

🔍 Renewables 2022

Executive summary

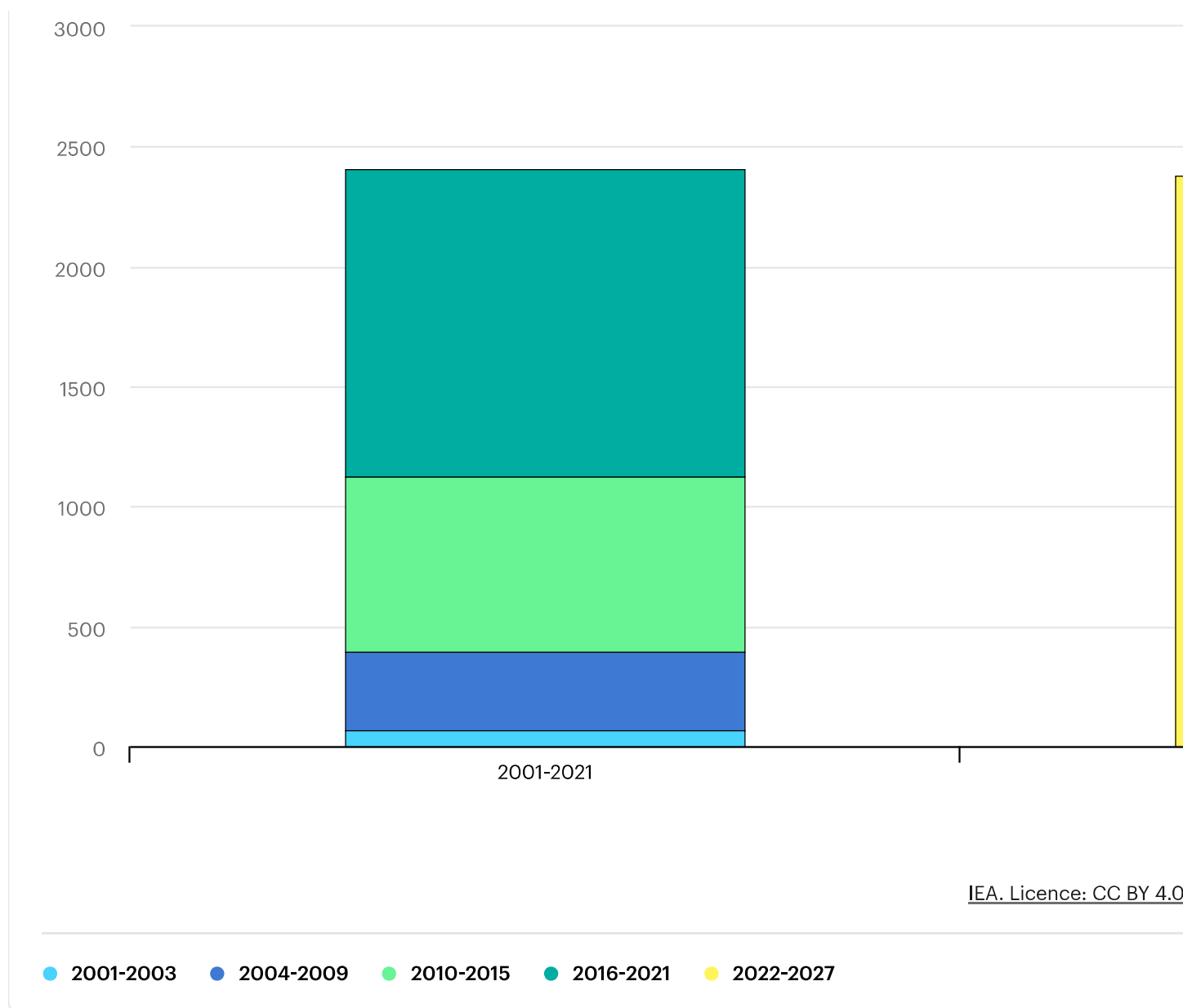
Energy security concerns and new policies lead to largest ever upward revision of IEA's renewable power forecast

The first truly global energy crisis, triggered by Russia's invasion of Ukraine, has sparked unprecedented momentum for renewables. Fossil fuel supply disruptions have underlined the energy security benefits of domestically generated renewable electricity, leading many countries to strengthen policies supporting renewables. Meanwhile, higher fossil fuel prices worldwide have improved the competitiveness of solar PV and wind generation against other fuels.

Total renewable electricity capacity additions, 2001-2027

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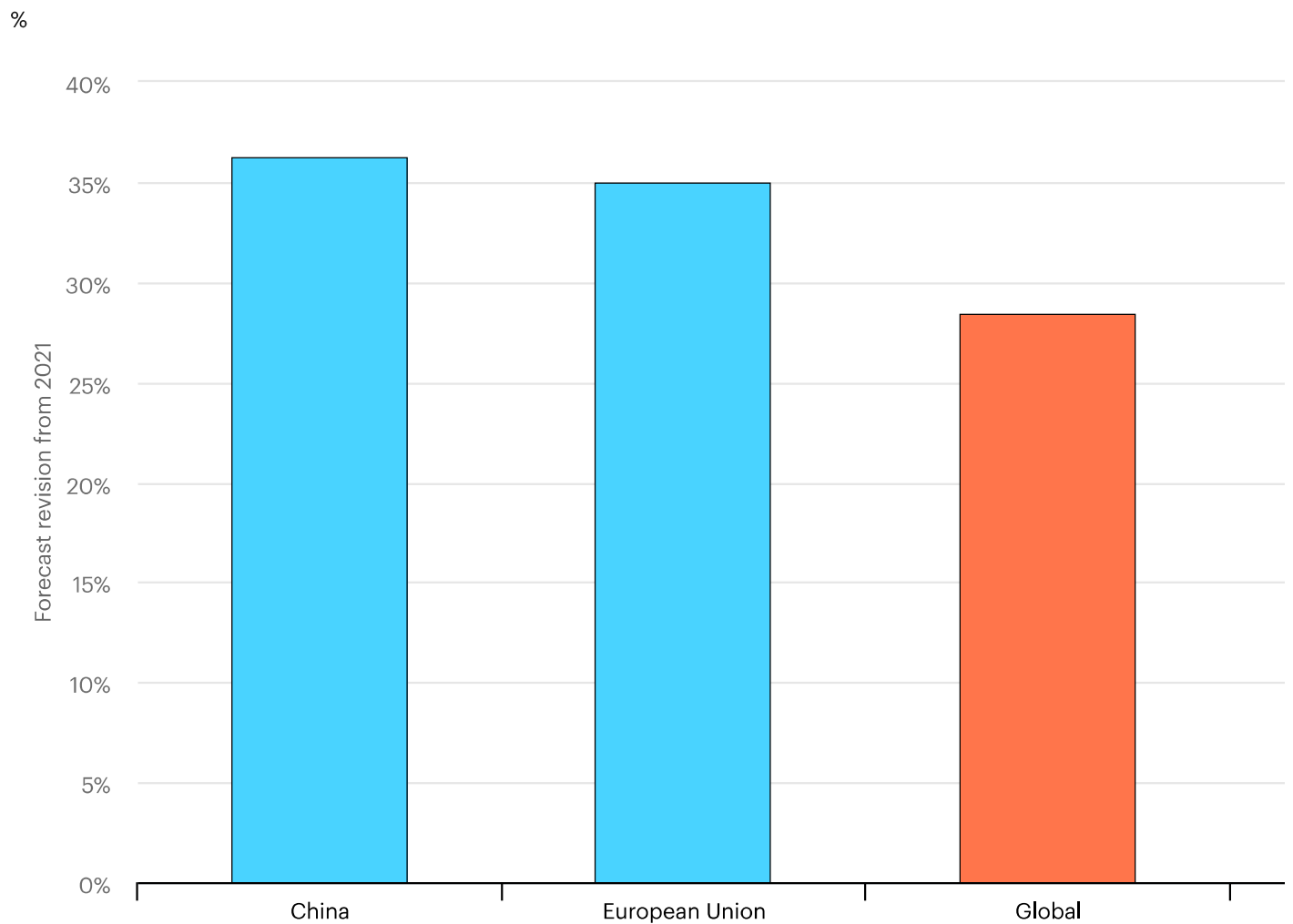
GW



