

Delivering on the UAE Consensus

TRACKING PROGRESS TOWARD
TRIPLING RENEWABLE ENERGY CAPACITY AND
DOUBLING ENERGY EFFICIENCY BY 2030



THE UAE CONSENSUS

COP28 delivered the historic UAE Consensus, an ambitious negotiated response to the First Global Stocktake charting progress against the Paris Agreement. It includes unprecedented language around transitioning away from fossil fuels in a just, orderly and equitable manner. The negotiated text – agreed by 198 Parties in Dubai – also includes a number of global goals, such as calls for tripling renewable energy, halting deforestation and doubling energy efficiency by 2030.

In early 2024, IRENA was designated the Custodian Agency for tracking and reporting on two of these goals; this report is the third edition of a resultant annual series of reports charting global progress toward them:

II. A. 28. **Further recognizes** the need for deep, rapid and sustained reductions in greenhouse gas emissions in line with 1.5 °C pathways and **calls on** Parties to contribute to the following global efforts, in a nationally determined manner, taking into account the Paris Agreement and their different national circumstances, pathways and approaches:

(a) Tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030;

UNFCCC, Outcome of the First Global Stocktake, 2023.



Simon Stiell

Executive Secretary

*United Nations
Framework
Convention on
Climate Change*



With an all-time record of new renewable power capacity added in 2025, avoiding almost half a trillion US dollars in fossil fuel costs, IRENA's new data shows why the global energy transition is charging ahead - because it makes even more economic sense with each passing day, amid the ongoing fossil fuel cost chaos hitting households, businesses and national budgets.

But while the progress toward tripling renewable energy and doubling energy efficiency is encouraging, the world is still not moving quickly enough. Humanity is still burning colossal amounts of coal, oil and gas which is heating our climate and driving more frequent and intense natural disasters. These brutal climate-driven heatwaves, floods, and droughts are getting worse across all regions, wrecking lives, business and vital infrastructure, and driving up inflation on household basics, including food.

The task now is to scale up and speed up, turning pledges into greater real-world results. Many countries and communities need support to do this, so delivery of all finance commitments is essential, as are parallel efforts to build climate-resilience. Faster, fairer transitions to clean energy and climate resilience are the only way to stop economy-wrecking climate change. They're also the key to building stronger economies, creating millions of jobs, improving health, strengthening energy security, access and affordability.



UAE
CONSENSUS

COP28
UAE



United Nations
Climate Change



The 31st Conference of the Parties to the UNFCCC (COP31) will be hosted by Türkiye in Antalya from 9 to 20 November 2026. Building on the foundations of previous COPs – in particular COP30 in Belém – COP31 aims to advance dialogue, strengthen consensus and accelerate the implementation of the Paris Agreement.



The **International Renewable Energy Agency** (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future. The Agency serves as the principal platform for international co-operation, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. www.irena.org



The **Global Renewables Alliance** (GRA) was established by the Global Wind Energy Council, Global Solar Council, International Hydropower Association, Green Hydrogen Organisation, Long-Duration Energy Storage Council and the International Geothermal Association to unify these global bodies. Collectively we strengthen the private sector's voice on accelerating the energy transition, working to triple global renewable energy capacity by 2030 to at least 11 000 GW. www.globalrenewablesalliance.org



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DELIVERING ON THE UAE CONSENSUS



Francesco La Camera

Director-General, International Renewable Energy Agency



As the custodian agency tasked with monitoring global advancement toward the renewable power capacity and energy efficiency goals of the UAE Consensus, IRENA can report that steady and encouraging progress continued to be made in the deployment of renewable power in 2025. With 693 GW added worldwide, the year marks another record, representing a growth rate of 15.5%.

Whilst the projected gap to 11.2 TW in 2030 is closing, the tripling goal still requires average capacity additions to almost double in the remaining years to 2030. The lack of progress toward the complementary goal to deliver sustained improvements in energy efficiency also poses a considerable challenge. For the third consecutive year, energy efficiency improvement in 2025 was negligible. Consequently, the average annual rate of improvement required between 2026 and 2030 is now 5.6%, well beyond the 4% called for in the Outcome of the First Global Stocktake.

The historic UAE Consensus goals remain essential to our progress in meeting the ambitions of the Paris Agreement. However, this lack of progress in energy efficiency improvement, coupled with greater than anticipated energy demand and indications of a potential slowdown in capacity expansion, serve a stark reality check; the UAE Consensus goals may no longer be sufficient to keep the world on 1.5°C-compatible pathway.

Rapid end-use sector electrification is vital if we are to achieve the efficiency gains required, particularly in transport, heat, buildings and industry. Electrification can reduce overall final energy demand, even as consumption increases, while also accelerating decarbonisation; it is also absolutely essential that electrification is powered by renewable generation if we are to have any chance of meeting Paris Agreement goals.

However, grids have failed to expand and modernise to match the pace of renewable deployment, resulting in growing connection queues that have only been exacerbated by permitting bottlenecks. This consistent failure to deliver the upgraded infrastructure required, as repeatedly emphasised by IRENA analyses over several years, threatens to undermine the considerable opportunities for economic development, energy security and climate protection offered by renewable technologies.

Lack of appropriate infrastructure directly undermines the UAE Consensus goals, as it serves to discourage the renewable capacity expansion required. Simply put, the decisions taken today, the vital discussions ahead of and throughout COP 31, and the actions taken as a result, will determine the success of the global energy transition and the subsequent delivery of the global climate agenda.

BUILDING MOMENTUM FOR A 35% BY 2035 ELECTRIFICATION TARGET AT COP31



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Murat Kurum President-Designate, COP31



The transition is moving forward swiftly, but progress remains unequal. COP31 will be a critical moment for targeted interventions to address the shortcomings identified in this report.

On the one hand, many indicators are greatly encouraging. Renewables are booming and the gap to hit the Global Stocktake's renewables target is narrowing. In the last two years we have closed the projected shortfall from 1.5 TW to only 600 GW. Renewables, particularly solar, remain the most cost-competitive source of new electricity in most markets, with 90% of newly commissioned capacity costing less than the cheapest new fossil fuel alternatives.

At a time of volatile and insecure global energy markets, the social and economic benefits of the clean energy transition are much needed. Renewables are already delivering tangible economic benefits while contributing to greater energy security and resilience. This proves that global cooperation can produce results that improve peoples' lives.

However, not all the data is tracking in the right direction, which threatens the overall mission. Progress is uneven, as the high cost of capital in emerging and developing markets is still stifling investment. Energy efficiency improvements and infrastructure investments are some of the most concerning laggards. Far more is needed to decarbonise buildings, transport and industry.

Uneven progress and a two-speed transition with many left behind threaten global security. Furthermore, if we do not have grids to absorb renewable power, new projects will get stuck in the queue to connect. If we do not improve energy efficiency then new capacity will be swallowed up by increased demand. Something needs to change.

For the COP31 Presidency, electrification is at the core of our agenda to address many of the issues identified in this report. Electrification provides multiple co-benefits. It vastly enhances energy efficiency. It improves air quality and health outcomes. And it reduces dependency on volatile global energy markets. By addressing final energy consumption, it also completes the energy transition architecture, complementing power generation, distribution and efficiency.

Past COPs have used science-based targets to bring together global actors to drive progress. They allow us to agree what good looks like, track delivery, and give policy makers a chance to correct course when we identify that progress is uneven. This report itself is a prime example of the power of a collective target as an agent of change.

At COP31 in Antalya, we will advance our global electrification objective, supported by IRENA's analysis, to increase the share of electricity in global final energy consumption to 35% by 2035. COP31 will provide a critical moment to translate ambition into implementation. It will be equally important to ensure that progress reflects the diversity of national contexts and development pathways, while supporting a just, inclusive and affordable energy transition.

Progress to electrify buildings, transport and industry, as well as on resilient grids and finance will all be critical components of the COP31 Action Agenda. Through the COP31 electrification outcomes, we will work with partners to strengthen international cooperation, share knowledge, support implementation and review collective progress towards our global electrification objective.

We are therefore issuing a global invitation for all actors to align behind this target, come to Antalya ready to share their solutions, and build global momentum to meet our collective goals.



ELECTRIFICATION POWERED BY CLEAN ENERGY IS KEY TO ACHIEVING GLOBAL CLIMATE GOALS



Chris Bowen**President of Negotiations for COP31,
Minister for Climate Change and Energy, Australia**

Electrification will be a fundamental part of meeting global goals for climate action. As we face the hottest decade on record and intensifying climate impacts, acting together is becoming more urgent.

This report is an important update. It makes clear that although the world is progressing towards our 2030 renewable energy goals, more progress is needed and at a faster pace.

As COP31 President of Negotiations, Australia has heard clearly from countries, investors and industry that electrification is one of the most cost-effective ways to strengthen energy security, expand energy access and cut emissions. Around the world, countries are recognising that electrification addresses several challenges and that electrified economies, powered by clean electricity and backed by modern grids, will be successful in future.



Electrification is key to the UAE Consensus. The shift to more efficient electric technologies improves energy efficiency across economies. It also creates a powerful demand signal for investment, driving the capital required to build and scale the grids, storage and reliable electricity systems that underpin modern economies.

The economics are compelling, and markets have backed the transition with trillions of dollars of investment in clean energy. As enabling technology extends to transport, buildings and industry, electrification becomes a practical pathway to lower energy costs, improve productivity and access to reliable energy, and reduce emissions at the same time. These gains are making electrification an appealing reform across many national circumstances.

The COP28 pledge laid out a clear path forward. IRENA's report shows the distance we still must close by 2030, but all the technology we need is available to us today. We can reduce demand through energy efficiency, diversify supply through renewable energy, and strengthen energy security through electrification.

In Australia, we are living the clean energy transition, proving it works with households leading the charge. Australia has world-leading uptake of rooftop solar and home batteries, with electric vehicle sales overtaking petrol cars for the first time in August. IRENA underscores the importance of more investment in modern grids, battery storage, system flexibility and clean, efficient renewables to meet our global 2030 goals. That's why Australia is working closely with Türkiye to make COP31 an 'Electrification COP'.

P A C I F I C
PRECOP31
F I J I / T U V A L U

FROM COMMITMENT TO IMPLEMENTATION: THE WINDOW IS CLOSING



Ben Backwell
Chair, Global Renewables Alliance

The ongoing crunch on oil and gas supplies caused by the military confrontation in the Strait of Hormuz marks a decisive tipping point for the global energy transition. A combination of improved economics and policy action has added impetus to an already accelerating trend, as countries – particularly in Asia and Europe – face price spikes in key energy sources and move to rapidly reduce their dependence on imported fossil fuels. In 2025, renewable power capacity grew by a record 692 GW, proving that clean energy is not just viable but unstoppable. Renewables saved the global economy USD 480 billion in fossil fuel costs last year alone, underscoring their role as the bedrock of energy security and economic stability. Yet, for all this progress, we are still not on track to triple renewable capacity to 11.2 TW by 2030.



Encouragingly, the predicted 2030 gap is narrowing – from 1.49 TW in 2024 to 0.6 TW today – but the challenge of building out the transition at the required pace continues. To meet the 3X target, we must double annual additions of renewable technologies over the next four years. This is achievable: the manufacturing capacity exists and the economics are irrefutable; but deployment must accelerate now, particularly in emerging markets and developing economies, where financing costs and policy barriers remain stubborn obstacles.

The stakes could not be higher. Renewables are already the cheapest and fastest to deploy source of new electricity in most of the world, and their expansion is transforming security and affordability from Pakistan to Africa. Yet, grid congestion, permitting delays and inadequate investment in transmission infrastructure threaten to slow progress further. The disconnect between ambition and action is stark: while terawatts of renewable projects sit in late-stage development queues, the window to deploy them in time is closing.

Three priorities must guide us forward: first, policy must try to evolve at the pace of technology. Streamlining permitting, reforming interconnection queues, and aligning national targets are non-negotiable. Second, finance must flow where it is needed most. Public and private sectors must collaborate to de-risk investments and unlock trillions in renewable potential. Third, grids and storage must keep pace with deployment. Without modernised infrastructure, curtailment will rise, and the full benefits of renewables will remain out of reach.

We must also unite to communicate what the tripling goal means for people and economies. It means jobs, lower and more stable energy costs, stronger energy security, investment and economic growth. These are not future benefits. They are already being delivered.

The tripling goal is within reach, but only if we act with clarity, speed, and solidarity. COP31 must be the moment where leaders move from commitment to implementation, demonstrating that multilateralism can deliver a just and equitable transition.



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KEY FINDINGS

RENEWABLE POWER CAPACITY

3X

Tripling
by 2030
requires:

+1 204 GW/yr
2026-2030

+16.7%
annual
growth

2025

+693 GW

+15.5%
growth
2025

(0.4 percentage
points more
than in 2024)

Solar PV



+512.7 GW
added in 2025

Total

2 388 GW

Wind energy



+158.4 GW
added in 2025

1 291 GW

Hydropower



+18.3 GW
excluding
pumped hydro

1 296 GW

Bioenergy



+2.9 GW
added in 2025

155 GW

Geothermal,
CSP and Marine



+1.1 GW
combined added
in 2025

24.5 GW

ENERGY EFFICIENCY

1.7% energy intensity
improvement
rate in 2025

**UAE
CONSENSUS**

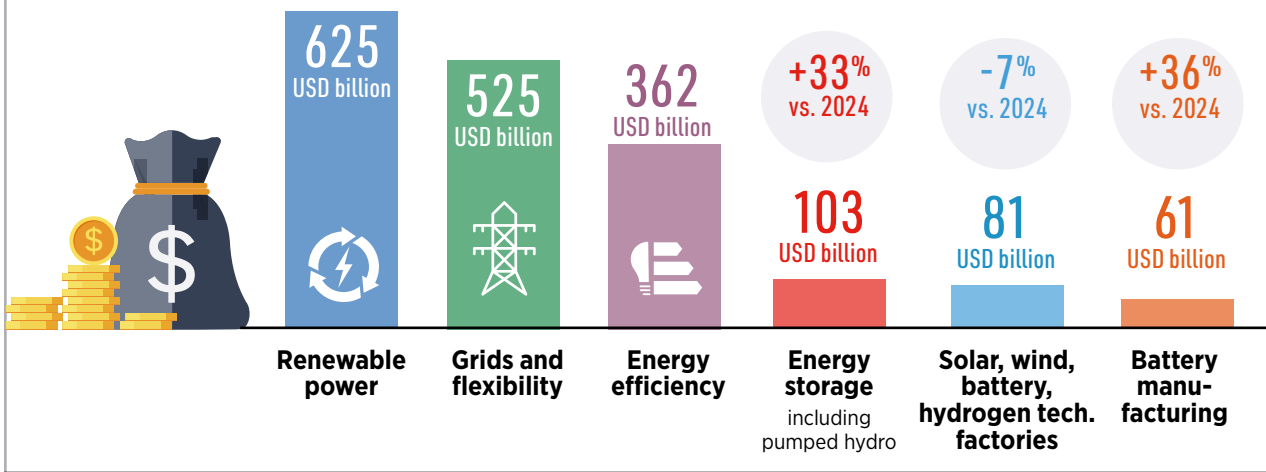
requires 4%
improvement each
year in 2023–2030

**14.1
million**

residential
heat pumps
sold in 2025
(-2% vs. 2024)



INVESTMENT IN 2025



Notes: CSP = concentrated solar power; EVs = electric vehicles; GW = gigawatts; GWh = gigawatt hour; MW = megawatt; NDCs = nationally determined contributions; PV = photovoltaic; RE = renewable energy; yr = year.

