND 2030

A prolonged accelerated deployment of renewables is necessary in the long-term to reduce our emissions.

To successfully reduce our emissions and reach ambitious climate targets, we must be able to fully decarbonise our electricity systems.

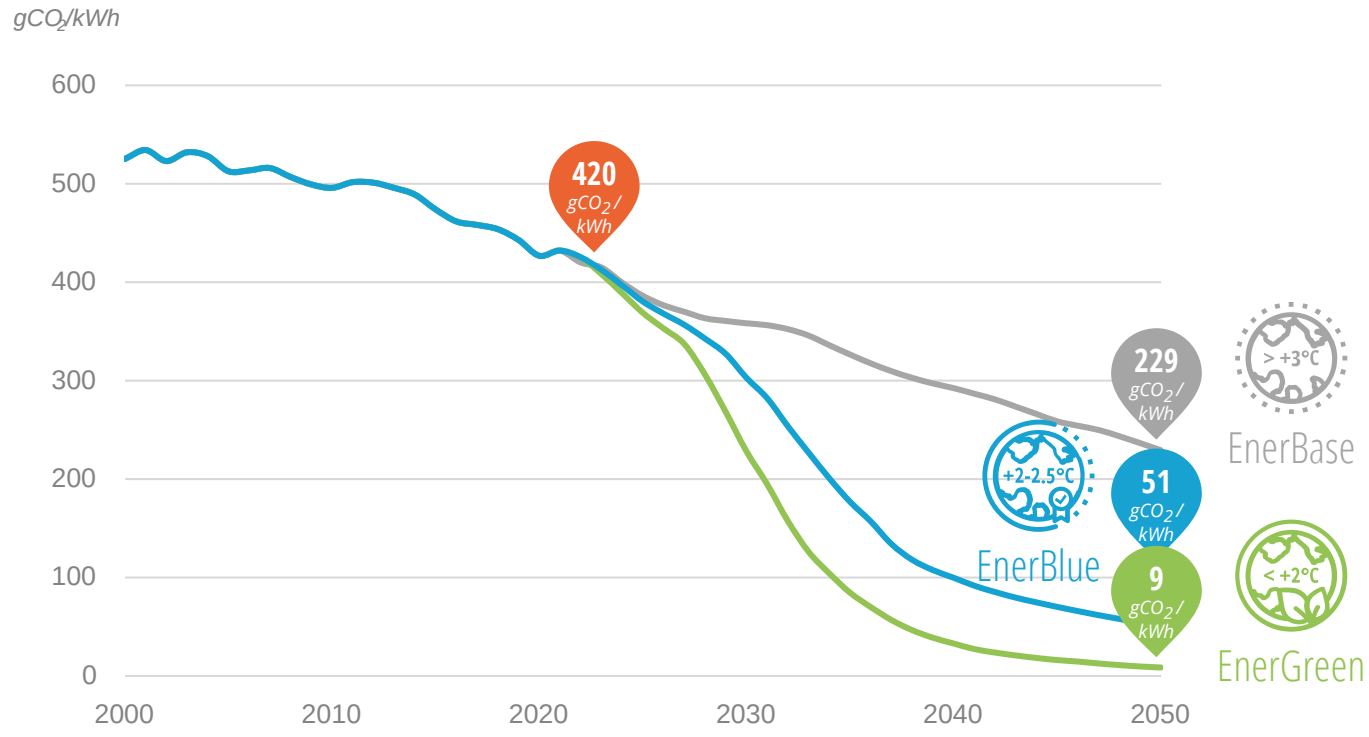
- In EnerBase, despite lacking strict climate policies, there is already a **progressive shift towards renewable energy**, leading to a nearly **50% drop in average electricity emission factor from 2021 to 2050**.
- In EnerBlue, driven by Nationally Determined Contributions and domestic policies, there is a **strong embrace of renewables**, resulting in an **88% emission reduction per kWh from 2022 to 2050**.
- The EnerGreen pathway, with the goal of staying **below 2 °C warming**, necessitates a **stronger commitment to renewables**, which will enable to **slash specific emissions by 98% by 2050**.