Renewable capacity expansion in the next five years will be much faster than what was expected just a year ago. Over 2022-2027, renewables are seen growing by almost 2 400 GW in our main forecast, equal to the entire installed power capacity of China today. That's an 85% acceleration from the previous five years, and almost 30% higher than what was forecast in last year's report, making it our largest ever upward revision. Renewables are set to account for over 90% of global electricity capacity expansion over the forecast period. The upward revision is mainly driven by China, the European Union, the United States and India, which are all implementing existing policies and regulatory and market reforms, while also introducing new ones more quickly than expected in reaction to the energy crisis.

China's 14th Five-Year Plan and market reforms, the REPowerEU plan and the US Inflation Reduction Act are the main drivers of the revised forecasts.

Upward revisions to renewable capacity expansion forecasts from Renewables 2021 to Renewables 2022

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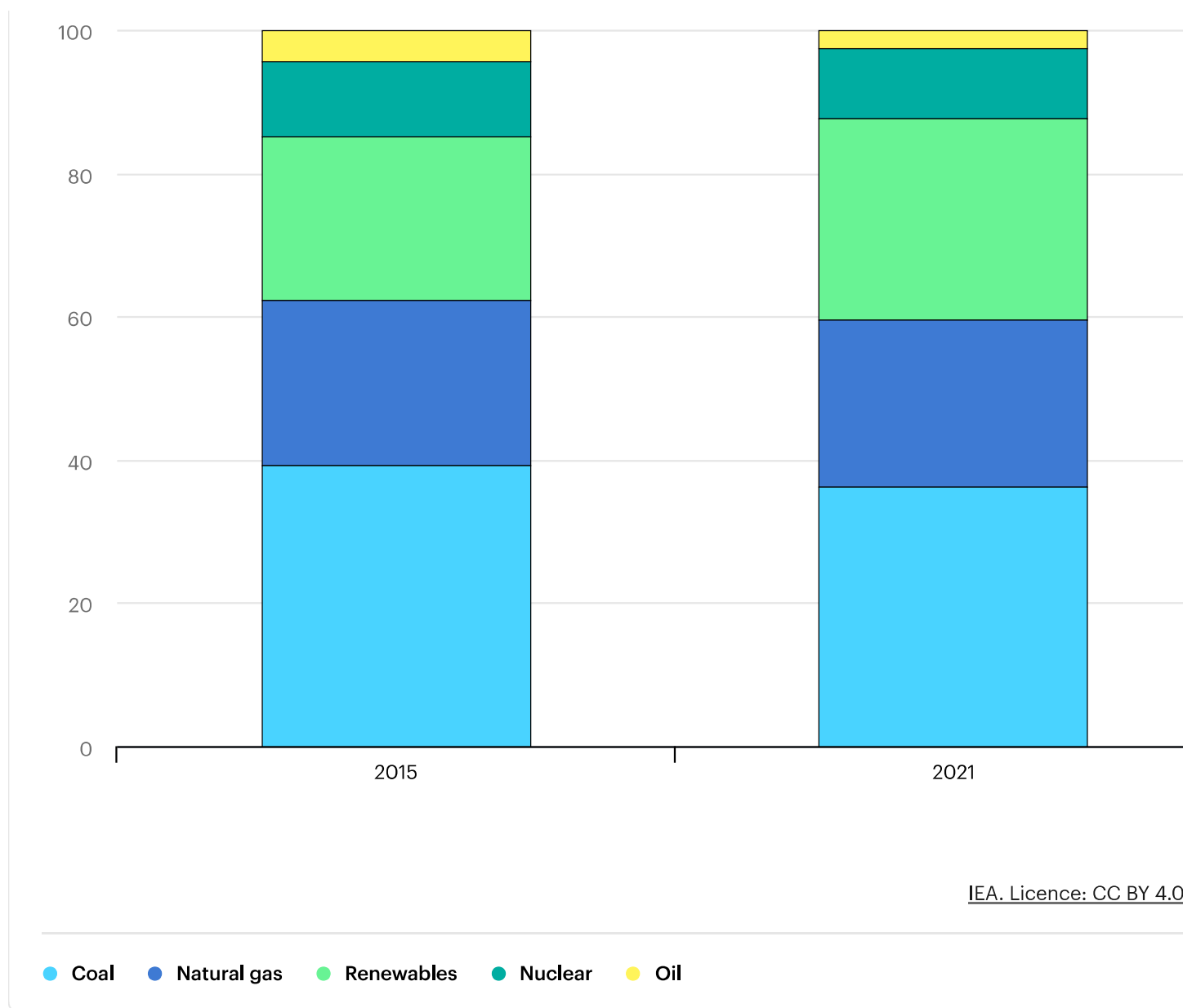
Renewables will transform the global power mix through 2027, becoming the largest source of electricity

Renewables become the largest source of global electricity generation by early 2025, surpassing coal. Their share of the power mix is forecast to increase by 10 percentage points over the forecast period, reaching 38% in 2027. Renewables are the only electricity generation source whose share is expected to grow, with declining shares for coal, natural gas, nuclear and oil generation. Electricity from wind and solar PV more than doubles in the next five years, providing almost 20% of global power generation in 2027. These variable technologies account for 80% of global renewable generation increase over the forecast period, which will require additional sources of power system flexibility. Meanwhile, the growth of dispatchable renewables including hydropower, bioenergy, geothermal and concentrated solar power remains limited despite their critical role in integrating wind and solar PV into global electricity systems.