COST AND EMISSIONS IN 2025

8.4
gigatonnesof carbon dioxide
(CO₂) emissions
avoided thanks to
renewables480
USD billionin fossil-fuel
costs avoided
in 2025Renewable generation in
Indonesia, Thailand and the
Philippines displaced5.7
USD billion
in coal and gas

ENERGY STORAGE 2025

+112 GW

(around 307 GWh) of
battery storage capacity added48%
more than
in 2024

Breakdown of capacity additions in 2025

61 GW

China

18 GW

United
States

16 GW

Europe

17 GW

Rest of
worldBattery storage costs
in 2025:140
USD/kWh

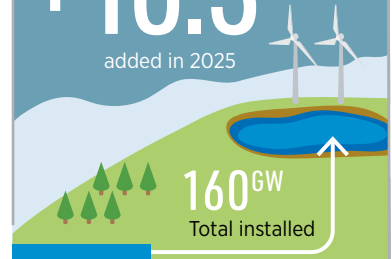
2024-2025

-30%

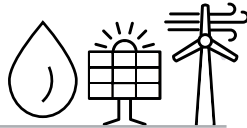
2010-2025

-95%

Pumped hydro storage capacity:

+10.3 GW
added in 2025160 GW
Total installed

FOCUS AFRICA

+11.3 GW
added in 2025

+1.9 GW

North Africa

East Africa
capacity grew
by 42% to a
total of 18.7 GW

+5.6 GW

+0.4 GW

Central and
West Africa
combined

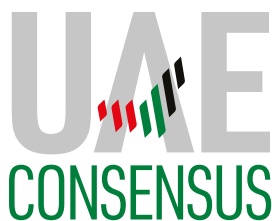
Southern Africa

+3.5 GW

NDC 3.0

120 parties submitted
NDC 3.0106 mention increasing
renewable power
capacity108 mention
energy
efficiency67% have a quantifiable
renewable energy target43% have a quantifiable
energy efficiency targetEVs accounted for a record 26%
of global new car sales in 2025

ACTIONS FOR POLICY MAKERS



Delivering the UAE Consensus goals by 2030 will require a marked acceleration in implementation over the remainder of the decade. Renewable power deployment needs to move from the record 693 GW added in 2025 towards average annual additions of around 1.2 TW between 2026 and 2030, while progress on energy efficiency must accelerate substantially. Achieving this scale of change will depend not only on faster technology deployment but also on the investment, infrastructure, policy frameworks, supply chains and skills required to support it.

ACCELERATE RENEWABLE POWER DEPLOYMENT AND ENERGY EFFICIENCY

- **Accelerate renewable power deployment across all major technologies to close the gap to the 2030 tripling goal.** Policy makers must support streamlined permitting, strengthen project pipelines and address implementation bottlenecks, while incentivising a diversified renewable technology mix.
- **Strengthen energy efficiency action across buildings, transport and industry to restore progress towards the 2030 goal.** This requires stronger performance and appliance standards, building codes, renovation programmes and industrial energy-management measures, and the promotion of electric vehicles.
- **Adopt integrated energy planning approaches to advance efficient electrification in parallel with renewable power expansion.** Power-system, end-use and enabling infrastructure planning must become increasingly integrated.

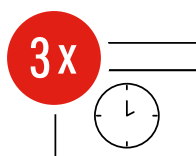
MOBILISE INVESTMENT AND REDUCE CAPITAL COSTS

- **Scale up investment in renewable power, energy efficiency, grids and flexibility.** Policy makers should focus on converting targets into investable project pipelines, improving the financial position of off-takers and mobilising private capital at the scale required through 2030.
- **Reduce financing costs in emerging markets and developing economies through targeted de-risking, guarantees and concessional finance.** Country-level risks – including sovereign, currency, policy and regulatory risks – are key barriers to the scale up of deployment in these markets.
- **Strengthen investable project pipelines and improve the financial viability of off-takers to mobilise private capital.** Bankable projects require transparent procurement frameworks, reliable sources of income and stronger institutional capacity.

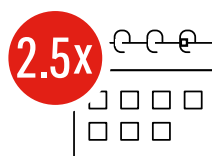


POWER SYSTEM FLEXIBILITY NEEDS BY 2030 COMPARED TO 2019:

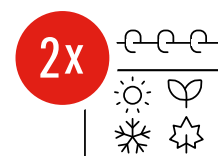
QUICKFACT



daily
flexibility



weekly
flexibility



seasonal
flexibility

EXPAND, MODERNISE AND MAKE BETTER USE OF ELECTRICITY GRIDS

- **Speed up grid expansion, modernisation, reinforcement and permitting to keep pace with renewables deployment and electrification**, in addition to addressing historical under-investment in grids in some regions.
- **Release existing grid capacity through grid enhancing technologies (e.g. dynamic line rating, advanced conductors), digitalisation and flexible connection arrangements** in order to reduce connection delays and limit curtailment.
- **Support hybrid renewable configurations through regulatory frameworks that allow co-location of storage with wind and solar, and shared connection agreements.**

SCALE FLEXIBILITY THROUGH A PORTFOLIO OF SOLUTIONS

- **Set targets and remuneration frameworks that incentivise the scaling of energy storage alongside demand response, sector coupling, interconnections, and dispatchable renewable generation, including hydropower.**
- **Design flexibility strategies around system-specific daily, weekly and seasonal requirements.** Planning and market frameworks should recognise and appropriately value the different services provided by flexibility resources.
- **Enable demand to respond more actively to power-system conditions.** Smart charging, demand response, digital energy management and time-responsive tariffs can relieve peak pressures, reduce curtailment and enhance renewable integration.



ENHANCE POLICY, MARKET AND REGULATORY STRUCTURES

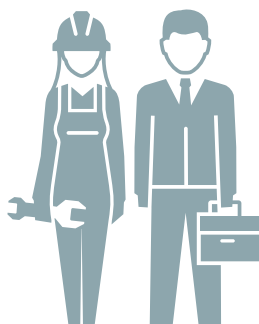
- **Integrate renewable energy deployment into cross-government economic, social and industrial planning.** Governments should co-ordinate energy, industry, finance, labour, environmental, health and social policies to strengthen energy security and resilience; competitiveness; local value creation; employment; affordability and public health, ensuring that the benefits of the transition are broadly shared.
- **Provide stable, credible and long-term policy signals for renewables, energy efficiency and electrification.** These can help to reduce investor uncertainty and accelerate implementation across the energy transition.
- **Translate the UAE Consensus into clearer and more measurable national targets and implementation frameworks including through Nationally Appropriate Mitigation Actions (NAMAs), Nationally Determined Contributions (NDCs) and national energy plans.**
- **Ensure market-based mechanisms in power markets are carefully sequenced with grid readiness, enhanced regulatory frameworks and adequate consumer safeguards to support renewable energy deployment and integration.**
- **Where barriers remain, targeted support should continue, but support mechanisms should be adapted to the maturity of technologies and markets.** Emerging technologies, less-developed markets, smaller actors and vulnerable consumers may still need targeted policy and financial support.

ACCELERATE RENEWABLE-BASED ELECTRIFICATION

- **Determine clear long-term policy signals on EV deployment and speed up the roll-out of charging infrastructure.** This should be complemented by targeted financial support where high up-front costs remain a barrier, especially for lower-income consumers.
- **Speed up building retrofits and efficient electrification of heating and cooling, with targeted support where affordability is still a barrier.** Building codes, efficiency standards, renovation policies and targeted incentives must work together.
- **Deploy the most appropriate low-carbon solutions for industrial processes, with direct electrification as one of the main decarbonisation routes alongside green hydrogen, renewable heat and sustainable biofuels.**

BUILD RESILIENT AND COMPETITIVE SUPPLY CHAINS

- **Strengthen supply chain resilience across critical material processing, manufacturing and renewable energy technology value chains.** Policy makers should mitigate concentration risks while recognising that upstream resource availability is often geographically determined, and is a source of local development.



- **Avoid measures that unnecessarily restrict the availability or affordability of transition technologies.** Trade and industrial policies should be carefully designed to consider their impacts on supply security, deployment costs, domestic value creation and speed of renewable expansion.
- **Promote competitive and sustainable manufacturing markets.** Industrial policies must balance resilience and diversification goals with the necessity of keeping competitive technology costs and avoiding unnecessary duplication of capacity.

BUILD THE WORKFORCE NEEDED FOR RAPID IMPLEMENTATION

- **Scale education and training measures to meet the growing needs of the energy transition workforce.** Integrate skilling priorities into energy and climate plans and policies, and invest in skilling and upskilling pathways including degrees, technical and vocational education and training (TVET), trade certifications and micro-credentials.
- **Address current and emerging skills gaps across the renewable energy value chain.** Digital skills will be important for an increasingly digitalised energy transition while bridging the growing digital divide.

- **Integrate inclusion and accessibility in workforce development.** Implement measures to ensure the meaningful participation of women, young people, persons with disabilities, minorities and other under-represented groups.
- **Strengthen public-private collaboration in education and training.** Foster co-operation between government, industry, education and other stakeholders to increase financing, implement training standards and harmonise qualifications, and improve the quality and availability of training provisions.

DIGITALISATION, ARTIFICIAL INTELLIGENCE AND THE ENERGY TRANSITION

- **Leverage digitalisation and AI to enhance forecasting, congestion management, system operation and renewable integration.** Digital instruments can help to make better use of existing infrastructure, while enhancing reliability and responsiveness across increasingly complex power systems.
- **Enable flexible and grid-responsive operation of data centres, supported by clear criteria for renewable additionality, temporal and geographical matching.** Good siting and co-location with renewables and storage and flexible operation can help minimise network constraints and support system integration.

RENEWABLE POWER AND ENERGY EFFICIENCY

01

RENEWABLE POWER

The tripling of global installed renewable power capacity to reach 11.2 terawatts (TW) by 2030 compared to the base year of 2022 requires average additions of around 1.20 TW each year between 2026 and 2030.

The compound annual growth rate (CAGR) required during this period to meet the tripling goal is 16.7%, up slightly from the 16.6% annual growth trajectory projected in IRENA's 2025 analysis.

By the end of 2025, global installed renewable power capacity had reached 5.15 TW (IRENA, 2026a). During 2025 alone, 693 gigawatts (GW) of new renewable power capacity was added, representing an annual growth rate of just over 15.5% – an increase of 0.4 percentage points compared with the 15.1% growth seen in 2024. Despite this progress, capacity growth still falls short of the trajectory required to achieve the tripling target by 2030, as illustrated in Figure 1. If the growth rate recorded in 2025 were maintained over the remaining years of this decade, global installed renewable power capacity would reach 10.6 TW by end-2030, leaving a shortfall of approximately 0.6 TW relative to the target. This gap is closing, having fallen from the 0.9 TW calculated in the 2025 edition of this report (IRENA, 2026a; IRENA *et al.* 2025).

However, over the remaining five years of this decade, approximately 6.02 TW of additional renewable power capacity is required. This equates to net average additions of around 1.2 TW per year, compared to the 693 GW added in 2025. Delivering this scale of deployment would mark a major structural shift in the global power system. Under this pathway, variable renewable technologies would overtake total fossil fuel capacity by 2030, and account for around 62% of total installed power capacity – comprising approximately 42% solar PV and 20% wind – up from around 35% in 2025.

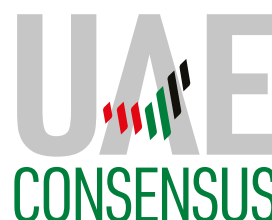
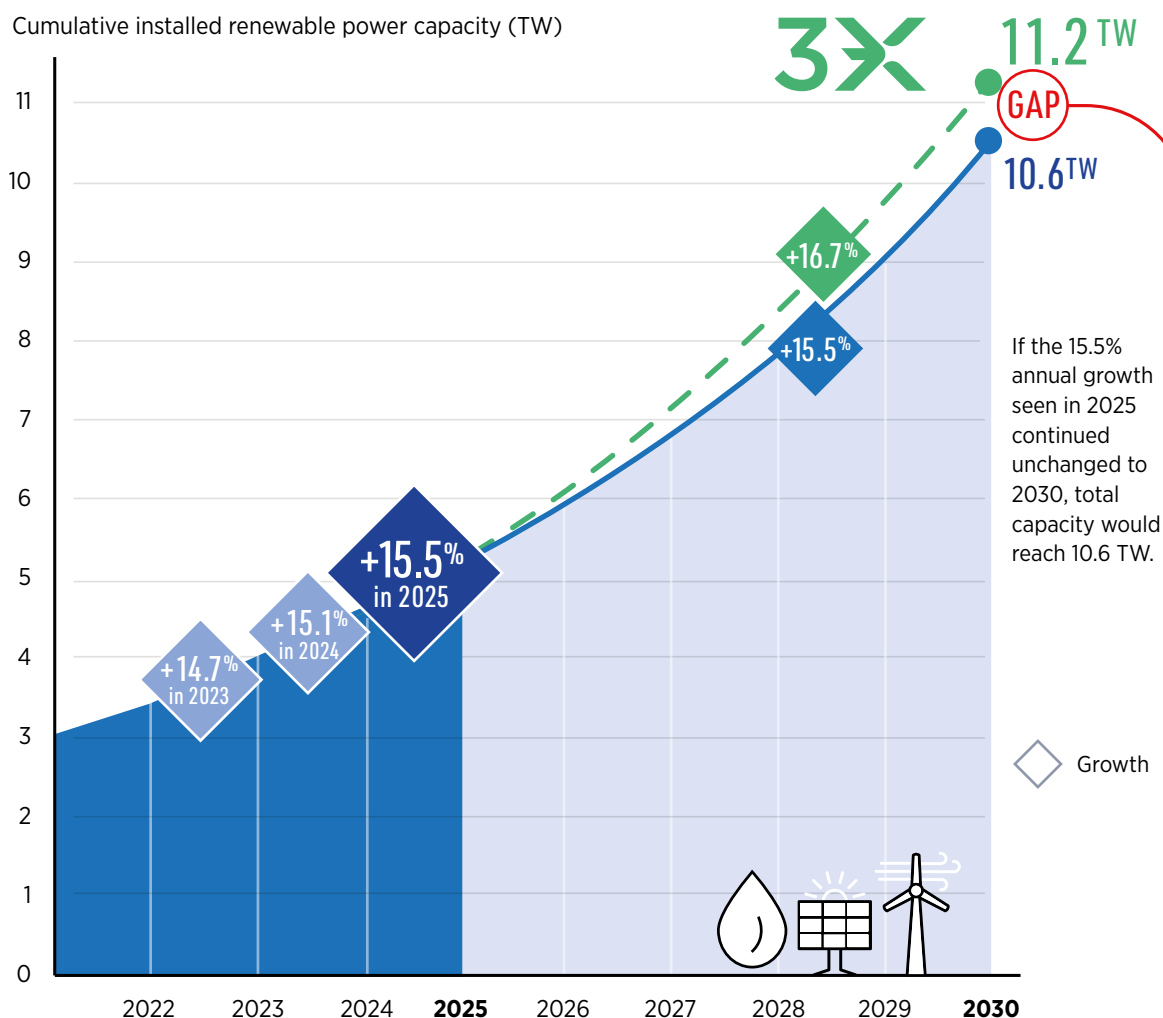
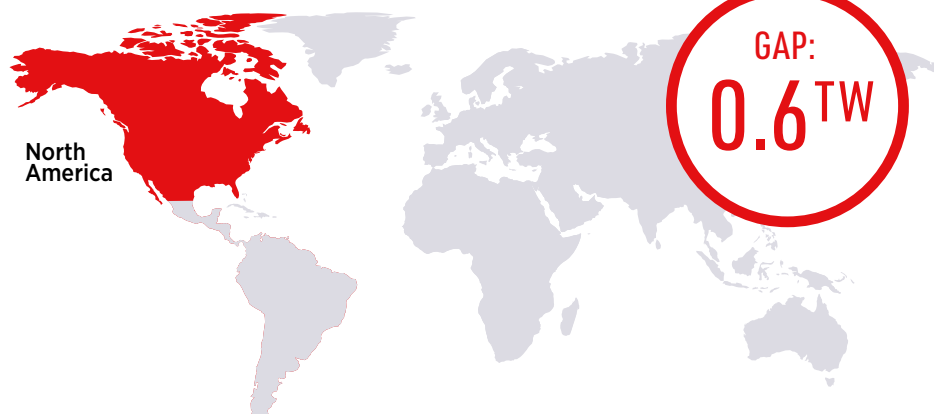


FIGURE 1 Closing the gap



The 0.6 TW gap is equivalent to approximately the combined 2024 year-end cumulative installed renewable power capacity of North America (612 GW):

PATHWAY
TO 1.5°C
2030



Note: TW = terawatts.