Share of renewables in electricity generation



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

CO_2 intensity of electricity generation

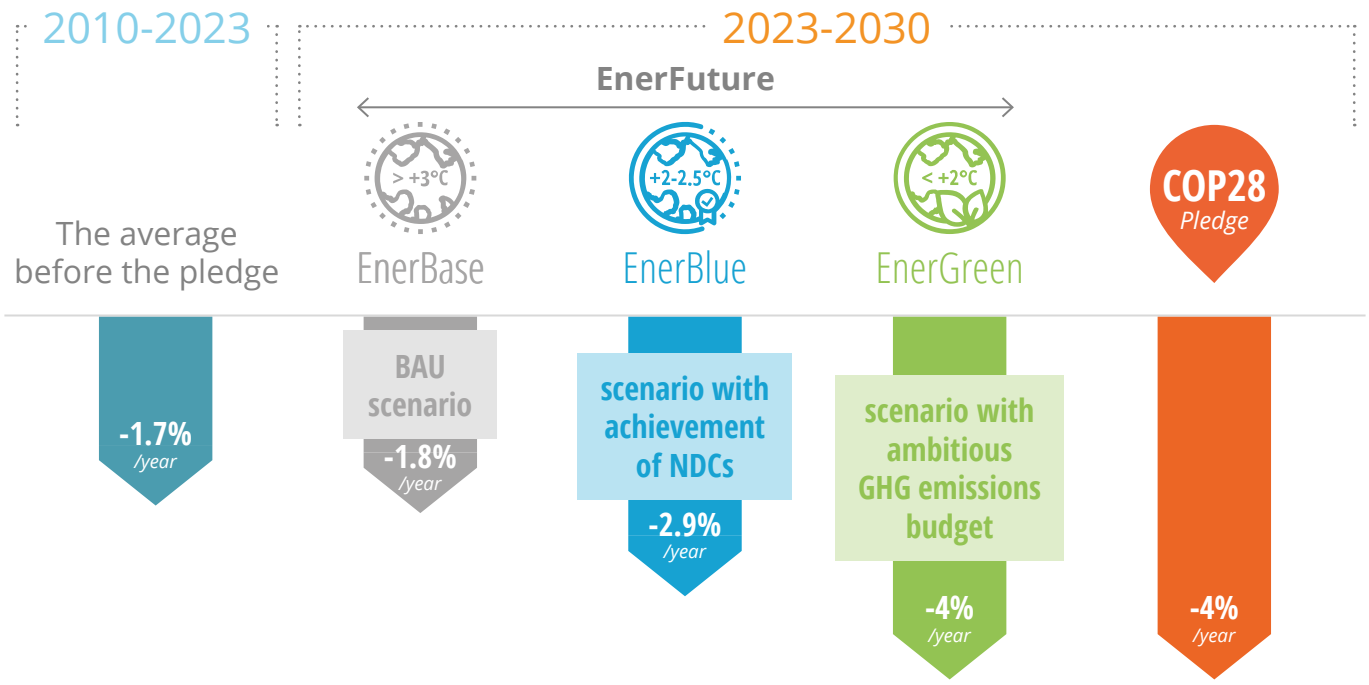


Source: EnerFuture scenarios – Enerdata – www.enerdata.net

DOUBLING ENERGY EFFICIENCY PROGRESS IS MORE AMBITIOUS THAN THE CURRENT NDCs

This energy efficiency objective is in line with the Paris Agreement, but goes well beyond the current ambition of countries.

Comparison of primary energy intensity evolution in different scenarios



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

Primary energy intensity decreased by approximately **2%/year** on average since **2015**.

Doubling this pace is **compatible** with a **"well below 2 °C"** pathway:

- Indeed, EnerGreen leads to average energy intensity improvement of **4%/year by 2030**.

However, the **current country-level objectives** are **not sufficient**:

- The EnerBlue **scenario**, leads to **3%/year** improvement on average **by 2030**.