Global electricity generation by technology, 2015, 2021 and 2027

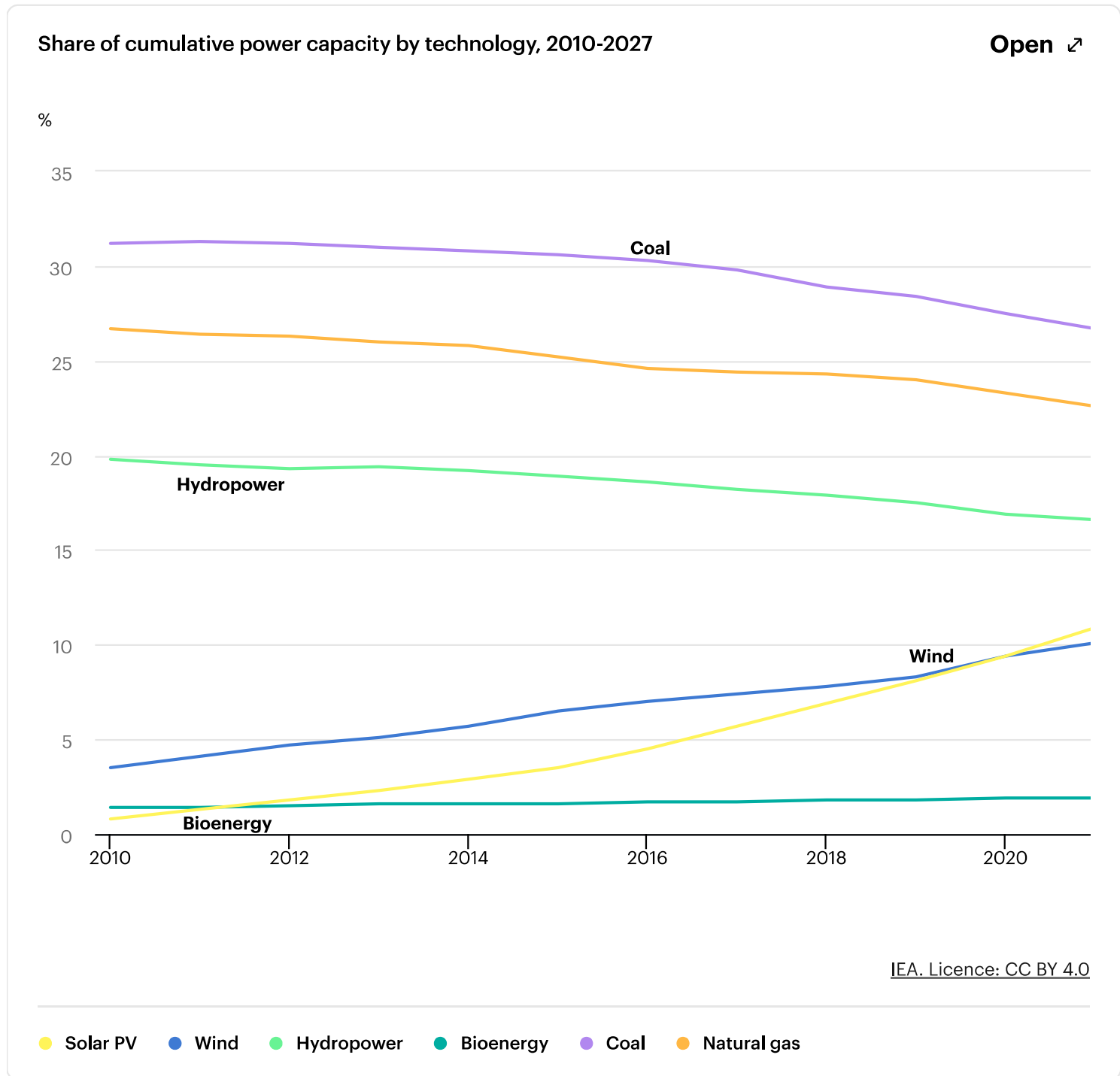
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%



Solar PV's installed power capacity is poised to surpass that of coal by 2027, becoming the largest in the world. Cumulative solar PV capacity almost triples in our forecast, growing by almost 1 500 GW over the period, exceeding natural gas by 2026 and coal by 2027. Annual solar PV capacity additions increase every year for the next five years. Despite current higher investment costs due to elevated commodity prices, utility-scale solar PV is the least costly option for new electricity generation in a significant majority of countries worldwide. Distributed solar PV, such as rooftop solar on buildings, is also set for faster growth as a

result of higher retail electricity prices and growing policy support to help consumers save money on their energy bills.



Global wind capacity almost doubles, with offshore projects accounting for one-fifth of the growth. Over 570 GW of new onshore wind capacity are forecast to become operational over the 2022-27 period. However, onshore wind additions will only break their annual record, set in 2020, by the end of the forecast period because of lengthy permitting procedures and lack of improvements to grid infrastructure. Offshore wind growth accelerates globally, while Europe's share of installed offshore capacity declines from 50% in 2021 to 30% in 2027 as China's provincial policies support faster expansion and the United States becomes a sizeable market at the end of the forecast period.

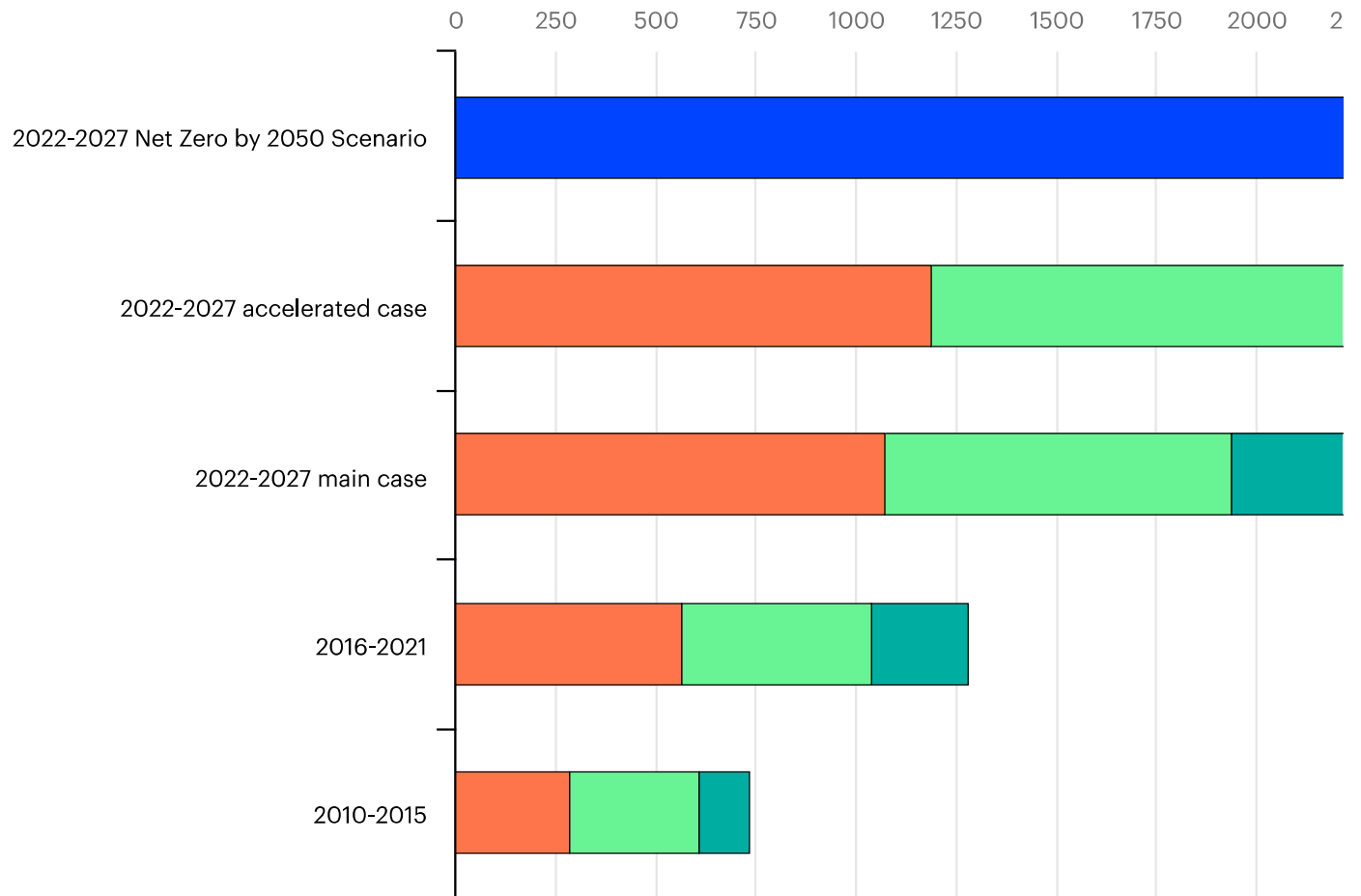
Improved policies can narrow the gap to net zero by 2050

Our accelerated case shows global renewable capacity can expand by an additional 25% compared with the main forecast if countries address policy, regulatory, permitting and financing challenges. Most advanced economies face challenges to implementation, especially related to permitting and grid infrastructure expansion. In emerging economies, policy and regulatory uncertainties still remain major barriers to faster renewable energy expansion. Finally, in developing economies, weak grid infrastructure and a lack of access to affordable financing hamper the timely commissioning of projects in our main forecast. Should countries address those challenges, global renewable capacity could expand by almost 3 000 GW. This faster increase would significantly narrow the gap on the amount of renewable electricity growth that is needed in a pathway to net zero emissions by 2050.