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Solar Photovoltaic (PV) was the largest source of installed renewable capacity in 2025, accounting for 46.3% of the global total (2 388 GW), followed by hydropower at 25.1% (1 296 GW), wind at 25% (1 291 GW), bioenergy at 3% (155 GW), geothermal at 0.3% (16 GW), and concentrated solar power (CSP) at 0.2% (8 GW), alongside a small contribution from marine energy (IRENA, 2026a).



Around three quarters of the new capacity added in 2025 was in the form of solar PV (513 GW; 12% more than the capacity added in 2024), which represented the highest annual addition of any renewable power technology in a single year. This was followed by wind energy, with an addition of 158 GW (150 GW in the form of onshore wind). Variable renewable energy accounted for 96.9% of all net renewable additions in 2025. Renewable hydropower capacity (which excludes pumped hydro) increased by 18 GW, while bioenergy, geothermal, concentrated solar power (CSP) and marine energy combined rose by approximately 4 GW, with bioenergy accounting for 72% of this (IRENA, 2026a).

The revised IRENA 1.5°C Scenario

Since the call on all Parties to the UNFCCC to contribute to global efforts to triple renewable energy capacity by 2030 within the Outcome of the First Global Stocktake in 2023, and as the designated Custodian Agency for tracking global developments to this end, IRENA has consistently assessed progress against a quantitative target of 11 174 GW. This was derived from the Agency's analytical pathway drawn from the *World Energy Transition Outlook* that formed the statistical basis of the COP 28 ambition. The rounded, 11.2 TW benchmark is retained in this report series to ensure continuity in assessing progress towards the original tripling goal.

Since COP28, however, IRENA's long-term scenarios have been updated to reflect recent developments in energy systems, technology and related policy. Where the report refers to IRENA's 'revised 1.5°C Scenario', these references should not be interpreted as a revision of the established tripling benchmark; rather, they reflect the revised 1.5°C Scenario that will feature in the forthcoming *World Energy Transition Outlook 2026*.



Solar PV technology is experiencing consecutive, record-breaking installation rates. This remarkable deployment has established solar PV technology as the backbone of the global energy transition. Yet, capacity must double in the 2026–2030 period compared to the 2025 level to deliver the cumulative capacity required by 2030 to meet the UAE Consensus goal. This is feasible, given the shorter permitting period, widespread public acceptance, mature supply chain and ultimate cost-competitiveness of the technology. However, achieving the target will require agile policy evolution to match the momentum of solar deployment (IRENA, Forthcoming).

Global wind power capacity additions in 2025 set a new annual record, with 158 GW added during the year – 39% more than in 2024.* Whilst onshore wind capacity deployment continued to expand – from 106 GW added in 2024 to 150 GW added in 2025, representing a historic year-on-year growth of +42% – offshore wind capacity additions remained relatively unchanged at around 8 GW (+1.3% growth). Total global installed wind capacity reached 1 291 GW by end-2025; in the remaining years of the decade, an additional 2 243 GW of wind capacity is required to meet the UAE Consensus target in 2030, equating to average annual capacity additions of 449 GW in 2026–2030.

Global, cumulative installed hydropower capacity (excluding pumped hydro) grew by 1.4% in 2025, with 18.3 GW added during the course of the year to reach 1 296 GW. Following a downturn in 2024, annual capacity additions not only regained momentum in 2025 but surpassed the five-year rolling annual average of 17 GW. Hydropower is receiving increasing recognition among policy makers and power system operators as a fundamental pillar of energy security, system resilience and decarbonisation (IHA, 2026). However, the deployment remains below the trajectory required to meet the tripling goal. A net average annual addition of 34 GW of hydropower capacity is required each year to 2030, emphasising the need for faster permitting processes, stronger policy signals and accessible market frameworks for investors.



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* IRENA, like many other international organisations, uses the United Nations Statistical Commission's [International Recommendations for Energy Statistics \(IRES\)](#) as the basis for the collection of energy data. IRENA renewable power capacity data, specifically, reflects plants that are in commercial operation and are actively generating power as at 31 December for the respective reporting year, generally sourced from official materials provided by its Members.

Data obtained from other organisations and alternative sources such as trade bodies and industry associations – including industry installation data, order data and project pipelines – may show variations arising from different collection methods, reporting periods, definitions, methodologies, or the timing and frequency of data updates. Such variations between independently compiled datasets from different sources do not indicate errors in the underlying data of these sources or of IRENA's own official data.

FIGURE 2

TRACKING COP28 OUTCOMES: TRIPLING RENEWABLE POWER BY 2030

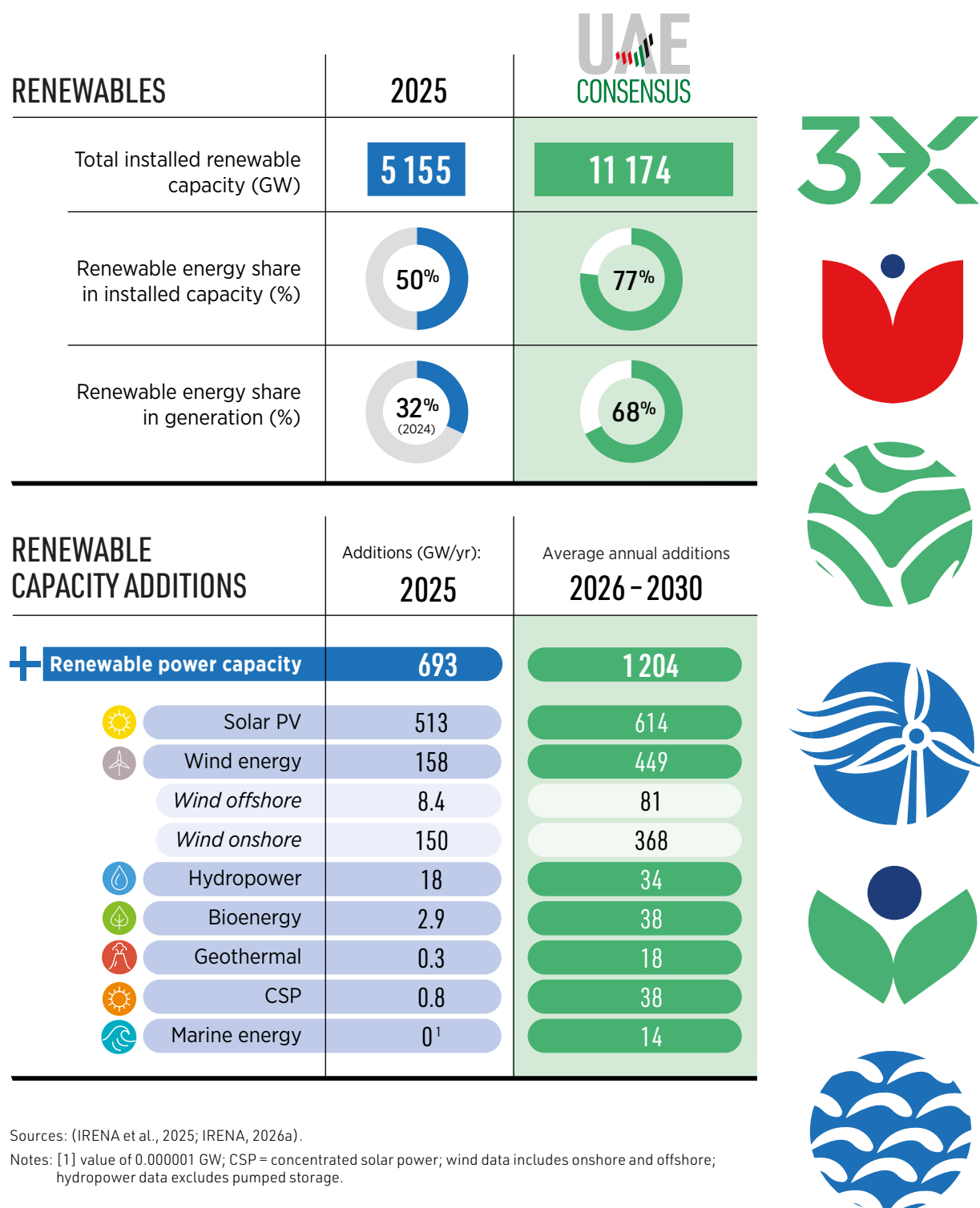
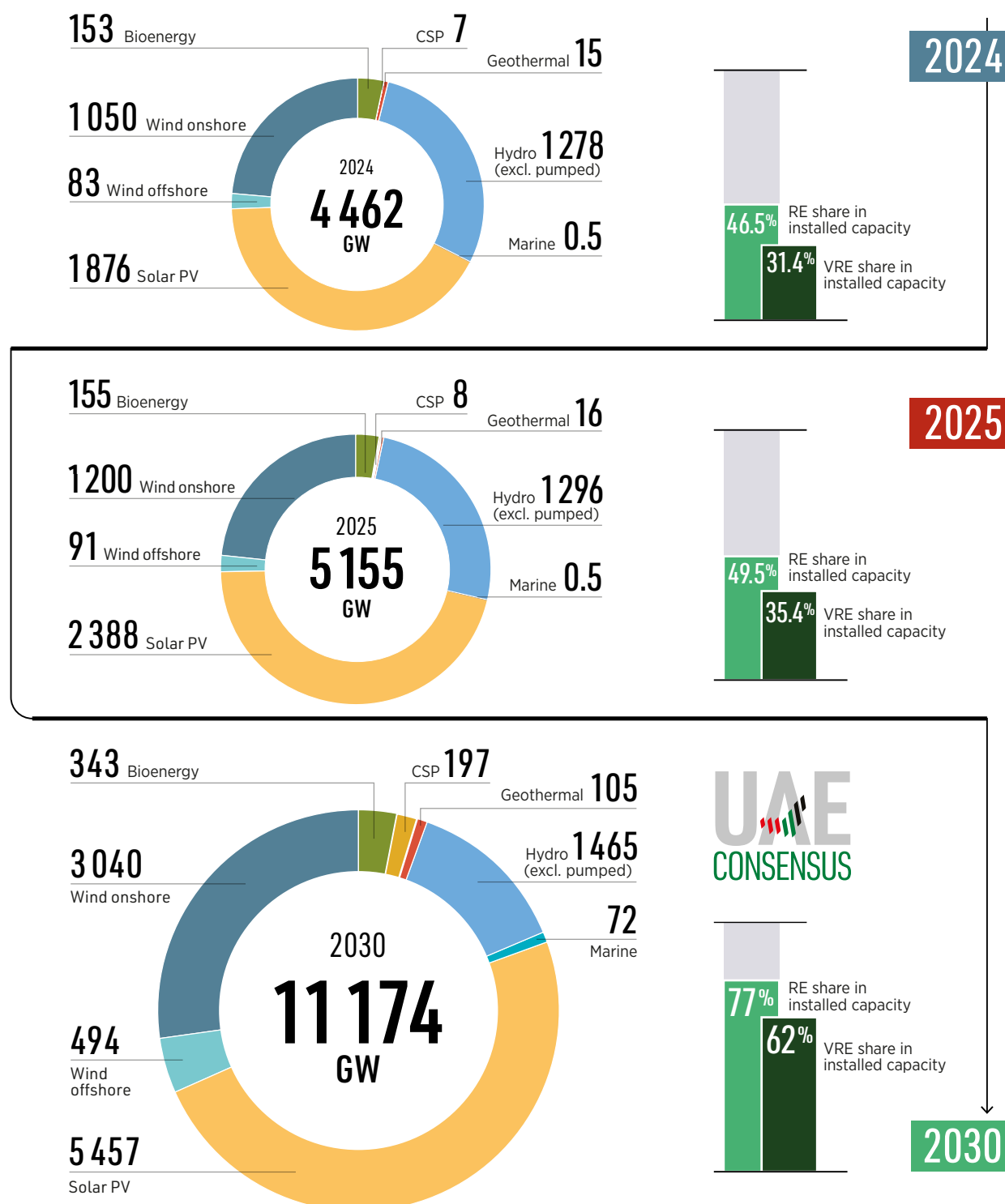


FIGURE 3 Global installed renewable power capacitySources: (IRENA *et al.*, 2025; IRENA, 2026a).

Notes: CSP = concentrated solar power; GW = gigawatt; PV = photovoltaic; RE = renewable energy; VRE = variable renewable energy; bioenergy includes biogas, biomass waste and biomass solid; hydropower data excludes pumped hydro; tripling target for the global installed capacity by 2030 is compared to 2022 status.

In 2025, 2.9 GW of bioenergy was added, bringing the cumulative installed capacity to 155 GW. Capacity additions experienced a drop of 39% in 2025 compared to the additions made in 2023 and 2024, and meeting the UAE Consensus target will require total bioenergy capacity to roughly double by 2030.

Geothermal, CSP and marine energy collectively accounted for 1.1 GW of new power capacity added in 2025. These technologies continue to play a niche role within the power sector, representing a relatively small share of installed capacity (a cumulative total of 24 GW), mainly owing to lack of policy support. Although these technologies can provide valuable dispatchable renewable electricity whilst enhancing system flexibility and resilience, their capacity growth has remained modest, undermining their potential contribution.

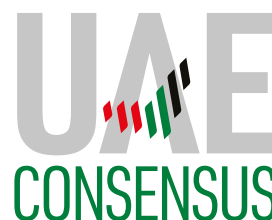
The geographic deployment of renewables remains highly uneven, with Asia, Europe and North America accounting for 86% of installed renewable power capacity at end-2025. The remaining 14% was shared by Africa, Central America and the Caribbean, South America, Eurasia, the Middle East and Oceania. Asia accounted for the majority of new capacity additions in 2025 (74%), increasing by 514 GW to reach 2 895 GW. Asia accounts for 56% of the global total. Europe's capacity expanded by 77 GW (9% growth year-on-year) to reach 18% of global capacity. Meanwhile, North America expanded by 42 GW (+7.4%). Africa experienced its largest growth on record, with 11.3 GW of additions (+15.9%), as did the Middle East at 29.2% (+12.8 GW) in 2025. Oceania's installed capacity increased by 6 GW (8.7% growth); Central America and the Caribbean expanded capacity by 9.5% (+1.8 GW); and South America continued its upward trend adding 20 GW (+6.3% year-on-year).

Renewable capacity additions in the Group of 20 (G20) nations¹ in 2025 reached 650 GW, raising the total capacity installed to 4.6 TW. This represents an annual growth rate of 16.3%, with the G20 accounting for 94% of global capacity additions in 2025. To meet the UAE Consensus target, total installed renewable power capacity in the G20 will need to double in the period 2026–2030 to reach 9.4 TW.