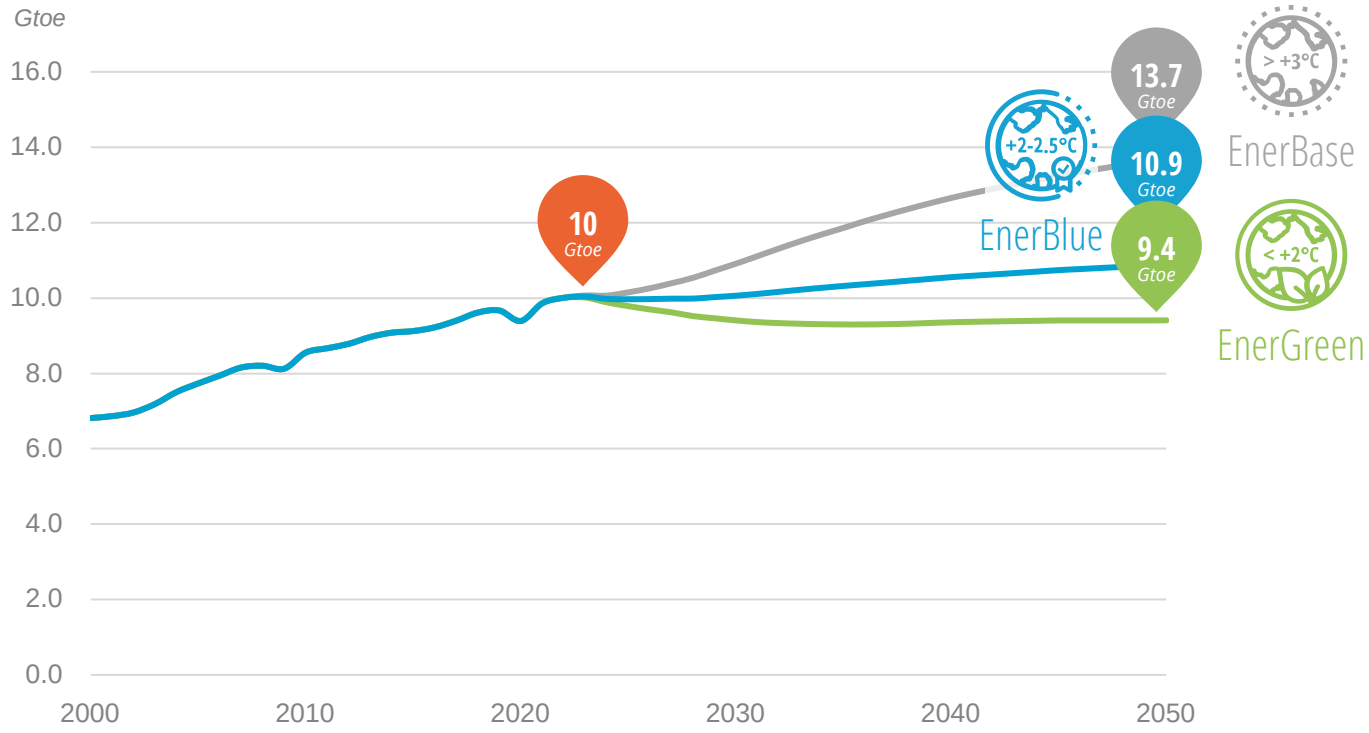
LIMIT FINAL ENERGY CONSUMPTION

Global final energy consumption must tend to decrease slightly, to comply with the Paris agreement.

In examining energy use in relation to different climate ambitions, it is clear that a **reduction in final energy consumption is essential for lowering greenhouse gas emissions**.