Renewable capacity growth in the main and accelerated cases, 2010-2027

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GW



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● World ● China ● Advanced economies ● Emerging and developing economies

Russia's invasion of Ukraine is a turning point for renewables in Europe

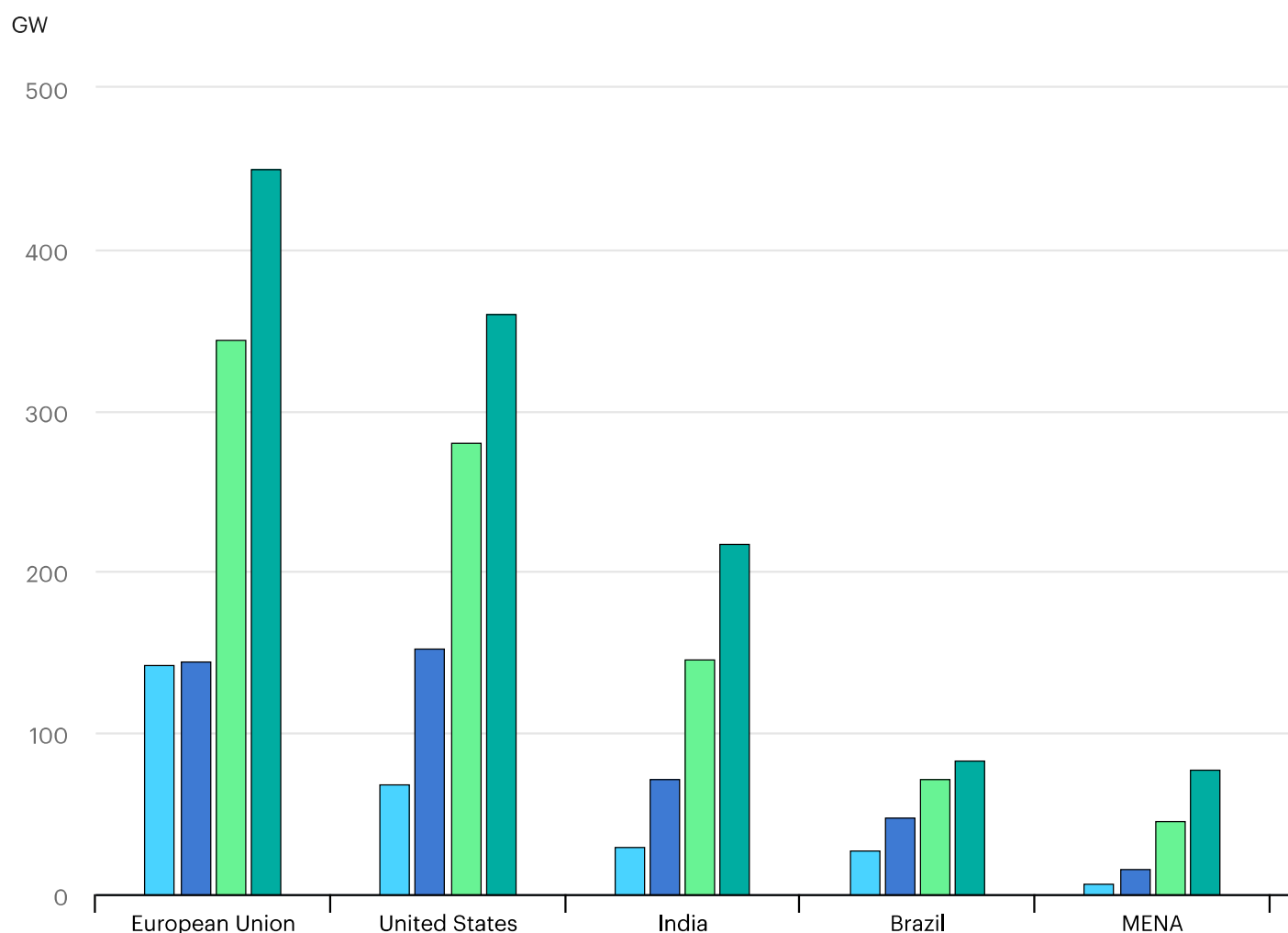
The war is expediting Europe's clean energy transitions. The energy crisis hit the EU while it was already discussing ambitious renewables targets under the Fit for 55 package. After Russia invaded Ukraine in February 2022, energy security emerged as an additional strong motivation to accelerate renewable energy deployment. At the EU level, the European Commission's REPowerEU plan released in May 2022 proposes ending the bloc's reliance on Russian fossil fuels by 2027. Among other goals, the plan aims to increase the share of

renewables in final energy consumption to 45% by 2030, exceeding the 40% previously under negotiation.

Europe’s renewable electricity expansion doubles over the 2022-2027 period as energy security concerns add to climate ambitions. Many European countries passed or proposed action plans to further raise their ambitions, increased policy support and addressed non-financial challenges. Our forecast for growth in the EU has been revised upward significantly (by 30%) from last year’s report, led by Germany (50% higher) and Spain (60% higher). Germany has increased renewable electricity targets, introduced higher auction volumes and improved remuneration for distributed PV while reducing permitting timelines. Spain has streamlined permitting for solar PV and wind plants, and increased grid capacity for new renewable energy projects.

Renewable capacity growth outside of China, main and accelerated cases, 2010-2027

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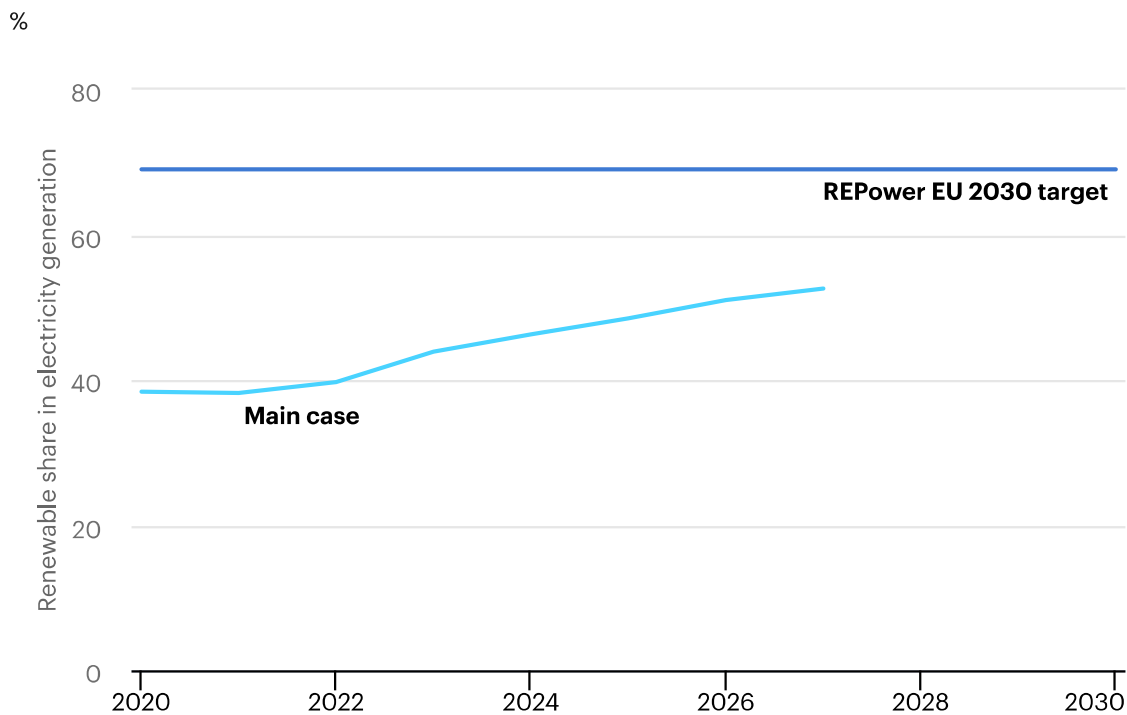
● 2010-2015 ● 2016-2021 ● 2022-2027 main case ● 2022-2027 accelerated case