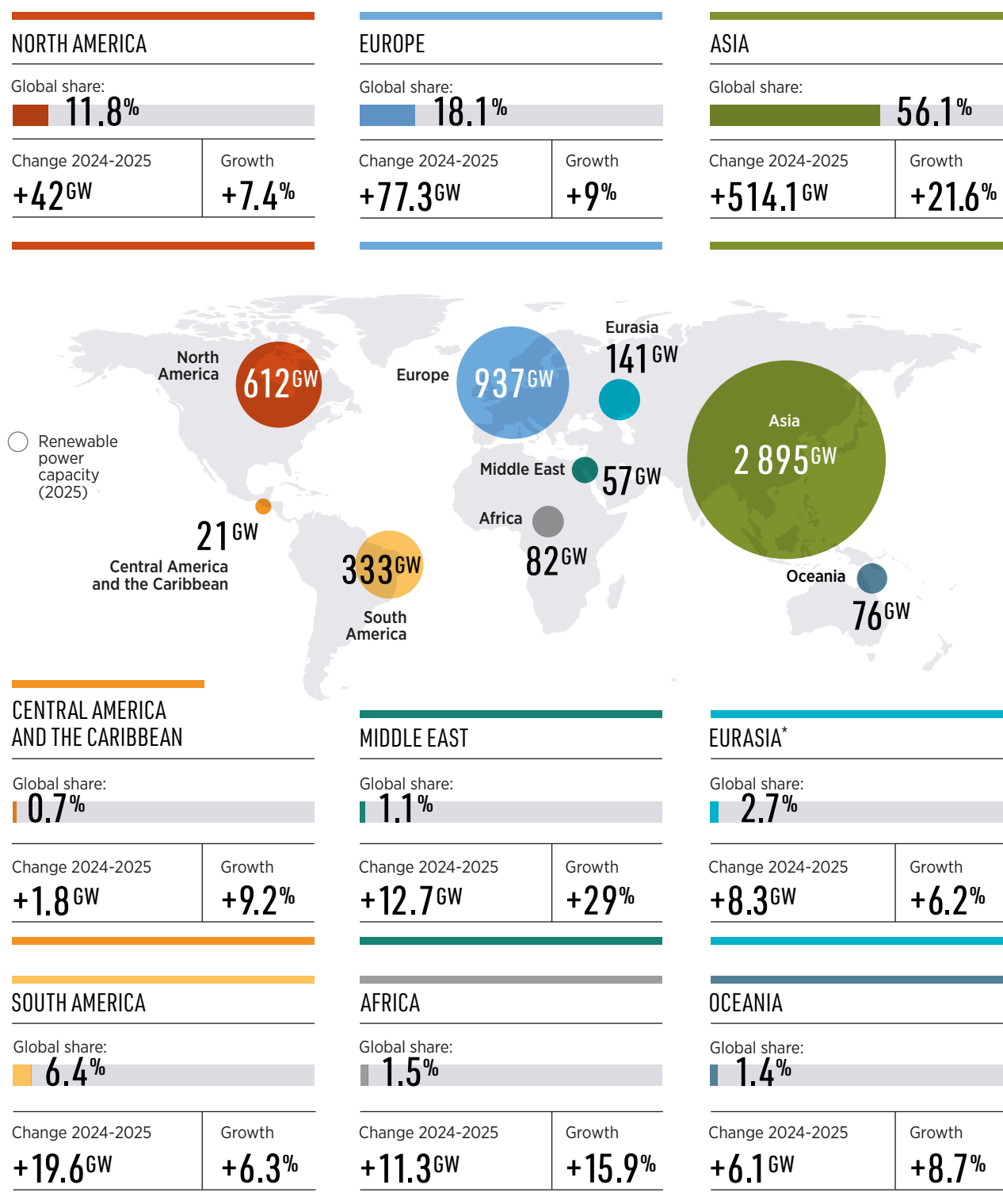
The Group of 7 (G7) must lead with collective ambition. G7 leadership on the 2030 goal requires renewable power capacity to reach 2 TW in 2030 (from 1.1 TW in 2025), accounting for 21% of global capacity.

The European Union (EU) is making strong progress in renewable power expansion. The EU-27 added 70 GW of new renewable power capacity in 2025, bringing the total installed to 779 GW – an increase of 10% compared to 2024. To reach the 1.3 TW required by the UAE Consensus goal by end-2030 will require average annual additions of 97 GW each year in the period 2026–2030.

¹ Includes South Africa but excludes other African Union countries.



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FIGURE 4 Renewable power capacity by region in 2025

Source: (IRENA, 2026a).

Notes: *Comprising Armenia, Azerbaijan, Georgia, Russian Federation and Türkiye; GW = gigawatt; GWh = gigawatt hour.

Disclaimer: These maps are provided for illustration purposes only. Boundaries and names shown on these maps do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

The Association of Southeast Asian Nations (ASEAN) added 11 GW of new renewable energy capacity in 2025, bringing its cumulative installed capacity to 125 GW. Capacity additions grew by 9% year-on-year from 2024 to 2025. Despite this encouraging growth, acceleration is needed, particularly in solar and wind. Renewable power capacity in the region must almost triple, to reach 370 GW by 2030, in order to meet the UAE Consensus goal. This would result in a renewable share of 57% by 2030, up from 34% in 2025.

The broader Asia-Pacific region added 510 GW of new renewable energy capacity in 2025, bringing its cumulative installed capacity to approximately 3 340 GW and representing an 18% year-on-year growth. The region accounted for almost 65% of global installed renewable capacity in 2025, and is expected to see further capacity growth at a compound annual rate (CAGR) of 17% between 2025 and 2030, consistent with the global trend.

BRICS economies² added 519 GW of new renewable energy capacity in 2025, bringing the total installed to 2 880 GW – an annual increase of 22%.

With 12.8 GW of new renewable installations in 2025, the Middle East region recorded its highest annual growth at 29.2%. Currently, the Middle East has around 57 GW of installed renewable power capacity – representing just above 1% of global installed renewable capacity. The region's share of renewable energy in total electricity capacity also rose, from 12% in 2024 to 14% at end-2025. The Middle East has a key role to play in achieving the tripling target; with abundant solar resources, growing energy demand and rising policy ambition, countries such as the United Arab Emirates, Saudi Arabia and Oman are scaling up investments in solar PV, wind and green hydrogen. Middle East power demand growth to 2030 will require six times the total installed renewable capacity in 2025 to meet its economic ambitions and the needs of its peoples. Building on its financial capacity, infrastructure and strategic location, the region can emerge as a hub for renewable generation and export, while also enhancing energy security and resilience in the face of regional tensions.

Africa experienced its largest growth on record, with 11.3 GW of renewable power capacity added in 2025. East Africa accounted for almost half of the total, adding 5.6 GW and expanding its installed capacity by 42% to 18.7 GW, and was followed by Southern Africa (which added 3.5 GW) and North Africa (which added 1.9 GW). Central and West Africa added less than 0.4 GW combined. Despite this encouraging progress, the region urgently requires more renewables to meet rising electricity demand and provide broader energy access.



² Brazil, China, Egypt, Ethiopia, India, Indonesia, Islamic Republic of Iran, Russian Federation, South Africa and the United Arab Emirates.



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Latin America is already a global leader in renewable energy capacity, with a renewable energy share in total installed capacity of around 74% in 2025, yet further growth is needed to accelerate the region's decarbonisation.

While South America has had a long-standing reliance on hydropower, with the diversification of its generation mix, solar and wind will drive future renewable growth. Central American countries accounted for around 14 GW of installed renewable capacity by the end of 2025.

Renewables remained the most cost-competitive source of new electricity in most markets in 2025, with 90% of newly commissioned utility-scale capacity delivering power at a lower cost than the cheapest, newly installed fossil fuel-based alternative (see Figure 4). Onshore wind remained the most affordable new power source, with a global weighted average levelised cost of electricity (LCOE) of USD 33 per megawatt hour (MWh), followed by solar PV at USD 44/MWh and offshore wind at USD 78/MWh. These global averages were significantly influenced by China, which accounted for most new renewable capacity in 2025, and which benefits from a structural cost advantage. If China is excluded, the global weighted-average LCOE was higher, year-on-year, at USD 55/MWh for solar PV (up 23%³), USD 51/MWh for onshore wind (up 55%), and USD 70/MWh for hydropower (up 13%), all of which remain lower than the average cost of new fossil fuel-fired power generation.

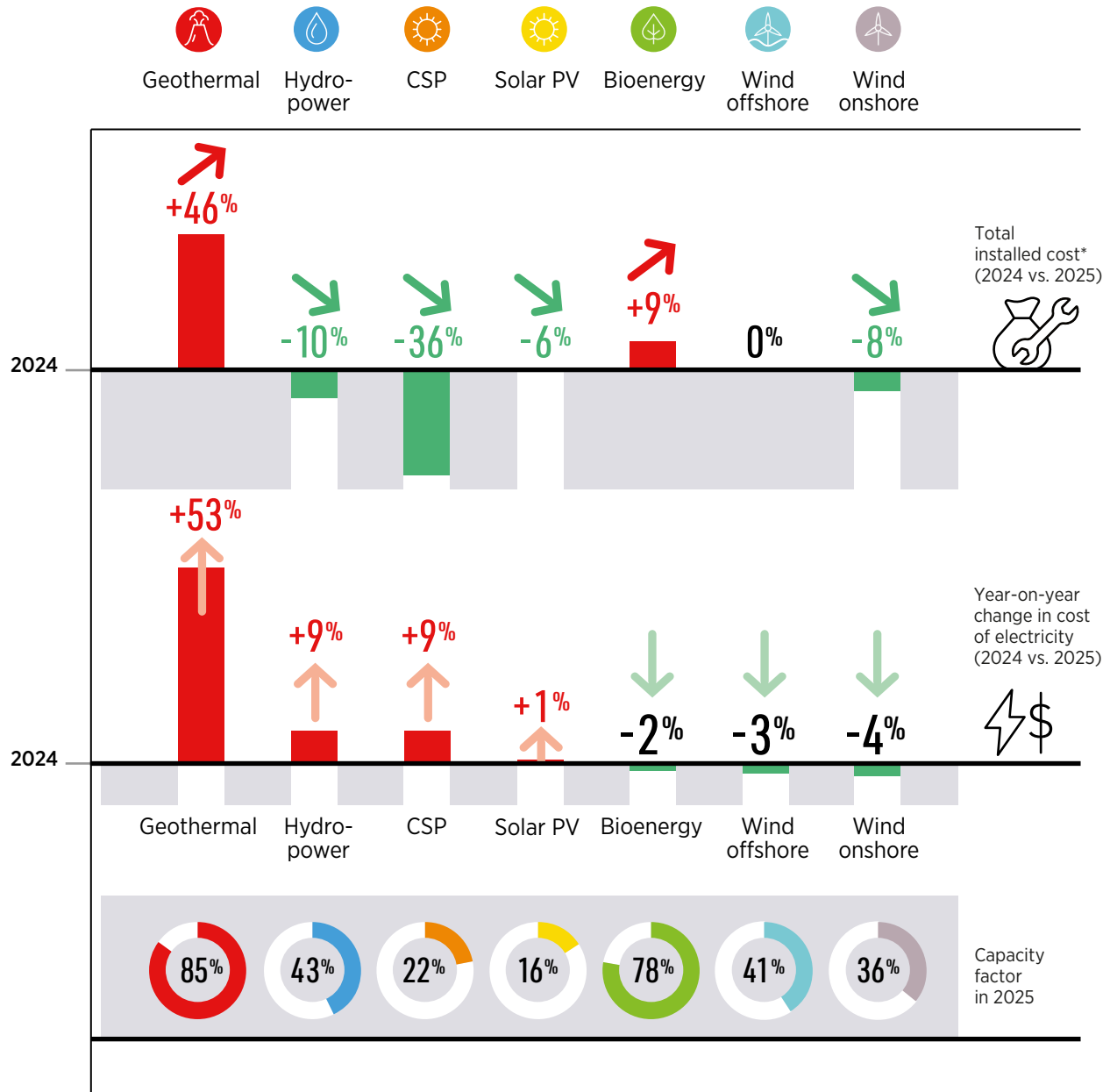
In contrast, most dispatchable renewable technologies⁴ recorded higher costs, with hydropower, geothermal and concentrated solar power rising to USD 62/MWh, USD 89/MWh and USD 115/MWh, respectively. Bioenergy was the exception in this group, with its cost declining to USD 86/MWh. The increase in the costs of most dispatchable renewables was driven by lower output, rather than changes in technology costs. Driving these changes were two opposing factors that largely offset each other: on the one hand, cheaper equipment and lower installed costs for renewable technologies; on the other, higher costs of capital combined with slightly lower capacity factors. (IRENA, 2026b).

Cost of capital remains the decisive differentiator between markets. Total installed costs (TICs) have fallen worldwide, yet LCOEs still differ widely between markets; financing and resource quality now explain much of that gap. IRENA data make the point directly: global average solar PV installed costs fell by around 6% in 2025, yet the LCOE of this technology remained unchanged. This was because a higher cost of capital offset the cheaper equipment and systems for solar PV and onshore wind, the difference in the cost of electricity is increasingly being determined by cost of capital and resource quality/geographic factors, rather than installed costs where variations have narrowed significantly. Indeed, some of the most significant cost differences have been driven more by where a project is built than by what is built.

³ These percentages show the increase in the global average when China is excluded and are calculated on unrounded values.

⁴ 'Dispatchable' renewables include those technologies that can be adjusted to meet demand when required, namely bioenergy, geothermal, hydropower and concentrated solar power.

FIGURE 5 Change in total installed cost, capacity factor and average cost of electricity for newly commissioned utility-scale renewable power in 2025



Source: (IRENA, 2026b).

* Total installed cost (TIC) is the 'overnight' capital cost of bringing a project into operation. It includes equipment, development and installation costs, but excludes financing costs (including interest during construction) and any allowance for the time value of money. It also excludes subsequent operating, maintenance, replacement and end-of-life decommissioning expenditures; CSP = concentrated solar power; PV = photovoltaic.

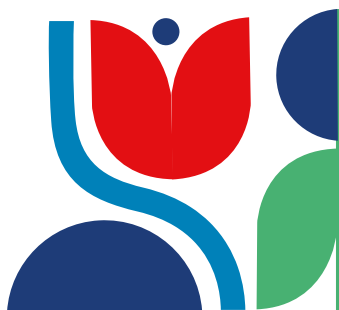


IRENA's cost-of-capital model suggests country-level conditions (sovereign default risk, the depth of local debt markets, currency and convertibility risk, policy and regulatory risk) and inflation explain about 56% of the variation in financing costs – roughly 2.3 times the share attributable to technology. The same technology can therefore cost far more to finance in an economy with higher perceived risk than in OECD countries. This impact is most significant for emerging markets and developing economies (EMDEs), where most new demand will arise. In these markets, the cost of capital – not the cost of technology – is the largest single driver of cost differences between markets, making targeted de-risking the critical lever.

Globally, the use of renewables avoided 8.4 gigatonnes of carbon dioxide (CO₂) emissions and USD 480 billion in fossil-fuel costs in 2025. Renewable power generation and energy efficiency are the ultimate means to achieve energy security. They provide predictability on costs, and insulate the power sector and consumers from fossil fuel price shocks, while improving the balance of trade for fossil fuel importing countries. As such – depending on electricity market design – they can significantly reduce the inflationary impacts of fossil fuel shocks on consumers.

The geographical distribution of these economic and environmental benefits closely mirrors the concentration of global renewable power generation. China reduced its fossil fuel imports by about USD 177 billion – representing around 37% of the total avoided costs in 2025; the country also avoided roughly 3.4 gigatonnes (Gt) of CO₂ emissions – around 40% of the global total. These numbers reflect both the scale of China's renewable fleet and the predominantly coal-based generation it displaces. Avoided costs and emissions in the United States in 2025 were around USD 35 billion and 761 million tonnes (Mt) of CO₂, respectively; Brazil avoided USD 32 billion and 432 Mt CO₂; India USD 18 billion and 451 Mt CO₂; Germany USD 18 billion and 215 Mt CO₂; and Japan USD 15 billion and 166 Mt CO₂.⁵

The costs of 'firm', around-the-clock renewable generation are beginning to undercut new gas-fired alternatives. At high-quality sites, IRENA findings show the levelised cost of solar-plus-storage at 95% reliability fell from above USD 100/MWh in 2020 to USD 54–82/MWh in 2025 (IRENA, 2026b). Further reductions in the region of 30% can be expected by 2030 and 40% by 2035. This would bring the best sites to a cost level below USD 50/MWh. Firm wind-plus-storage is generally more expensive, reflecting multi-day low-wind periods – although combining solar and wind lowers the cost of both. Large projects already demonstrate this approach: a complex at Al Dhafra in the United Arab Emirates is set to pair 5.2 GW of solar with 19 gigawatt hours (GWh) of storage to deliver a firm 1 GW (an amount equivalent to a medium-sized thermal plant) at around USD 70/MWh (IRENA, 2026c).