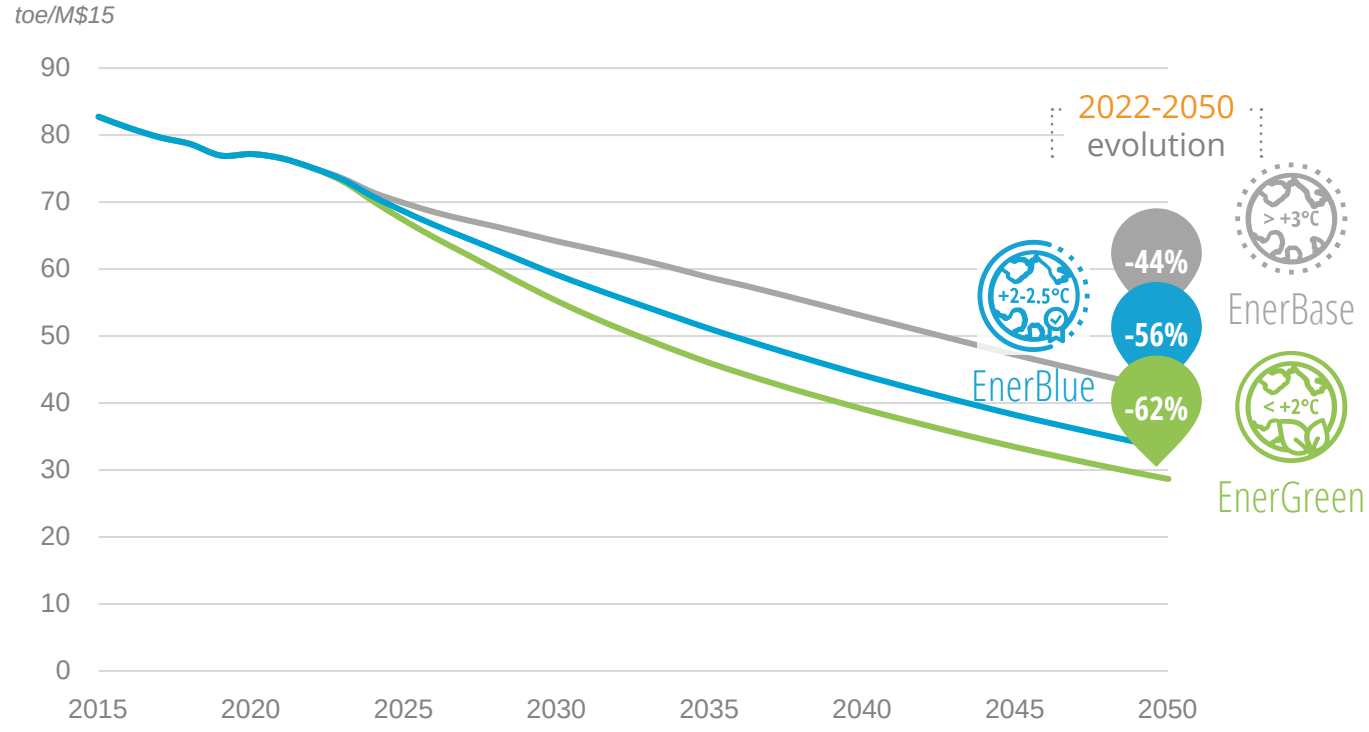
- In EnerBase, where climate ambition is lacking, **final consumption keeps rising**, though the energy intensity of GDP decreases in line with past trends.
- In EnerBlue, **policies promoting energy efficiency help limit consumption growth**, but not enough to stop it from rising.
- To achieve a scenario with global warming below 2 °C, as in EnerGreen, **final energy consumption must decrease** from current levels, **with a stronger decoupling of GDP growth from energy consumption growth**.

Final energy consumption – WORLD



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

GDP final energy intensity - WORLD



Source: EnerFuture scenarios – Enerdata – www.enerdata.net

Summary

KEY TAKEAWAYS

The COP28 pledge: both ambitious and insufficient.

The **2030 climate objectives** from the **COP28 are aligned with the Paris agreement** goal to maintain **global temperature** increase **"well below 2 °C"**, as illustrated by EnerGreen.

However, the **Nationally Determined Contributions** (NDCs) are **not sufficient to reach the 2030 climate objectives**.

Both **tripling** the global **renewable capacity** and **doubling** the pace of **energy intensity improvement** by 2030 **require a major disruption of historical trends**.

These objectives rely on an **improved support towards renewable energies**, and a **massive rollout of technologies and options** that could significantly impact energy efficiency (e.g., electric vehicles, heat pumps, and more).

However, **these objectives are not sufficient to meaningfully address climate change**:

- Historically, **energy efficiency improvements have not compensated for increased activity**, resulting into a **continuous rise in energy demand**.
- **Renewables** have **supplemented**, **rather than substantially replaced**, **fossil fuels** in power generation.
- **Technology-oriented strategies neglect impact on critical materials**.

A consistent decarbonisation pathway must address activity level through, for instance, **energy sufficiency**, **circularity**, and **modal shifts**. This would mitigate our dependence on uncertain technological progress and deployment, as well as limited resources.

Enerdata
intelligence + consulting

HELPING YOU SHAPE THE ENERGY TRANSITION

Enerdata is an independent research company that specialises in the analysis and forecasting of energy and climate issues, at a variety of different geographic and business / sector levels. The company is headquartered in Grenoble, France, where it was founded in 1991, and has a subsidiary in Singapore.

Leveraging its globally recognised databases, business intelligence processes, and prospective models, Enerdata assists clients – which include companies, investors, and public authorities around the world – in designing their policies, strategies, and business plans.

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