Sluggish growth of renewables in the transport and heating sectors holds back higher renewable energy penetration in the EU. In our main case, renewables' share of transport energy demand expands from 9% in 2020 to 15% in 2027, which is not in line with the EU's aspirations for 2030. While demand for electric vehicles and biofuel expands, state and EU-level incentives to meet higher renewable shares are not in place in most cases. For heating and cooling, the annual increase in the share of renewables would need to almost quadruple from historical and forecasted growth to be on track with the REPowerEU plan targets.

Policy improvements can drastically increase renewables expansion and put the European Union in line with REPowerEU goals. Our main forecast falls short of the modelled goals of REPowerEU plan for all sectors. For electricity, in order to reach the installed capacity needed to generate 69% of electricity from renewables by 2030, average annual net additions need to be 30% higher for solar PV and more than twice as high for wind. Faster acceleration of wind and solar PV would require EU member states to reduce permitting and licensing timelines, extend auction schemes with clear schedules, redesign auctions to reflect the increasing cost of renewables and their energy security benefits, and improve incentive schemes for distributed solar PV generation. If EU governments rapidly implement these changes, the accelerated case sees growth 30% higher, putting the EU on track with its more ambitious REPowerEU modelled goals. For transport, countries would need to implement more ambitious transport decarbonisation programmes, including both biofuels and EVs. In the accelerated case, renewable energy's share in transport climbs to 20% by 2027, narrowing the gap with the EU goal of 29% by 2030. For heating and cooling, accelerating the rollout of heat pumps will require overcoming high upfront costs through incentives, regulations and low-cost financing for households to facilitate investment.

[Renewable electricity progress summary in the European Union, 2020-2030](#)

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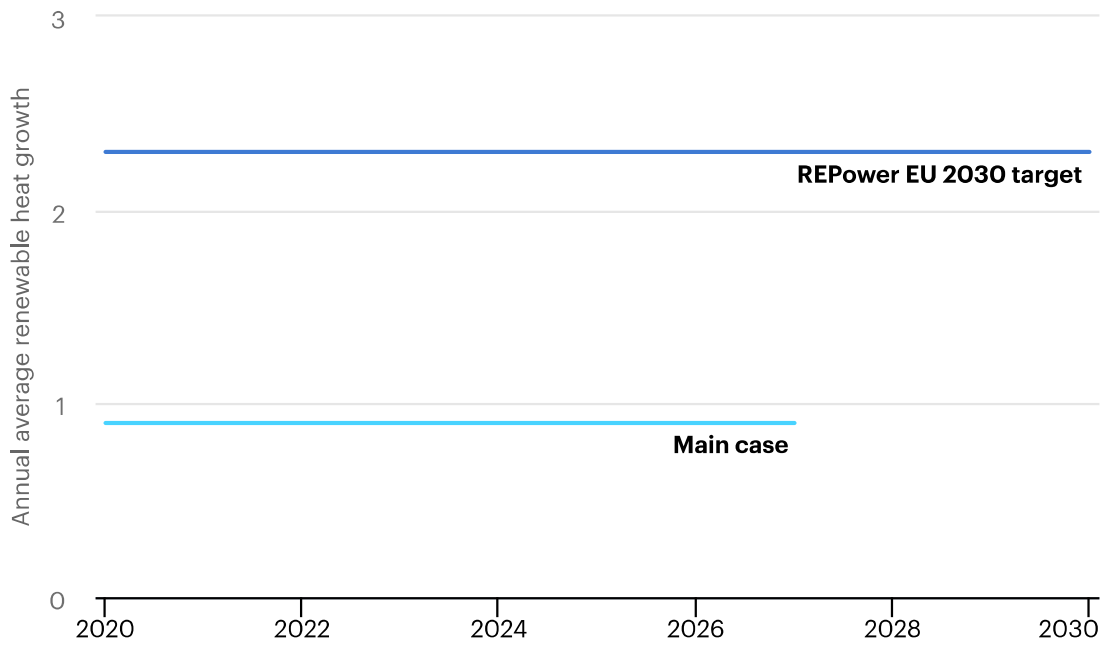
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● Main case ● REPower EU 2030 target

Renewable heat progress summary in the European Union, 2020-2030

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%

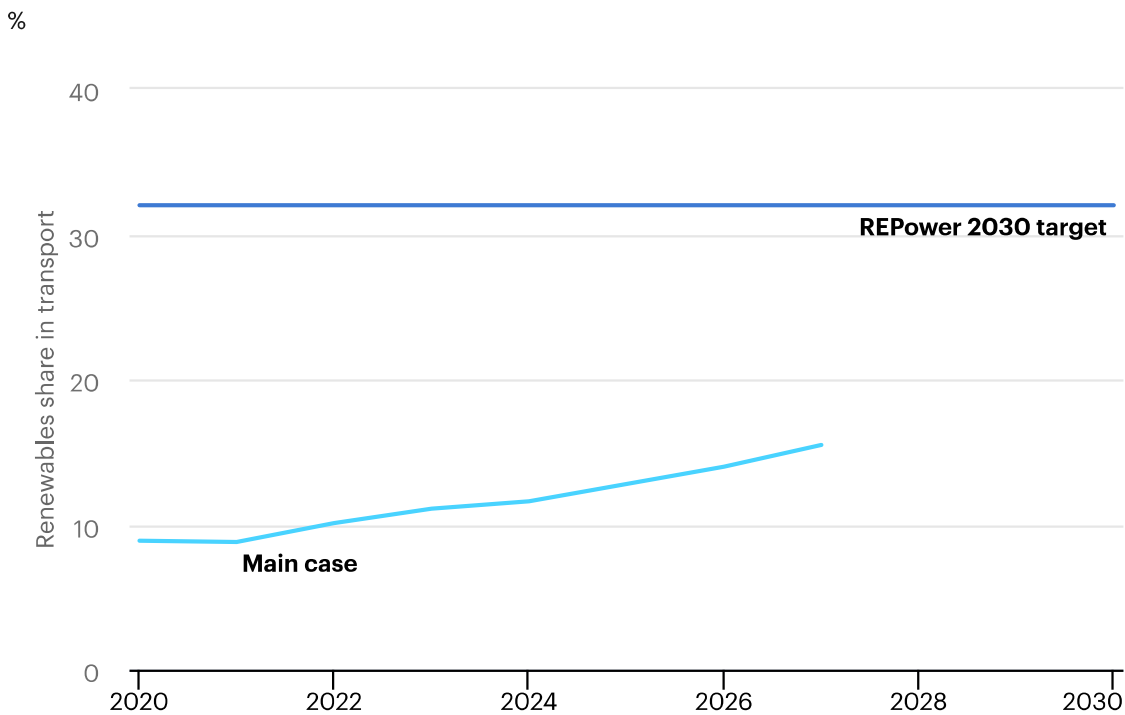


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● Main case ● REPower EU 2030 target