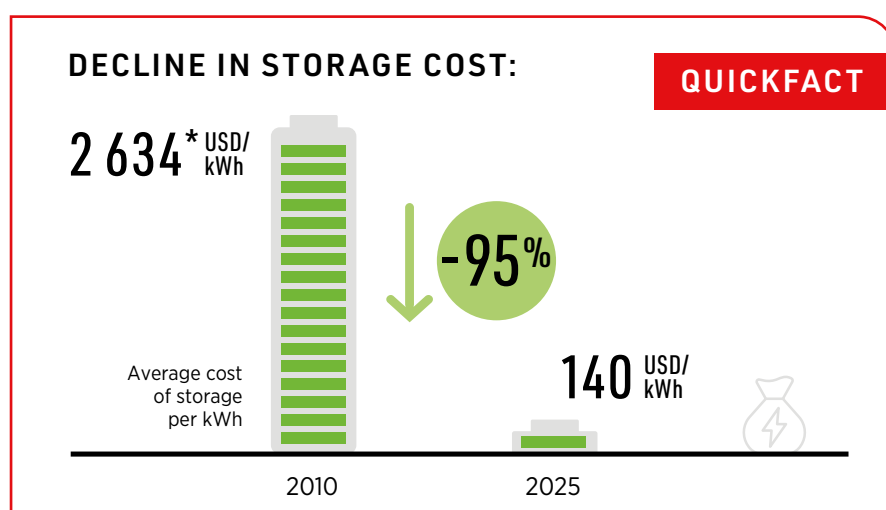
In 2025, the renewable generation of three, import-exposed Southeast Asian economies – Indonesia, Thailand and the Philippines – displaced an estimated USD 5.7 billion of coal and gas that would otherwise have been purchased, much of it imported.

⁵ These figures represent gross estimates: they do not consider the changes in net capital costs of the renewable or fossil fuel capacities themselves, nor do they monetise avoided local air pollutants, such as sulphur dioxide (SO₂), nitrogen oxides (NO_x) and fine particulate matter. Reducing these delivers further, well-documented public health benefits beyond the scope of this calculation.

Independent analysis shows a similar result. A large and fast-growing volume of co-located solar and storage was commissioned worldwide in 2025, at an average cost below that of new gas-fired generation. Such systems are already cheaper than new gas for most hours of the year across many markets, and for almost all demand in the most favourable cases, such as Spain (BNEF, 2026a).

Co-located solar and storage has moved into the mainstream, accounting for around one-quarter of the utility-scale solar capacity commissioned globally in 2025 (BNEF, 2025a). This trend reflects growing pressure on standalone solar projects in some markets, where declining daytime prices and increasing curtailment have reduced the value of generation during peak production periods.

Falling battery storage costs are facilitating firm renewable power; the costs of a fully-installed and commissioned battery storage project fell by almost 30% between 2024 and 2025. Between 2010 and 2025 these costs have declined by some 95%, from USD 2 634/kilowatt hour (kWh) to USD 140/kWh. China is the largest battery energy storage system (BESS) market, with a mature and robust manufacturing supply chain driven by strong domestic demand, while the industry also remains strongly export oriented. The energy storage supply chain is diversifying, while the United States continues to expand its manufacturing capacity and strengthen its ability to meet domestic demand (SEIA, 2026). These industry trends continued in 2025, with cost declines driven by oversupply and intensified competition among manufacturers.



* Expressed in 2025 US dollars; historical battery storage cost estimates reflect the current reference year's prices. The figures differ depending on the current reference year due to price-level adjustments rather than revisions to the underlying cost estimates.



Globally, with the growing share of variable renewable power generation, energy storage plays a pivotal role in ensuring successful delivery of reliable, renewables-based electricity systems. Energy storage technologies such as batteries and pumped hydro storage have the fastest response capabilities of all flexibility options. These technologies can stabilise frequency, bolster resilience during outages and provide backup power, thereby ensuring grid stability (IRENA, 2026b). Battery energy storage systems can enhance system flexibility by capturing surplus electricity and discharging it when needed, as well as cutting transmission losses and minimising grid congestion (IRENA, 2026b).

In 2025, approximately 112 GW (around 307 GWh) of battery storage capacity was added, marking a 48% increase over the 76 GW added in 2024 (BNEF, 2026b). Declining renewable technology costs, combined with grid flexibility (to maintain reliability while allowing greater variable renewable energy penetration), is driving a rapid transformation of the battery energy storage landscape.

China, the United States and Europe remain at the forefront of global battery storage capacity expansion, collectively accounting for nearly 85% of total annual battery storage capacity additions at end-2025 (BNEF, 2026b). China remained the largest contributor to new global capacity in 2025, commissioning 61 GW (173 GWh) – representing an increase of 54% compared to its additions in 2024. The United States added 18 GW (55 GWh), followed by Europe with 16 GW (33 GWh).

The rapid growth of battery capacity in China stemmed from a target to roll out more than 180 GW of new energy storage by the end of 2027. Chinese provincial mandates require energy storage to accompany utility-scale variable renewable projects and enhance grid stability (IRENA, 2026b).

In the United States, deployment growth was propelled by expanding state-level ambitions for renewable energy and energy storage – with 13 states having official energy storage targets. At the federal level, the One Big Beautiful Bill Act (OBBBA) provided continued policy support by preserving key storage tax credits.

Similarly, Europe's growth was underpinned by supportive government policy frameworks, renewable energy expansion, and emerging potential in energy arbitrage and ancillary services (IRENA, 2026b).

Pumped hydro storage reached an all-time high deployment of 10.3 GW of capacity in 2025, bringing the cumulative installed capacity to 160 GW. It remains the most competitive long-duration energy storage (LDES) technology, with a global average TIC of USD 153/kWh (IRENA, 2026b). Pumped hydro storage plays an instrumental role in improving grid stability, maintaining energy security and enabling smooth integration of renewable energy into the global power system. Based on International Hydropower Association (IHA) data on the global pipeline of pumped storage projects, around 240 GW is now under construction worldwide, pointing to a step-change in annual deployment over the coming decade that can be further increased with robust government targets backed by supportive regulatory frameworks (IHA, 2026).

Beyond pumped hydropower storage, other forms of LDES (such as compressed air, liquid air, thermal storage, flow batteries and metal-air systems) remain at an early stage of development. These forms deliver wide storage ranges from eight-hours to multiple days and offer greater siting flexibility than pumped hydropower storage. Total current and projected non-pumped LDES capacity, including projects in development, reached a capacity of at 10+ GW with a storage capacity of 236 GWh (Long Duration Energy Storage Council, 2026a, 2026b). This implies almost 24 hours of storage, on average, in this capacity stock projection, which can support reliable system operation reliably during extended low renewable periods and overcome system flexibility constraints.

With an estimated addition of just over 2 GW of hydrogen electrolyser capacity in 2025, global cumulative capacity has exceeded 4 GW, marking a major milestone in the long-term delivery of the energy transition (IEA, 2026a). However, the project pipeline to 2030 depends on investment decisions made in the near term and consequently has reduced by about a quarter over the past year (IEA, 2026a). The sector faces several hurdles, including manufacturing capacities greatly exceeding demand, and falling investment in hydrogen deployment in 2025 (BNEF, 2026c). Unlike for solar PV and batteries, overcapacity in this instance has not led to faster deployment. This is largely because equipment costs represent only a portion of the delivered hydrogen cost and demand is limited by a shortage of buyers.



7 IRENA's hydrogen analysis is being updated as part of the world energy transition outlook workstream and these figures will most likely be revised downwards.



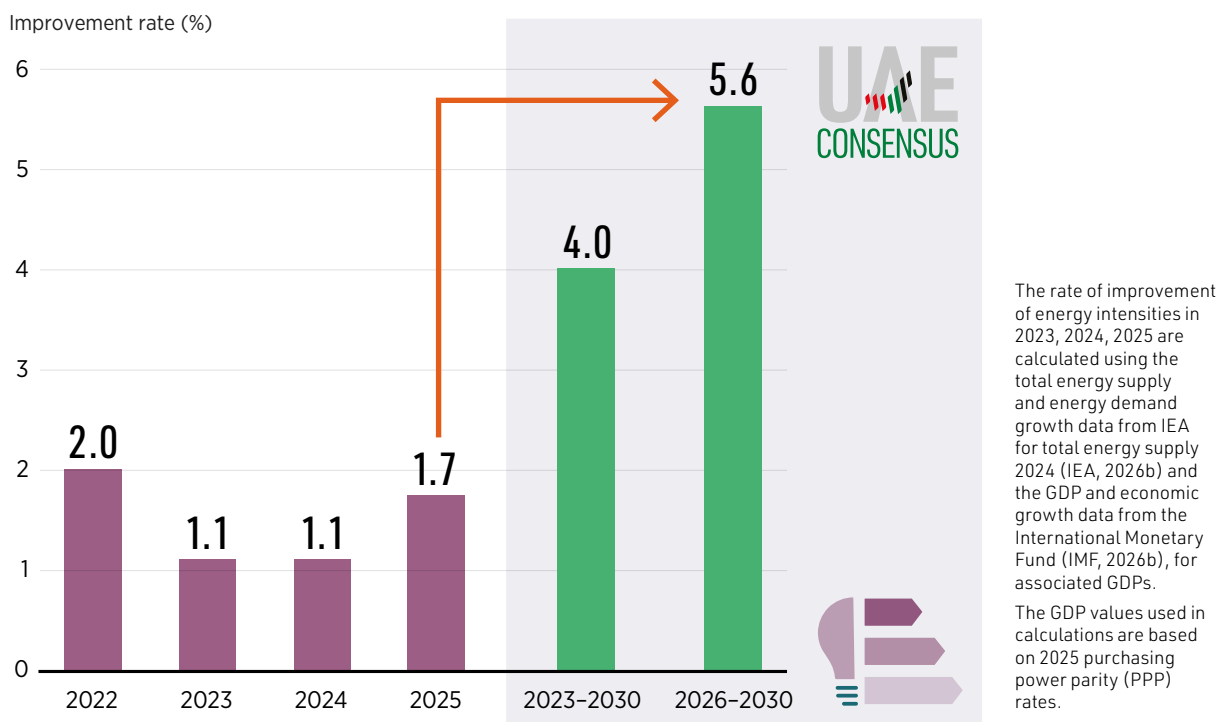
ENERGY EFFICIENCY

Doubling energy efficiency⁶ by 2030 from 2022 levels is a crucial complement to the tripling of renewable power capacity. Achieving the energy transition requires adopting more energy-efficient technologies, securing structural and behavioural changes, and accelerating energy efficiency measures across all end-use sectors. In 2024 and 2025, annual energy demand increased by 2% and 1.3%, respectively (IEA, 2026b), while global economic growth has been around 3.4% per year (IMF, 2026a).

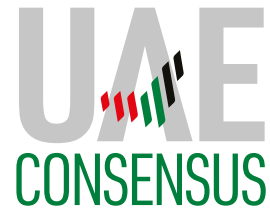
The 1.7% energy intensity improvement achieved in 2025, and the average annual improvement seen in 2023–2025, were well below the UAE Consensus energy efficiency target of 4% improvement each year between 2023 and 2030. IRENA's updated Planned Energy Scenario indicates that only around 3% annual improvement can be expected over the period 2026–2030 (IRENA, Forthcoming). To meet the UAE Consensus 2030 energy efficiency target will now require an improvement of 5.6% per year over the next five years to make up for the shortfall (see Figure 6).

⁶ Changes in energy intensity are used as a proxy for improvements in energy efficiency. Energy intensity is calculated as total primary energy supply divided by gross domestic product (GDP), while 'energy intensity improvement' measures the rate at which this ratio evolves over a given period. It is tracked to measure the efficiency gains in energy use, crucial for reducing overall energy demand and emissions.

FIGURE 6 Energy intensity improvement



Electrification plays a key role in meeting the UAE Consensus goal to double the global rate of energy efficiency improvement by 2030. Crucially, with increased renewable electricity supply, electrification becomes a multiplier for decarbonisation through improved efficiency and reduced emissions intensity of energy use. The electrification of end-use sectors must rise from 23% of total final energy consumption (TFEC) in 2023 to around 30% by 2030 to meet the UAE Consensus goal. Buildings would remain the most electrified sector, with electricity's share increasing from 36% to 53% by 2030. In industry, the share would rise more slowly, from 27% to 31%, reflecting the sector's greater reliance on high-temperature process heat and fossil fuel feedstocks that remain harder to electrify in the short term. Transport starts from a much lower base, requiring electrification to increase from just 1% in 2023 to 7% in 2030. Reaching these levels of electrification will depend on accelerated deployment of electrification technologies such as heat pumps and electric vehicles, alongside more traditional complementary efficiency measures such as appliance standards, labelling, fiscal incentives and building renovation.



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Further acceleration will be needed to electrify 35% of total final energy consumption by 2035 to facilitate the scale-up of efficient, renewables-based electrification across end-use sectors (IRENA, 2026d). Achieving this level will require faster deployment of efficient electric technologies alongside the expansion and modernisation of power systems, including renewable generation, grids, storage and other flexibility solutions, to accommodate growing electricity demand reliably and sustainably.

FIGURE 7 Annual energy intensity improvement rates recorded in recent years and future evolution under PES and UAE Consensus

 ENERGY EFFICIENCY						
	2022	2023	2024	2025	2030	
Energy intensity improvement rate (%) ¹	2.0%	1.1%	1.1%	1.7% 	5.6% 	
Building renovation rate (% stock/year) ²	1%	1%	1%	1% 	2% 	

 ELECTRIFICATION OF END-USE CONSUMPTION						
	2022	2023	2024	2025	2030	
Electrification rate in TFEC (%) ³	23%	23%	24%	N/A	30% 	
Electric and plug-in hybrid light passenger vehicles stock (million) ⁴	26	40	57	78 	360 	
Heat pumps in buildings (GW) ⁵	1173	1280	1376	~1500 	8 937 	

Notes: [1] 2030 value represents the annual improvement rate between 2026 and 2030.

[2] UNEP and GlobalABC, 2026; REN21, 2025.

[3] Recent years values are calculated from IEA World Energy Statistics & Balances.

[4] Recent year values from BNEF, 2025b.

[5] Recent year data from IEA, 2026b, EHPA, 2026 and AHRI, 2026.

Efficiency gains through electrification

BOX 1

Electrification and energy efficiency are closely linked because electric technologies provide the same energy service using substantially less final energy than fossil fuel-based alternatives. For example, electric vehicles convert over 77% of electricity into power at the wheels, compared with internal combustion engines that convert 12–30% of the energy contained in gasoline into power at the wheels (US Department of Energy, n.d.). Furthermore, modern heat pumps can reduce electricity consumption by more than 50% compared to traditional heating systems and achieve efficiency gains exceeding 300% by moving heat rather than generating it (US Department of Energy, 2023).

As a result, electrification can reduce overall final energy demand even as electricity consumption increases. For instance, the expansion of the global electric vehicle fleet avoided between 1.7 and 2.3 million barrels of oil consumption per day in 2025 (BNEF, 2026d; IEA, 2026b). Similarly, the deployment of heat pumps in Europe, China and Japan avoided an estimated 53 billion cubic meters of gas consumption in the same year (IEA, 2026c).

These efficiency gains make electrification an important contributor to progress towards the global energy efficiency goal. At the same time, its effect on the headline energy intensity indicator also depends on broader changes in the energy system and on the way primary energy is accounted for as electricity generation increasingly shifts from fossil fuels towards renewable sources.

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2030



Progress towards the 2030 energy efficiency goal will require faster deployment of efficient electric technologies across transport, buildings and industry. The pace and opportunities for electrification differ considerably across these sectors, reflecting their respective technologies, infrastructure needs and patterns of energy use.

The progress achieved in transport electrification in 2025 was significant but remains insufficient. Electric vehicles (EV) accounted for a record 26% of global new car sales in 2025 (BNEF, 2025b), marking their highest share to date, driven by recent fluctuations in global oil markets, increased competition, policy support and technological advancements.

The global stock of EVs (electric and plug-in hybrid light passenger vehicles) by late 2025 reached approximately 78 million, accounting for more than 4% of the global passenger vehicle fleet. In recent years, annual EV sales have significantly expanded, rising from 2.2 million units in 2019 to 22 million by the end of 2025, and increasing by 25% between 2024 and 2025. China leads this growth and represents 67% of annual volumes, followed by Europe (3.6 million) and the United States (1.6 million) (BNEF, 2025b).

The share of electric buses in new bus sales worldwide reached 43% in 2025 (BNEF, 2025b). China is the leading market, accounting for more than 60% of electric bus sales, while nearly all city buses sold were electric (IEA, 2026d). Europe has been the world's second largest electric bus market for the past decade, with 11 300 new buses registered in the EU in the first quarter of 2026, including 2 732 zero-emission vehicles, representing 24.2% of the total. In the city bus segment, electric buses accounted for 55% of new sold buses in the market (ICCT, 2026a).

Buildings accounted for around 30% of global energy demand and over half of worldwide electricity consumption in 2024 (IEA, 2025b). However, renovation rates remain too low, at roughly 1% of the global building stock each year (REN21, 2025a; UNEP and GlobalABC, 2026), compared with the 2% annual rate needed by 2030 to align with UAE consensus goal. This gap is significant because buildings and construction account for around 37% of global CO₂ emissions (UNEP, 2023).

Building energy codes are the main policy instrument for improving building efficiency by establishing minimum energy performance standards. These codes may be performance-based, prescriptive, or a combination of both, and increasingly include requirements for renewable energy, embodied carbon, energy management, and smart technologies. They apply to new buildings as well as major renovations. By mid-2025, building energy codes covered approximately 60% of new construction worldwide, although adoption remains uneven, with much lower coverage in many emerging economies (UNEP and GlobalABC, 2026).

Global sales of residential heat pumps in 2025 declined by about 2% year-on-year to around 14.1 million units (IEA, 2026e). Markets in China and Japan remained broadly stable as demand for high-efficiency heating technologies continued, although overall market expansion slowed. Sales in the United States declined roughly 13%. This was the result of softer housing demand, a slower pace of residential construction, and disruptions related to the transition to new low-global warming potential (GWP) refrigerants under updated federal regulations. However, heat pumps were the most widely used technology for new residential space heating and cooling installations in the country (AHRI, 2026). Sales in Europe, by contrast, began to recover, rising by around 10% to 13% across 21 countries, supported by more stable government support schemes, improved electricity competitiveness, and gradually recovering consumer confidence. Nevertheless, sales remained below the record levels seen reached in 2022 (IEA, 2022).

Beyond short-term market fluctuations, heat pump deployment is increasingly shaped by broader energy security and climate adaptation considerations. Reducing reliance on imported fossil fuels continues to strengthen the strategic case for electrification, particularly in gas-importing dependent regions such as Europe, in line with the objectives of the European Commission's REPowerEU Plan, and can help insulate consumers from fossil fuel price shocks.

At the same time, more frequent and severe heat waves across Europe, North America and Asia, are increasing cooling demand and placing additional strain on electricity systems. Because reversible heat pumps can provide both heating and cooling, they can support three complementary objectives: improving energy efficiency, reducing reliance on fossil fuels and helping meet growing cooling needs associated with rising temperatures and more frequent heat waves.



ENERGY
TRANSITION
INVESTMENTS

02

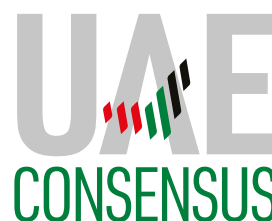
INVESTMENTS IN RENEWABLE POWER AND ENERGY EFFICIENCY

Global investment in renewable power generation capacity reached USD 625 billion in 2025,⁷ slightly below the amount invested in 2024.

Solar PV attracted almost two-thirds of total renewable power investment (USD 417 billion) in 2025, but investments fell from their 2024 peak, declining by 6% year-on-year, as falling costs required less investment to fund higher capacity additions. Wind accounted for around a quarter of investment (USD 155 billion), increasing by 13% year-on-year in 2025 and reflecting continued growth in onshore wind investment (USD 136 billion), while lower investments were seen for offshore wind (USD 19 billion) compared to previous years. Investment in hydropower increased by approximately 15% compared to 2024, reaching USD 37 billion in 2025. Meanwhile, investment in geothermal energy totalled USD 1.6 billion, representing 19% year-on-year growth. In addition, 2025 also saw a considerable decline of 38% year-on-year in investment in bioenergy for power (USD 12 billion) and a notable 18% decline in CSP investment (USD 2 billion). In 2025, G20 nations accounted for around 91% of renewable power generation capacity investment, dominated by China.

To meet the UAE Consensus target to triple renewable power capacity by 2030 will require an additional USD 8.6 trillion in investment in the period 2026–2030 – an average of USD 1.7 trillion each year. Solar PV investment is progressing in line with the tripling pathway, while other renewable technologies are facing widening investment gaps on an annual basis and must scale up substantially (see Figure 10). Meeting the tripling target will require annual investment in wind and hydropower technologies to scale up by five and four times the current levels respectively, while investment in bioenergy needs to rise tenfold. In addition, significant growth in annual investment is needed to refine dispatchable geothermal, CSP and marine technologies, underscoring the need for enhanced capital mobilisation.

⁷ Annual investment in renewable energy capacity is calculated based on the annual capacity additions per technology deployed in a given year multiplied by the global weighted average total installed cost of each technology. Other organisations may report financial commitments in a specific year (financial investment decisions), so comparisons may reveal a temporal separation in values.





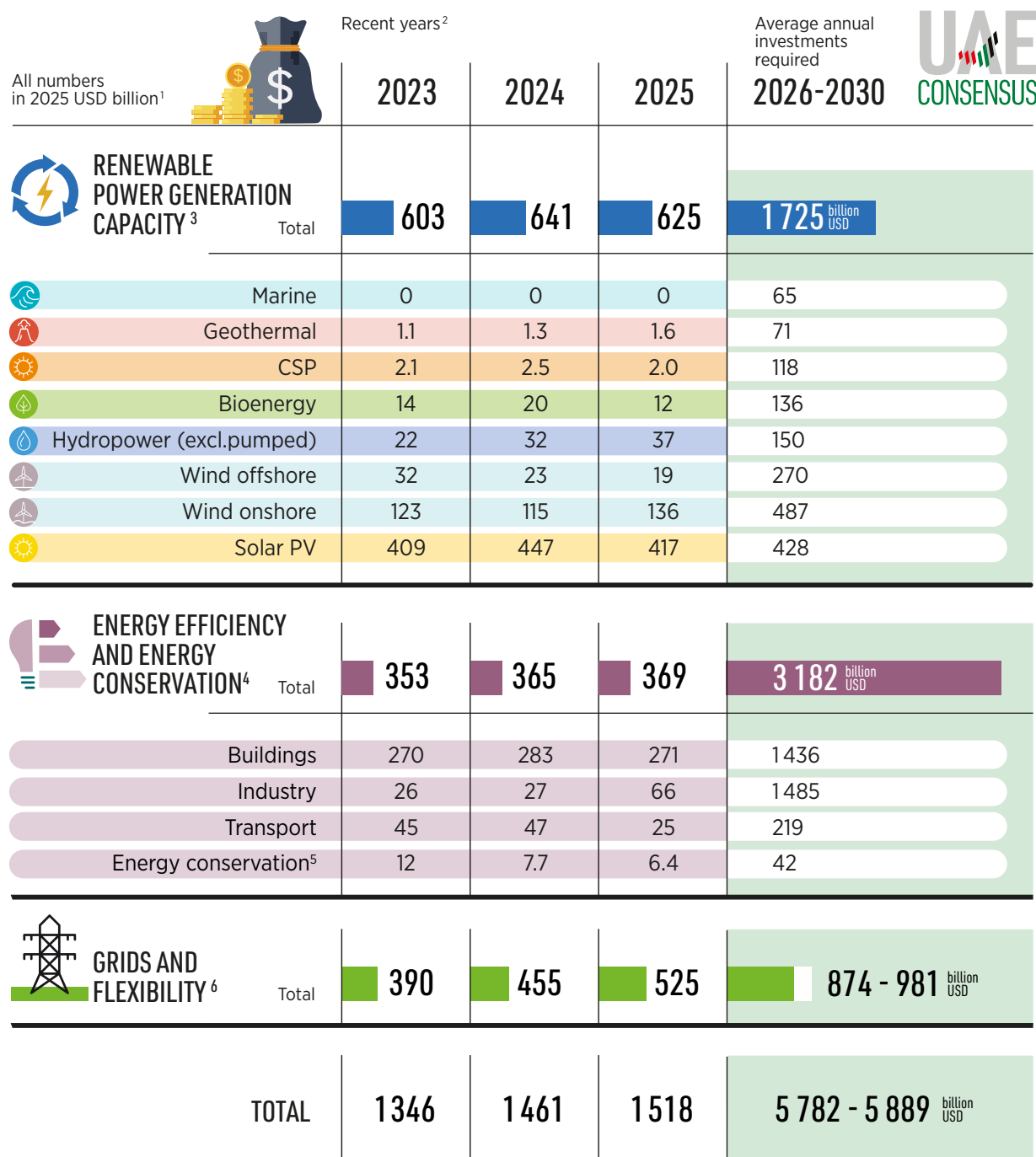
Average investments of up to USD 1 trillion each year are required in grids and flexibility between 2026 and 2030, compared to the investment of USD 525 billion seen in 2025. Of the total investment required, around USD 800 billion each year is needed to sustain the expansion and modernisation of electricity grids, while the remaining investment of up to USD 200 billion is required for scaling up energy storage solutions. Grid infrastructure investment reached USD 422 billion in 2025, growing 12% in 2025 compared to 2024 (IEA, 2026f). China, Europe and the United States were the main contributors to the recent growth in investments. However, a significant share of the growth was driven by higher equipment, material and labour costs, rather than higher volumes of infrastructure deployment. In developed economies, much of this spending is used to replace existing networks, rather than to expand systems; as a result, reported investment spending overestimates the pace of net network expansion. Grid expansion continues to face challenges including lengthy permitting procedures, inconsistent targets and inadequate policy frameworks (IEA, 2026f).

Without proportional investment allocated to grid expansion and modernisation, renewable power generation and electrification growth could slow. Some markets are already showing signs of strain, with increased curtailment of renewable power generation and network congestion. This may eventually lead to higher electricity costs or compromised reliability of electricity supply, if not addressed in a timely manner. A more holistic grid expansion and re-enforcement is thus a critical prerequisite for accelerated electrification and ensuring a reliable and cost-efficient electricity supply, and must align with renewables growth.

Investment in energy storage (including pumped hydropower) grew by 33% year-on-year in 2025, reaching USD 103 billion (IEA, 2026f). Battery storage additions reached 112 GW / 307 GWh in 2025, a 48% year-on-year increase in power terms (BNEF, 2026b). This was catalysed by falling battery prices, co-located storage with solar PV projects and the growing value of flexibility in systems with rising shares of variable renewables. This is demonstrated by the link between solar installations and storage; the ratio of annual solar to storage additions fell from 56:1 in 2016 to 6:1 in 2025, and is expected to narrow further to 4:1 in 2026 (BNEF, 2026b; Kikuma, 2026).

Investment in energy efficiency and energy conservation will need to average almost nine times the USD 369 billion spent in 2025. An average of USD 3.2 trillion is now required annually across buildings, transport and industry between 2026 and 2030 to meet the doubling of energy efficiency goal. Total energy investment (USD 3.3 trillion) in 2025 showed a 5% rise from 2024 – mainly driven by China, the US and EU – while energy efficiency spending increased by around 2% in 2025 compared to 2024 (IEA, 2026f).

FIGURE 8 Investments required to triple renewable power capacity and double energy efficiency by 2030 compared with recent progress



Notes: PV = photovoltaic; CSP = Concentrated Solar Power; yr = year

[1] All figures have been adjusted for inflation and are represented in real terms; i.e. 2025 US dollars.

[2] (IRENA, 2026b; BNEF, 2026f; IEA, 2026i).

[3] Renewable power generation capacity: Investment in deployment of renewable technologies for power generation.

[4] Energy efficiency in industry: Improving process efficiency, demand-side management solutions, highly efficient energy and motor systems and improved waste processes. Energy efficiency in transport: All passenger and freight transport modes, notably road, rail, aviation and shipping. Vehicle stock investments are excluded. Energy efficiency in buildings: Improving building thermal envelopes (insulation, windows, doors, etc.).

[5] Energy conservation: Investments in energy conservation includes those in bio-based plastics and organic materials, chemical and mechanical recycling and energy recovery.

[6] Grids and flexibility: Investment in transmission and distribution networks (excluding public EV charging stations investments), smart meters, pumped hydropower and battery storage among other energy storage technologies.

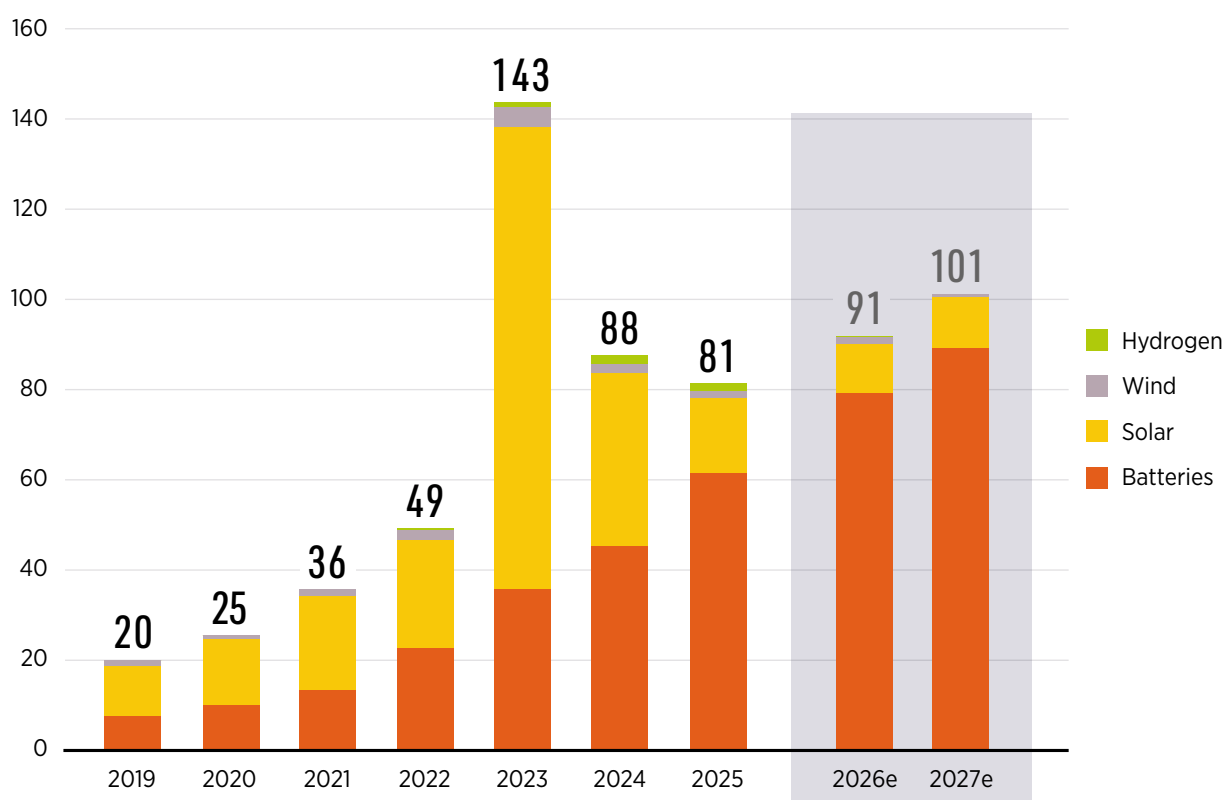
INVESTMENTS IN SUPPLY CHAINS

Investments in factories manufacturing solar, wind, battery and hydrogen technologies fell for a second consecutive year in 2025, declining 7% to USD 81 billion between 2024 and 2025 (BNEF, 2026c). Solar, wind and hydrogen investments all fell, a trend that is expected to continue into 2027, given the overcapacity in the market. By contrast, battery investments extended their strong growth, as manufacturers respond to the growing demand for energy storage solutions for renewable integration, grid flexibility, EVs and data centres (see Figure 10).