Renewable transport progress summary in the European Union, 2020-2030

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● Main case ● REPower 2030 target

Market interventions must shelter citizens from high costs but without hurting the business case for new renewable energy investments. In October 2022, the European Council passed emergency regulations to protect vulnerable customers from high energy prices, including windfall profit levies on electricity generators. While there is strong rationale behind these interventions, their impact needs to be assessed in terms of the potential harm to renewable developers' capacity to invest in new projects. Current and proposed market interventions in Europe (such as wholesale market caps and windfall-profit taxes) could create uncertainties for renewable energy investments if they are not well designed or co-ordinated across countries. Moreover, the ongoing energy crisis has also sparked new discussions within the European Union concerning possible future electricity market design. These proposed reforms could, in principle, boost market-driven renewable energy deployment, ensure energy security and encourage investment in flexibility resources. However, it is important that any proposals be carefully and transparently prepared, with clear visibility on timing and involving all relevant stakeholders, in order to avoid unintended uncertainty among investors.

China, the United States and India all double their renewable capacity expansion in the next five years, accounting for two-thirds of global growth

China is forecast to install almost half of new global renewable power capacity over 2022-2027, as growth accelerates in the next five years despite the phaseout of wind and solar PV subsidies. Policy guidelines and targets in China's new 14th Five-Year Plan on renewable energy are the basis for this year's 35% upward revision on last year's forecast. Very ambitious new renewable energy targets, market reforms and strong provincial government

support provide long-term revenue certainty for renewables. In most Chinese provinces, utility-scale renewables are cheaper than regulated coal electricity prices, driving rapid adoption. In the main forecast, China is expected to reach its 2030 target of 1 200 GW of total wind and solar PV capacity five years in advance.

In the United States, the Inflation Reduction Act is providing unprecedented long-term policy visibility for wind and solar PV projects. Passed in August 2022, the legislation extended tax credits for renewables until 2032. In addition, 37 out of 50 states have renewable portfolio standards and goals supporting expansion. By 2027, US annual wind and PV capacity additions double compared with 2021. Given that the United States now has clear long-term policy visibility, any remaining forecast uncertainties relate to supply chain constraints, trade measures, grid infrastructure inadequacy and long permitting lead times.

In India, new installations are set to double over our forecast period, led by solar PV and driven by competitive auctions implemented to achieve the government's ambitious target of 500 GW of non-fossil capacity by 2030.

New policies in the United States and India can lead to more diversified global solar PV manufacturing

Solar PV manufacturing investment in India and the United States is expected to reach almost USD 25 billion over 2022-2027, a sevenfold increase compared with the last five years.

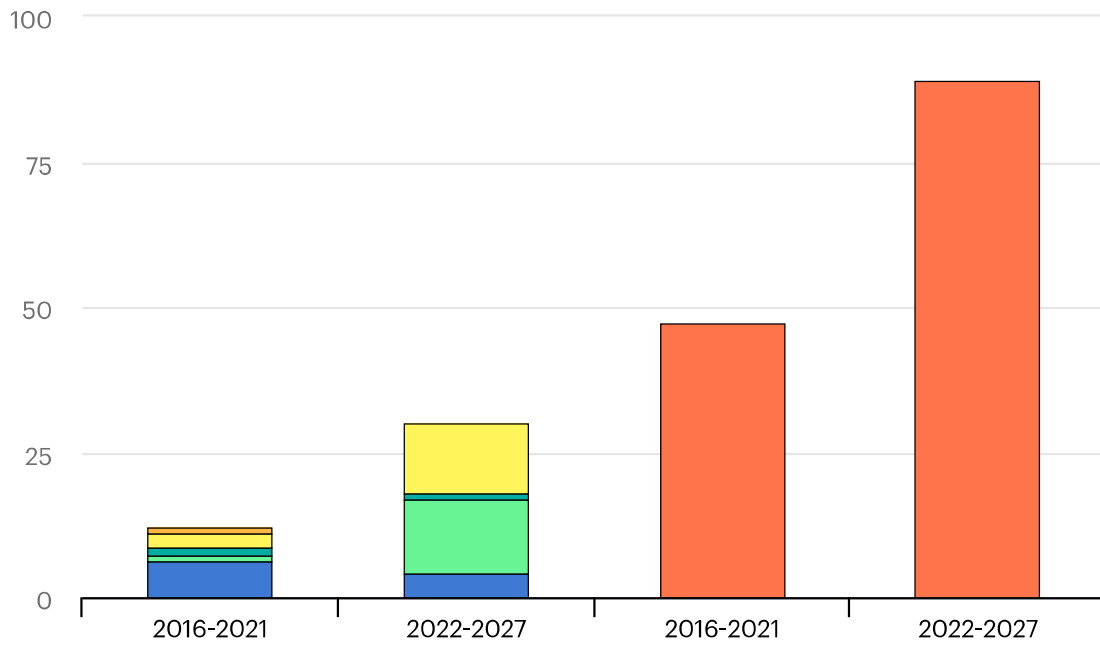
India's Production Linked Incentives (PLI) initiative closes nearly 80% of Indian manufacturers' investment cost gap with the lowest-cost manufacturers in China.

Meanwhile, fully monetising manufacturing tax credits in the United States could bring all segments of PV manufacturing to cost parity with the lowest-cost manufacturers. In addition to manufacturing subsidies, tariffs on imported PV equipment and local-content premiums encourage project developers to purchase domestically manufactured products in both India and the United States.

Total investment in solar PV manufacturing capacity by country and region, 2016-2027

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USD billion

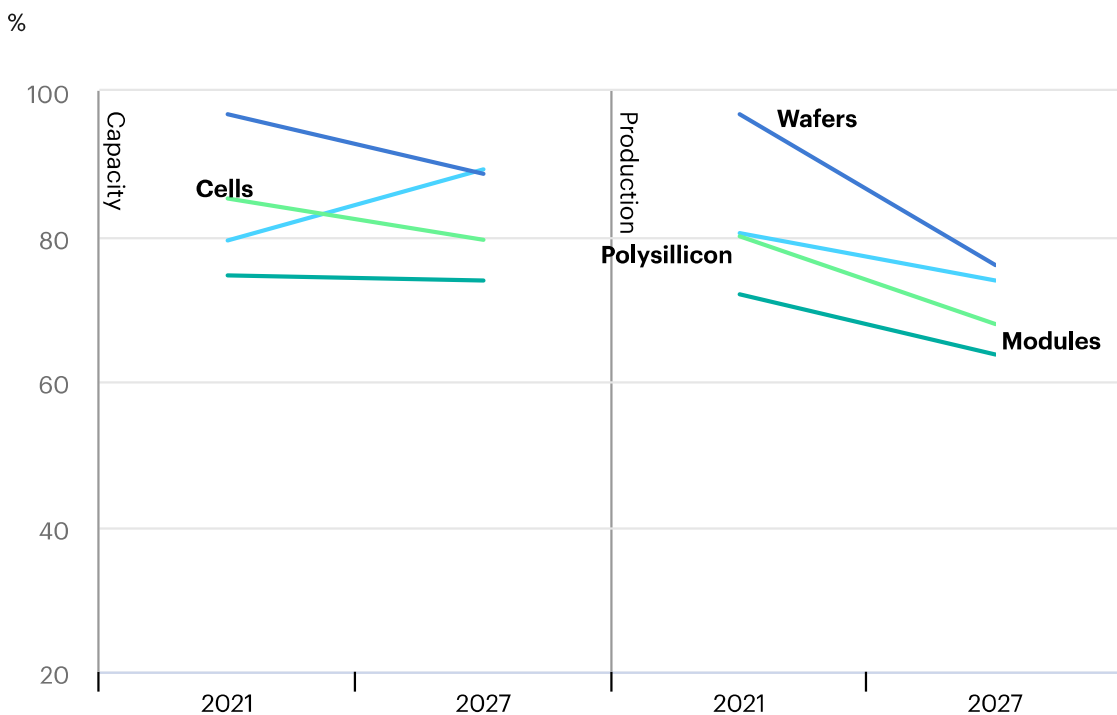


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● China ● Asia Pacific region ● India ● Europe ● North America ● Rest of the World

China's share of production capacity by market segment, 2021 and 2027

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● Polysilicon ● Wafers ● Cells ● Modules

The global solar PV supply chain is diversifying, but China will continue to dominate manufacturing. Despite growing investment in the United States and India, China is forecast to invest USD 90 billion over the forecast period, more than triple the expected investment by the rest of the world combined. China's share in global manufacturing capacity could decrease slightly, from 80-95% today to 75-90%, depending on the manufacturing segment. Furthermore, if countries maintain trade policies that limit imports and favour domestically produced PV products, greater geographical distribution of production could result in China's share shrinking more significantly to 60-75% by 2027 depending on the segment. At the same time, investment plans also indicate supply significantly exceeding expected global PV demand even in the most optimistic forecasts by 2027. In the absence of faster growth in global demand, this could result in plant utilisation factors as low as half today's levels for all manufacturing segments in China.

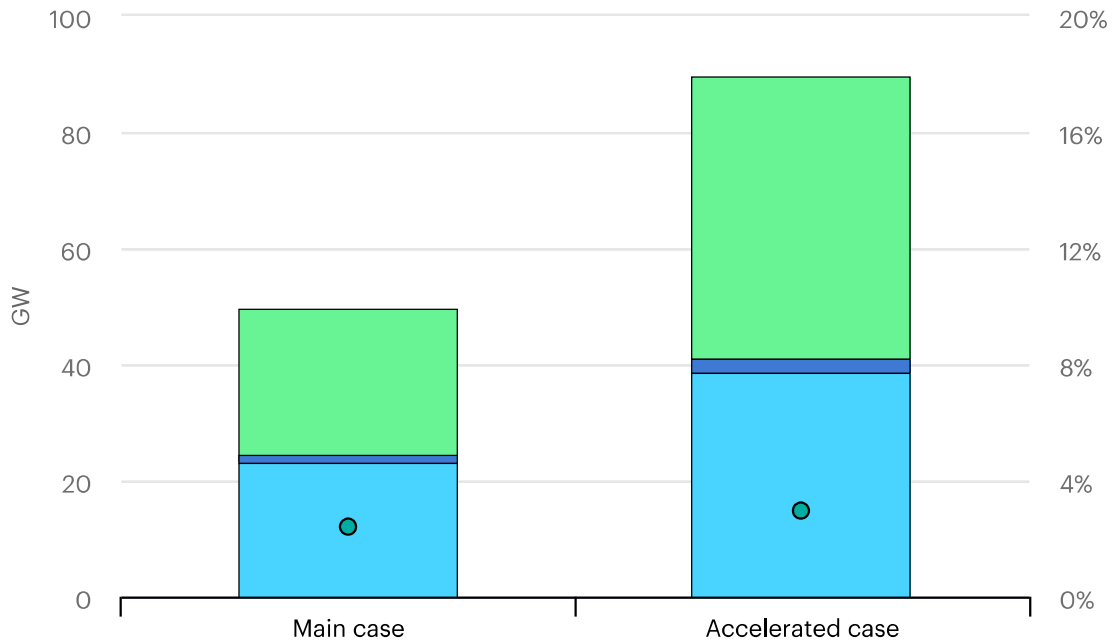
Policy efforts are turning hydrogen production from wind and solar PV into a new growth area

Global renewable capacity dedicated to producing hydrogen increases 100-fold in the next five years, offering opportunities to decarbonise industry and transport. Policies and targets introduced in more than 25 countries across all continents are expected to result in 50 GW of wind and PV capacity focused on producing hydrogen over the 2022-2027 period. This expansion is geographically diversified, with China leading the growth, followed by Australia, Chile and the United States. Together, these four markets account for roughly two-thirds of dedicated renewable capacity for hydrogen production. While renewable capacity dedicated to hydrogen accounts for only 2% of our main forecast, the share is significantly

higher at 13% in the Middle East and North Africa and 5% in Latin America because of export opportunities.

Total renewable capacity dedicated to hydrogen production in the main and accelerated case globally, 2021-2027

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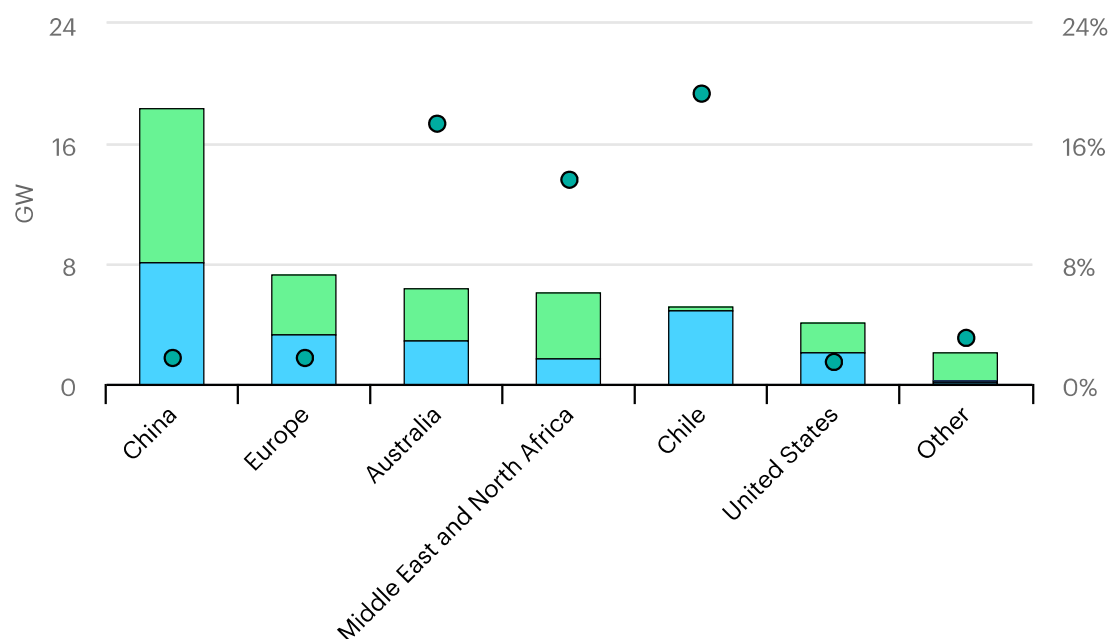


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● Onshore wind ● Offshore wind ● Solar PV ● Percentage of total renewable capacity growth

Total renewable capacity dedicated to hydrogen production in the main case by region, 2021-2027

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● Onshore wind ● Offshore wind ● Solar PV ● Percentage of total renewable capacity growth

Climate and energy goals underpin robust biofuels forecast

Total global biofuel demand expands by 35 000 million litres per year (MLPY), or 22%, over 2022-2027 in the main forecast. The United States, Canada, Brazil, Indonesia and India make up 80% of global expansion in biofuel use, as all five countries have comprehensive policy packages that support growth. Renewable diesel is expected to lead the global expansion for the first time mainly, driven by policies designed to reduce greenhouse gas emissions in advanced economies. Biojet fuel demand expands significantly to 3 800 MLPY in our main forecast – 35 times the 2021 level – to account for nearly 1% of total jet fuel consumption. Recent US tax incentives and the EU’s ReFuelEU target propel most of the growth in biojet fuel. Meanwhile, rising ethanol and biodiesel use occurs almost entirely in emerging

economies as they aim to reduce oil imports while benefiting the local economy by using indigenous resources.