Cumulatively, at least USD 458 billion had been invested in manufacturing facilities for solar, wind, battery and hydrogen technologies by the end of 2025, translating to more than 1.5 TW/year of solar PV module manufacturing capacity (REN21, 2025b) and more than 4 TWh of lithium-ion battery manufacturing capacity (IEA, 2026g). China continues to dominate: By the end of 2025, 89% of solar, 88% of battery, 76% of wind nacelle and 66% of hydrogen electrolyser assembly capacity was located in China (BNEF, 2026c).

FIGURE 9 Investments in solar, wind, battery and hydrogen technology manufacturing, 2019–2027

Investment (2025 USD billion)



Source: (BNEF, 2026c).

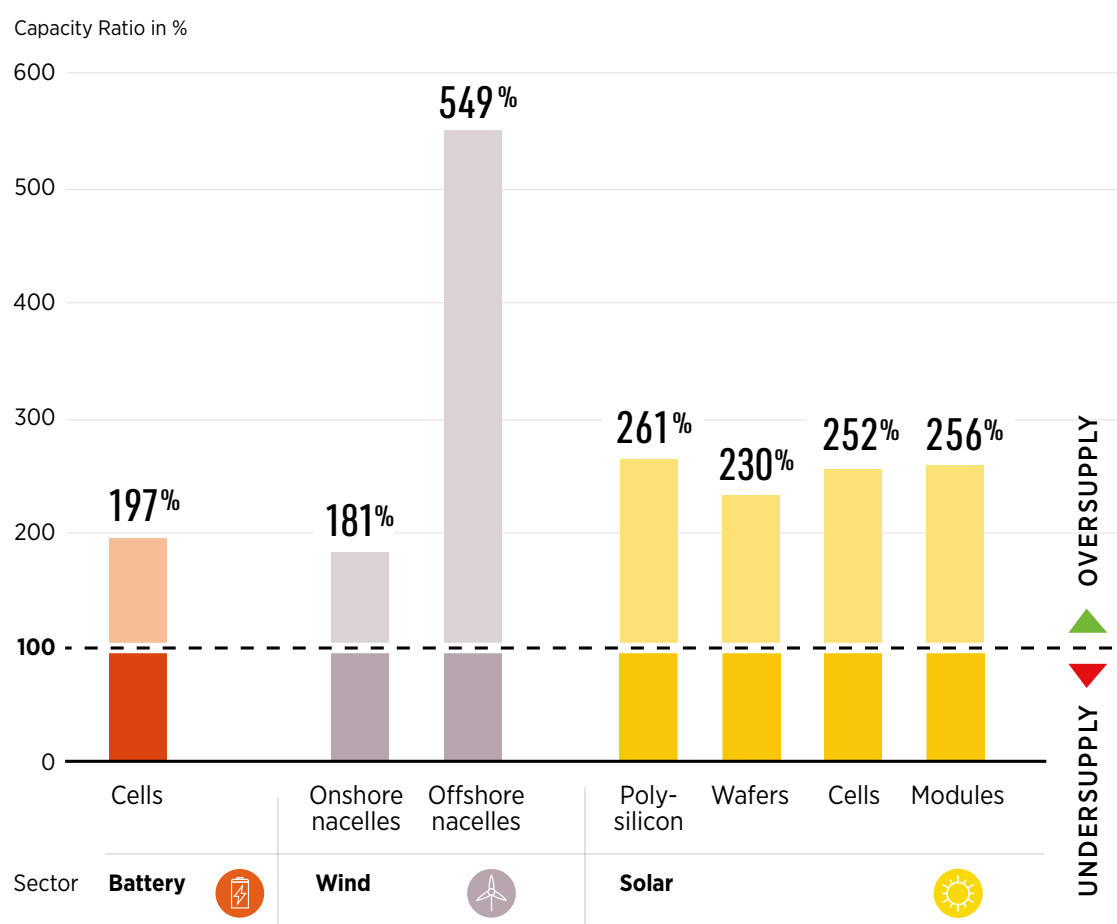
Notes: This includes factory investments across the manufacture of solar (polysilicon, wafers, cells and modules), batteries (separators, electrolytes, cathodes, anodes and cells), wind turbines (nacelles only), and hydrogen electrolyser manufacturing (stack assembly only).

Last year's report projected a higher share of new factory investment and construction outside China, as other countries look to scale domestic manufacturing capacity and diversify their supply chains. This year's findings confirm this: 23% of manufacturing investment in 2025 went to economies outside China, up from 20% in 2024 and 15% in 2023 – mainly occurring in the United States, Europe and India. While these investments can contribute to greater self-sufficiency and geographic diversification, in the absence retirements of older manufacturing they also preserve global oversupply – particularly given the slow pace of deployment of these technologies in some parts of the world.

Across all four sectors, manufacturing capacity now exceeds current demand (BNEF, 2026c). Overcapacity remains particularly acute⁸ in the offshore wind sector, with supply equivalent to 549% of the current market demand attributed mainly to China (see Figure 13). For other sectors (onshore wind nacelles, solar cells, wafers and modules, and battery cells), current supply is equivalent to between 197% and 261% of market demand. While the global oversupply has helped push prices down, benefitting countries looking to scale deployment, it has made it more difficult for manufacturers to maintain robust financial performance.

⁸ If we look at individual technologies (e.g. offshore nacelles, polysilicon, etc.), combined solar manufacturing capacity is higher than that of wind.

FIGURE 10 Manufacturing capacity vs. global demand in 2025



Source: (BNEF, 2026c).

Notes: Dotted black line indicates 100% on the y axis, where supply equals demand. Battery ratio uses risk-adjusted manufacturing capacity as of end-2025. Wind and solar ratios use nameplate manufacturing capacity as of end-2025. All sectors have their capacity divided by 2025 demand.



India accounted for nearly one-fifth of global solar PV manufacturing investment in 2025, up from just 1% in 2023. A record-high of more than USD 3 billion was invested in 2025, as the country continues the push to establish itself as a leader in clean tech manufacturing and export. Domestic solar module manufacturing capacity grew from less than 5 GW in 2018 to more than 125 GW in 2024 (Wood Mackenzie, 2025), underpinned by the Production Linked Incentive (PLI) scheme. This growth overlaps with a 52% decline in module exports to the US in the first half of 2025,⁹ mainly stemming from reciprocal US tariffs (Wood Mackenzie, 2025). Going forward, India's solar manufacturing and export success will depend on boosting local demand, trade terms with the United States, and competition from existing, as well as other emerging manufacturers such as Türkiye.

Outside India, solar manufacturing investments fell across the board, particularly in the United States, China and a number of Southeast Asian economies (Viet Nam, Malaysia and Thailand). The ongoing global oversupply has been compounded by additional factory buildout in Southeast Asia, India and Türkiye (BNEF, 2026c). Low module prices amidst a volatile tariff environment have squeezed the profit margins of some major manufacturers (BNEF, 2025c),¹⁰ leaving many under financial strain, and forcing them to cut back production and halt expansion plans (Saeed, 2025; Wood Mackenzie, 2025). The continued fall in costs and prices has benefited consumers. Markets such as Pakistan and the Philippines have benefited from lower prices, recording particularly high levels of solar PV imports in recent years, whilst uptake Southeast Asia and Sub-Saharan Africa has also accelerated (BNEF, 2026c).

Global investment in battery factories increased by 36% to reach USD 61 billion in 2025, with all regions reporting an increase as they look to build domestic production capacity. China made up 77% of investments in 2025 and is well-established as the dominant hub for battery manufacturing. Although its share is gradually declining, as other countries including the United States, EU countries and several developing economies launch efforts to localise battery production. Nonetheless, many remain dependent on China for large parts of the battery supply chain. Investments in India, Europe, Asia (excl. China), and rest of the world increased, making up 23% of investments in 2025 compared to 18% in 2024.

⁹ Compared to the same period in 2024.

¹⁰ Some of the decline is likely a result of an expected correction from peak investment in 2023.

By capacity, more than 800 GWh of lithium-ion batteries were traded internationally, a record-high and more than double the volume in 2022. Around 71% of the traded capacity is intended for EVs, with the remaining going to BESS, a segment that is also growing rapidly. Overcapacity in China, combined with a shift towards lower-cost lithium iron phosphate batteries, widely used in BESS, have also contributed to downward pressure on prices (BNEF, 2026c).

Investments in wind turbine manufacturing facilities,¹¹ and specifically nacelle factories (albeit representing a relatively small share of overall supply chain investment) fell again by 23% in 2025 (after a 54% decline in 2024) and the future outlook remains below 2024–2025 levels. The contraction reflects a period of consolidation among manufacturers outside China, following several years of intense pricing pressure, inflation, permitting delays and supply chain disruption that compressed margins across the sector. However, the sector's subsequent recalibration has begun to deliver a meaningful recovery in margins. This improved financial footing is expected to support a more stable manufacturing outlook that is more attractive to investors, even if near-term investment in new factory capacity remains below 2024–2025 levels.

Investments in hydrogen recorded another decline and are expected to remain low, as – unlike solar, wind and batteries – the anticipated demand for hydrogen has not materialised. Many planned projects have struggled to reach financial close due to costs, limited offtake agreements, and a range of other market-, policy- and trade-related risk factors discussed in IRENA's most recent analysis of global energy transition finance (IRENA and CPI, 2025).



¹¹ This only includes nacelles.



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03

ENERGY TRANSITION ENABLERS

MATERIALS, MANUFACTURING AND TRADE DYNAMICS

Renewable energy supply chains are shaped by conditions across the full supply chain, from access to critical materials and their processing to component manufacturing and trade. These dynamics are increasingly important for the pace and cost of renewable deployment needed to meet the tripling goal. Upstream material supply continued to expand in 2025 but remained concentrated in a limited number of producing countries, while trade measures became more widespread and pricing trends diverged across solar PV and wind supply chains.

In terms of mine output for key materials and material groups for the energy transition (such as cobalt, copper, lithium, natural graphite, nickel and rare earth elements), a comparison of 2024 data with 2025 estimates shows that production increased slightly overall, with particularly strong growth in lithium and natural graphite, while copper output remained unchanged (see Figure 13). Production remained highly concentrated, reflecting the geographical distribution of resource endowments. Indonesia was the main driver of estimated higher global nickel mine output in 2025, representing two-thirds of the global production with an estimated production of around 2.60 million tonnes of nickel content, while the Democratic Republic of the Congo (DRC) continued to account for nearly three-quarters of global cobalt output (USGS, 2026).

Indonesia significantly lowered its nickel ore mining quota in February 2026 in order to regulate nickel pricing while preventing rapid depletion of domestic reserves and protecting domestic industry viability (BMI, 2026; Hu, 2026; SunSirs, 2026). These developments have highlighted the important impacts that policy decisions in major producing countries could have on the availability and the pricing of materials within global renewable energy supply chains.



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Trade- and export-related measures have increasingly been used to influence access to critical material markets. Since 2020, nearly 100 new export measures have been introduced for critical energy transition materials, including licensing requirements, export taxes and export bans (UNCTAD, 2026). Measures introduced during 2025 included China's export-licensing requirements issued in April, covering seven medium and heavy rare-earth and related materials, as well as the DRC's transition from a temporary cobalt export suspension to a quota system. In March 2026, China introduced a broader industrial and supply chain security framework establishing mechanisms for risk monitoring and early warning, physical and capacity reserves, emergency responses and supply-chain security investigations (State Council, 2026). The implications of these measures for trade flows and supply availability differ according to their design and should therefore be assessed carefully rather than viewed uniformly as either restricting or supporting trade.

Downstream manufacturing markets showed contrasting price dynamics. In 2025, persistent supply chain oversupply, excess inventory and aggressive market competition drove significant price drops across most solar PV components, with polysilicon declining 11% to an annual average of USD 4.87/kg, cells falling to a record low of USD 0.043/watt peak (Wp), and modules sold in European markets hitting record lows led by a 24% drop in high-efficiency models (USD 0.15/Wp) compared to 2024. Wafers represented the exception to this downward trend, rising 2% to average USD 0.026/Wp, while bifacial modules held relatively strong with a minor 3.8% decline (USD 0.27/Wp) as their market share expanded to 68% (IRENA, 2026b).

Wind turbine pricing followed a different trajectory. Outside mainland China, prices increased as Western manufacturers sought to recover from slim or negative margins through higher-priced contracts (BNEF, 2025d), with the BNEF Wind Turbine Price Index (WTPI) increasing by 14% between 2024 and 2025. Chinese domestic turbine prices started to stabilise after years of steep declines, increasing 2% year-on-year (and 3% from Q4 2024 to reach USD 199/kW by Q4 2025) after a self-regulatory agreement among major manufacturers to curb unsustainably low pricing. In the first half of 2026, price differentials between turbine classes (Class I, II, III and S turbines) reduced significantly, converging to an average price of USD 1 104/kW, while significant differences between Chinese and Western turbine markets persisted¹² (IRENA, 2026b).

Taken together, these developments suggest that the challenge for scaling renewable power goes beyond the physical availability of materials. The resilience of supply chains also depends on the concentration of production, the evolution of trade and industrial policies, and the ability of manufacturing markets to expand while maintaining competitive and sustainable pricing. These factors will increasingly influence the cost and pace of deployment required to meet the global tripling goal.

12 Nordex saw a 4% price increase to USD 993/kW while Siemens Gamesa dropped 4% to USD 889/kW

POLICY, REGULATION AND NDCS

NDC 3.0

As of June 9, 2026, 120 third-generation Nationally Determined Contributions to the Paris Agreement (NDC 3.0) had been submitted to the UNFCCC, representing 119 individual countries in addition to the European Union¹³ (UNFCCC, n.d.) and accounting for 77% of global emissions.¹⁴

Of these 120 NDC 3.0 submissions by Parties to the UNFCCC, 117 included some form of policy commitment to reach at least one of the UAE Consensus outcomes on renewables, energy efficiency or transitioning away from fossil fuels in energy systems; 106 NDCs (88%) mentioned increasing the deployment of renewable energy; and 108 NDC (90%) mentioned energy efficiency.

To date, 67% of the 120 NDC 3.0 submissions have featured a quantified renewable energy target, yet only 43% contain a quantifiable energy efficiency improvement target. Also, 75% of NDC 3.0 submissions include a commitment to reducing the share of fossil fuels in the electricity mix; but only 23% contain a commitment to cease deployment of new coal plants or to phase down unabated coal power.

To date, more than three-quarters of NDC 3.0 submissions (93 of 120) indicate that achieving the NDC targets are conditional or partly conditional on international support. Scaling up international finance, technical assistance and technology transfer will therefore be key to meeting the ambitious targets set by developing economies, while also potentially enabling them to raise their ambition going forward.

Market design and incentives

While single-buyer and vertically-integrated utility models remain the most widely used power market structures globally, reforms in many power markets are moving more towards market-based mechanisms, open access and greater competition. This shift has created space for self-consumption of renewables (e.g. for small-, medium- and large-sized consumers), and new independent power producers (IPPs) to enter the market. Notably, new entrants have predominantly been solar IPPs since 2021 (World Bank, 2024). Figure 13 illustrates the various power market reforms that occurred in nine countries between the beginning of 2025 and mid-2026.¹⁵

13 The European Union and its 27 member States communicated one joint NDC, which for this report has been counted as one NDC, in line with the approach taken by the UNFCCC Secretariat's NDC Synthesis Report (UNFCCC, 2024).