Waste and residues are a key growth area for biofuels but require action to prevent a supply crunch

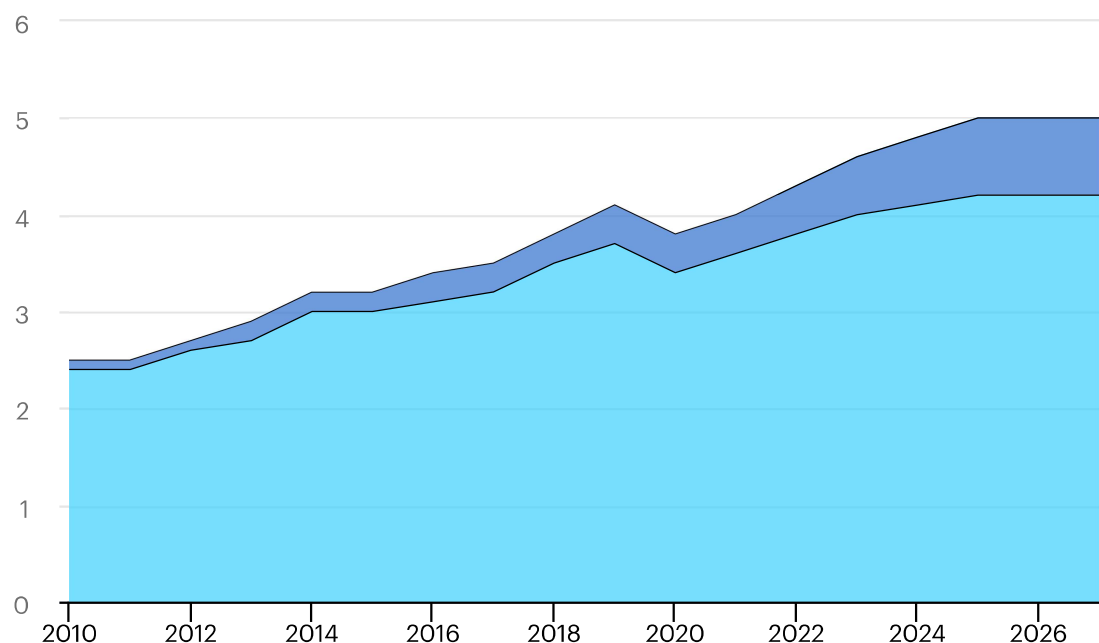
One-third of new biofuels production is set to come from waste and residues by 2027.

Transport greenhouse gas reduction policies in Europe and the United States are fuelling global demand for waste and residues. The United States' Inflation Reduction Act drives a 20% increase in our biojet and renewable diesel forecast. The policy rewards lower greenhouse gas intensity fuels, driving biofuel producers to focus on waste and residues. In Europe, the existing Renewable Energy Directive and member state policies reward biofuels made from waste and residues. Most biofuel growth in Europe is also for renewable diesel and biojet. Singapore and China are also expanding renewable diesel and biojet production from waste and residues to serve the European and US markets.

Global biofuel production by feedstock type in the main case, 2010-2027

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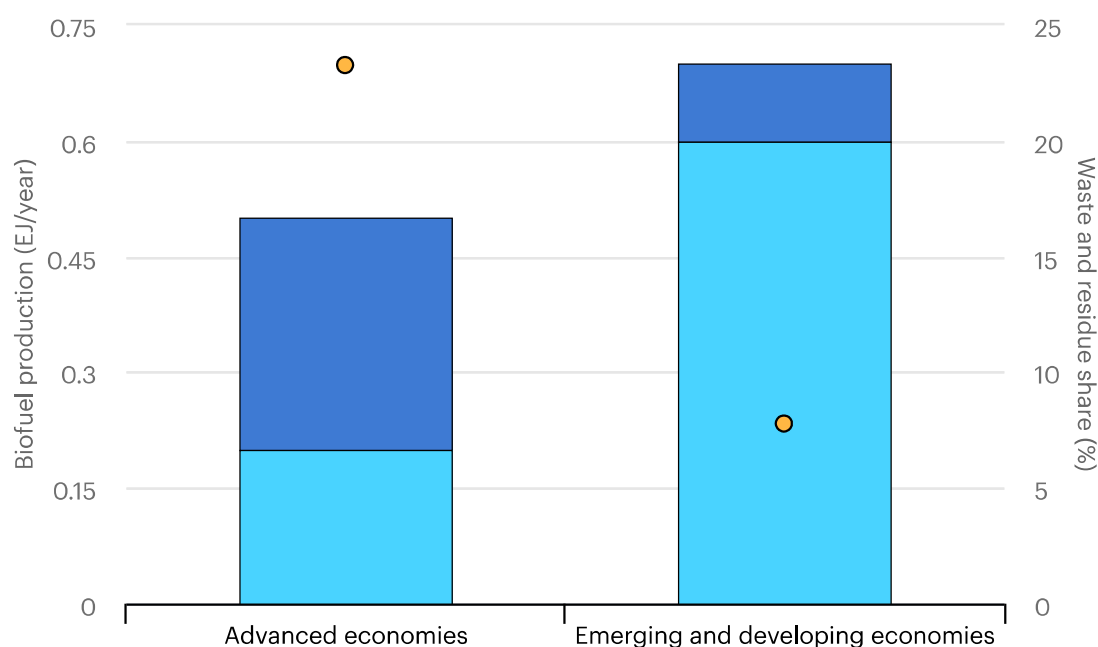
EJ / year



● Crop ● Waste and residues

Global biofuel production growth by feedstock type in the main case, 2022-2027

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● Crop ● Waste and residue ● 2027 waste and residue share

Unprecedented demand growth is straining supply chains, but government policies and innovation may yet provide relief. Demand for waste and residue oils and fats is expected to nearly exhaust supplies of the most readily available sources by 2027. In advanced economies, supply limits are prompting biodiesel, renewable diesel and biojet producers to secure conventional vegetable oils such soybean oil and rapeseed oil. Vegetable oil supplies dedicated to biofuel production expand to 23% from 17% over the forecast period. However, higher prices due to strong demand will prompt companies and governments to improve

feedstock supply chains, seek out new supplies and develop new techniques. Policies and innovation can also help unlock untapped supplies and support technology development, enabling the use of more widely available feedstocks for sustainable biofuel production.

Heating with renewables grows but not fast enough to contain fossil fuel use

Modern renewable consumption for heating purposes is expected to increase by almost one-third during 2022-2027, raising the modern use of renewables in heat from 11% to 14% by 2027. Renewable heat currently benefits from policy momentum, in particular in the European Union, in response to the energy security concerns fuelled by the current energy crisis. In both the industry and buildings sectors, the combination of rising shares of renewables in the power sector and greater reliance on electricity for heating, including through heat pumps, makes the largest contribution to renewable heat uptake. Nevertheless, renewable heat developments are insufficient to contain fossil fuel-based heat consumption.

Next Renewable electricity