14 Calculated based on Crippa *et al.*, 2025.

15 Further details are available in Appendix I.

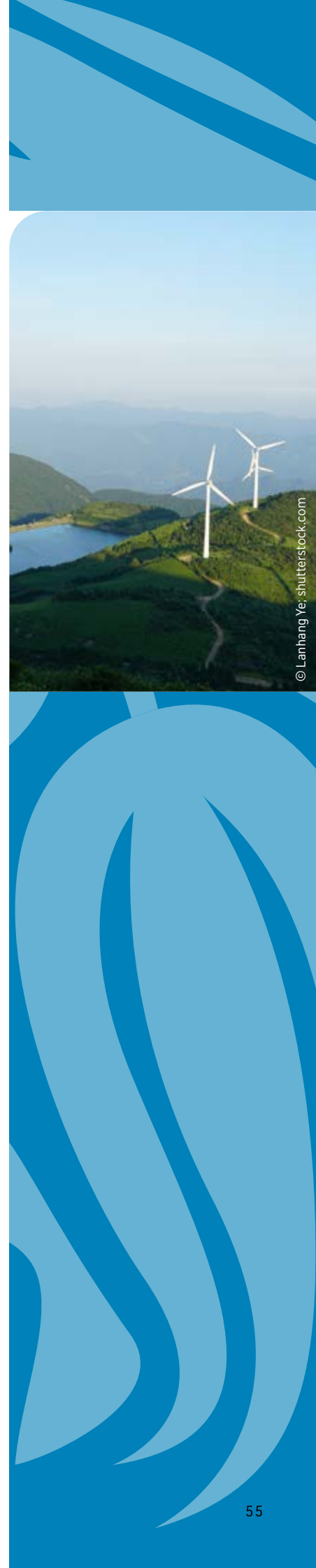


FIGURE 11 Recent changes in power market structures in selected countries, 2025 to mid-2026**Changes to Power Market Structures**

2025 to mid-2026

2025/26

1. Opening / expansion of competitive market access	 Brazil Market opening extended to smaller consumers  Pakistan Bilateral trading and wheeling framework launched  Philippines 100 kW consumers allowed to choose suppliers  South Africa Open market platform established  Viet Nam Direct renewable energy trading with large users formalised  Zambia Open-access framework introduced	1
2. Organised wholesale / unified national market reform	 China Unified national electricity market advanced  Sri Lanka Legal basis created for a national electricity market	2
3. Competitive procurement reform	 Peru Technology-neutral, more flexible electricity tenders	3
4. Unbundling	 Sri Lanka CEB split into six state-owned entities  South Africa Transmission system operator established	4
5. Renewable energy market integration and pricing reform	 China Wind and solar shifted to full market participation and market-based pricing	5



Quota and obligation-based instruments

Quota and obligation-based instruments are among the most direct regulatory tools for creating sustained demand for renewable electricity. These instruments require utilities, generators or consumers to meet a minimum share of electricity supply, procurement or consumption from renewable sources.

Between the beginning of 2025 and mid-2026, two countries updated obligation mandates targeting renewables-based electricity consumption. In India the Ministry of Power issued an amendment to the Renewable Consumption Obligation framework in September 2025, clarifying obligated entities, eligible renewable sources, exclusions, monitoring arrangements and penalties. It also provides greater compliance flexibility through direct renewable electricity consumption, renewable energy certificates – including through virtual PPAs – a buyout mechanism, and corporate-level aggregation for designated consumers under common control (Ministry of Power, 2026). These updates make the framework more practical to implement, while creating a more predictable demand signal for renewable electricity.

In China, the Energy Law in force from 2025 provided the legal basis for minimum renewable energy consumption targets (Article 23) and established shared responsibility between power suppliers, electricity sales companies, consumers and captive power plants. A July 2025 notice from the National Energy Administration made 2025 provincial renewable electricity consumption responsibility weights binding and introduced green electricity consumption ratios for energy-intensive sectors, including steel, cement, polysilicon and new data centres for these industries (NEA, 2025).

These enhanced demand-side obligations should nevertheless be considered alongside concurrent reforms to renewable energy pricing and market participation in China.¹⁶ The transition towards greater market-based pricing contributed to a front-loading of projects in 2025, as developers rushed to commission projects before the June 2025 pricing reform took effect; May 2025 alone saw nearly 93 GW of solar installed. In the context of this exceptionally high base in 2025, solar PV additions fell 66% year-on-year in the first half of 2026, while wind additions declined by around 25% (Howe, 2026).



¹⁶ Further details are available in Appendix I.

Renewable energy certificates

Quota and obligation-based instruments are often supported by renewable energy certificate (REC) systems. These allow obligated entities to demonstrate compliance by acquiring and submitting certificates representing the renewable attributes of electricity generation.¹⁷

In 2025, the global REC market was estimated to be worth USD 27.99–29.78 billion. Compared to a market value of USD 20.3 billion in 2024, the year 2025 marks an impressive year-on-year growth of at least 37.9% for RECs (Fortune Business Insights, 2026; MarketsandMarkets, 2025). Europe accounted for close to 42% of the global market share, followed by North America (30.9%), Asia Pacific (16.9%), Latin America (6.9%), and then Middle East and Africa (3.7%).

The growth of the global REC market can be attributed to a mix of increasing renewable energy targets, regulatory requirements, corporate sustainability pledges and consumer pressure for sustainability. The dominance of Europe and North America is largely due to the same factors, coupled with well-established certification systems and trading platforms. With growth expected to continue in the global REC market – and especially rapidly in Asia and the Pacific – renewable energy attribute mechanisms are seen as an increasingly popular and scalable option for achieving renewable energy targets in both compliance and voluntary markets (Fortune Business Insights, 2026; International Tracking Standard Foundation, 2026).

Auctions

A total of 256 rounds of competitive auctions for renewables, storage, and clean fuels were completed globally in January 2025–May 2026, with a further 164 auctions planned/announced; those completed awarded 230.8 GW of capacity. Solar and wind continue to dominate the auctioned capacities. This is equivalent in scale to roughly one-third of the 693 GW of renewable power capacity added globally in 2025.



¹⁷ RECs are part of a broader family of energy attribute certificates, which include green certificates, tradable green certificates, guarantees of origin or renewable portfolio certificates depending on the jurisdiction. A single REC unit represents one megawatt hour (MWh) of electricity produced from eligible renewable sources.

Feed-in tariffs

Feed-in tariff/feed-in premia schemes for renewables have been introduced or updated in three countries since the beginning of 2025. Switzerland's 2025 Federal Act on a Secure Electricity Supply from Renewable Energy established minimum remuneration rates for renewable energy plants and Bulgaria's 2025 Decision C-1 set premiums for producers of electricity from renewable sources (IEA, n.d.).

In early 2026, the Netherlands adopted changes to its small-consumer solar PV net-metering framework, ending net metering from 2027 while retaining feed-in remuneration for electricity exported to the grid (IEA, n.d.). These developments show countries' efforts to refine remuneration mechanisms to continue supporting renewable energy deployment while balancing sellers' cost recovery, prosumer incentives, as well system cost considerations.

At the same time, some countries moved away from tariff-based support. China shifted wind and solar towards full market participation and market-based pricing, while retaining a settlement mechanism for eligible generation;¹⁸ France replaced the open-access feed-in tariff for 100–500 kW rooftop and carport solar PV with competitive tendering; and Japan withdrew FIT/FIP eligibility for certain biomass projects from FY2026 and decided to end support for new ground-mounted commercial solar from FY2027 (EDF, n.d.; METI, 2026). These developments reflect not only changing policy priorities, but also the evolution of renewable energy industries within national circumstances—where increasingly mature technologies are moved from administratively set remuneration towards more competitive, market-based arrangements, as seen in France and China.



18 See Appendix I.

Fiscal incentives for renewable power

Fiscal incentives introduced in the power sector in the past year¹⁹ have been overshadowed by rollbacks in major economies and front-runners. The OBBBA in the United States, signed into law in July 2025, eliminated a range of fiscal incentives initially enacted as part of the Inflation Reduction Act (2022). The Clean Electricity Production Tax Credit and the Clean Electricity Investment Tax Credit for wind and solar facilities are being phased out²⁰ under the OBBBA (Alexander, 2026).

China has cancelled/reduced its value-added tax (VAT) rebate system for certain exported goods (including PV modules, inverters and batteries) that had been in place since the 1990s; the VAT rebate for solar products has been cancelled since 1 April 2026; but for batteries, it has been reduced to 6% from 9% until December 2026, after which it too will be cancelled (Dodd *et al.*, 2026).

To promote a level playing field for local industries and generate government revenue, Pakistan withdrew its tax exemption and imposed a 10% tax on imported solar panels in the Finance Act, 2025 (Federal Board of Revenue of Pakistan, 2025).

Canada extended its Clean Technology Investment Tax Credits in its Budget 2025 to include waste-to-electricity in addition to solar, wind and hydro; it also introduced a new Clean Electricity Investment Tax Credit – a refundable tax credit of up to 15% of the capital cost of eligible electricity generation, storage and transmission infrastructure (Canada Revenue Agency, 2026).

Bangladesh announced income tax exemptions for 15 years for entities owning renewable energy projects starting commercial production between July 2025 and June 2030 (100% for the first 10 years) (People's Republic of Bangladesh, 2024).

Kenya extended its fiscal incentives through the Finance Act 2025, while Sierra Leone amended the previous legislation to introduce Goods and Services Tax (GST) and Custom Duty exemptions for solar home systems through the Finance Act 2026 (J.v.G. Technology GmbH, 2025; Republic of Sierra Leone, 2025).²¹



¹⁹ This analysis covers the incentives that came into effect/reinforced/terminated between July 2025 and June 2026.

²⁰ Construction must begin by 4 July 2026 and be commissioned by 31 December 2027 to remain eligible for the tax credits.

²¹ Other notable developments in fiscal incentives for renewable power between July 2025 and June 2026 are available in Appendix II.

Fiscal incentives for energy efficiency²²

Fiscal incentives for energy efficiency improvement in buildings are being contracted without any significant additions. OBBBA terminated several credits for home energy efficiency improvements in the United States (Alexander, 2026).

Many European countries and Canada already have incentives in place for heat pumps and home renovation, resulting in few developments in the past year²³ (Embuild, 2026; Natural Resources Canada, 2025). Although the European Heat Pump Association found that European countries have adjusted or tightened their support mechanisms for heat pumps from 2023 to 2025, and these incentives are largely addressing low-income households (EPHA, 2025).

According to the United Kingdom's Climate Change Committee, due to the closure of the government support scheme, the growth in heat pump adoption slowed down significantly in 2025 (Climate Change Committee, 2026). In contrast, South Africa has extended its tax incentives for investment in energy efficiency measures by five years, to December 2030 (Republic of South Africa, 2025).

Developments in fiscal measures for electric vehicles worldwide have been diverse. Africa is expanding, while Asia and Latin America are entering a maturation-driven phase-down of fiscal support as the markets become self-sustaining. South Africa, the leading automotive manufacturer of Africa, is now focusing on EV manufacturing. The country is providing a 150% tax deduction on qualifying investment for EV production from March 2026 (DTIC, 2025). To promote local manufacturing, Indonesia ended import duty exemptions in December 2025, while Brazil and Mexico increased import taxes in July 2025 and January 2026, respectively (Antara, 2025; DoF, 2025; Federative Republic of Brazil, 2023; Mann, 2025; Rosenzweig *et al.*, 2025).

The European Union's newly introduced Automotive Package leans toward relaxing its initial internal combustion engine (ICE) car sales ban by 2035, with the 2030 target now requiring a 40% CO₂ reduction (initially 50%) and a 90% CO₂ reduction by 2035 (moving from an initial 100% ICE sales ban). With the EU relaxing its EV deployment policy in this way, the EV sales share could fall by 17 percentage points by 2030 from what was initially anticipated, and their share in the fleet could be limited to 80–90% after 2035 (ICCT, 2026b).



²² Other notable developments in fiscal incentives for energy efficiency improvements between July 2025 and June 2026, by incentive type, are shown in Appendix III.

²³ Incentives came into effect/reinforced/terminated between July 2025 and June 2026.

Fiscal incentives are expiring in some mature EV markets (e.g. Norway, China). In Norway, almost all incentives provided for EVs expired in 2025, as almost all new vehicles sold were electric (Elbilforeningen, n.d.). China also introduced a 5% purchase tax on EVs from January 2026, which may slow the recent boom in sales (Bostock, 2025; Hove, 2026), but the country also continues to promote EVs primarily through localised city mandates such as Hainan Province's 2030 fossil-fuel vehicle ban. Canada and Germany launched new subsidy mechanisms in 2026, with Germany providing higher subsidies for low-income households (European Alternative Fuels Observatory, 2026).

In the United States, major rollbacks – including the removal of federal EV purchasing tax credits and the dismantling of strict EPA tailpipe rules – will likely impact EV deployment greatly in another leading market.

Carbon credits under Article 6 of the Paris Agreement

Carbon crediting mechanisms are now fully operational following the issuance of credits under the Paris Agreement Crediting Mechanism (PACM) in early 2026. Under Article 6.2, 21 new bilateral agreements were signed in the reporting period,²⁴ bringing the total to 110 bilateral agreements (UNEP-CCC, 2026a, 2026b).

Since Thailand's first Internationally Transferred Mitigation Outcomes (ITMOs) sale in 2024, four countries (Guyana, Madagascar, Maldives, and Thailand) have sold ITMOs in this reporting period (IRENA, COP30 and GRA, 2025; UNEP-CCC, 2026a). Clean cooking, electric vehicles, and solar energy projects are under those ITMOs, but their combined share is only about 10% (UNEP-CCC, 2026c).

The first-ever credit issued under the PACM (Article 6.4) took place in February 2026 for a clean cooking programme in Myanmar (UNEP-CCC, 2026b; UNFCCC, 2026). Another 20 projects/programmes from Bangladesh, Uganda, Bhutan, the Dominican Republic, Ghana, and Jordan have been approved and registered in the PACM registry (UNEP-CCC, 2026b). Those projects/programmes mainly focus on clean cooking, efficient appliances, grid/energy supply efficiency, and hydropower and wind energy (UNEP-CCC, 2026c).

²⁴ This analysis lists the agreements that took place between July 2025 and June 2026, and is mainly based on data from the UNEP-CCC's Article 6 Pipeline dashboards, which cover data till May 2026, and is complemented by desk research for June 2026 (including SB 64 outcomes); see Appendix V.

INFRASTRUCTURE AND SYSTEM OPERATION

Grids and curtailment

Grid connection wait times have spiked in some markets where grid planning has not kept pace with renewable capacity and demand growth (AFRY and Beyond Fossil Fuels, 2026; Beyond Fossil Fuels *et al.*, 2025; Rand *et al.*, 2026), while the impacts of grid constraints have also become more significant, with curtailment growing (ACERA, 2026; Gupta, 2026; Montel, 2026).²⁵

Increasingly, network limits are constraining not only where generation can connect but where new demand can be accommodated (IEA, 2026h). System operators remain obliged to connect loads but grid reinforcement lead times now exceed the build times of the loads seeking access; hence, connection is often constrained through use of multi-year connection queues, restrictions on siting in constrained areas, and curtailable or flexible connection terms (Commission for Regulation of Utilities, 2021, 2025).

Germany, France and the Netherlands together curtailed a record 3.9 TWh of renewable output, up 21% from 2024 values (Montel Analytics, 2026). China national average curtailments²⁶ have increased for the second consecutive year, they stood at 2.7% for wind and 2% for solar in 2023, increasing to 4.1% and 3.2% respectively in 2024 and to 5.7% for wind and 5.2% for solar in 2025 (National Energy Administration, 2024, 2025). Curtailment rates are more severe in provinces with higher shares of wind and solar, such as Inner Mongolia, Gansu, Qinghai and Xinjiang, where the average annual wind curtailment rate ranged from 6% to 9%, while the solar curtailment rate ranged from 7% to 17%. Notably, Xinjiang and Qinghai saw more severe solar curtailment, with respective rates of 16.6% and 13.7% (China Energy Transformation, Energy Policy Newsletter, 2026).



²⁵ Curtailment refers to the amount of energy that could be produced from renewable sources but must be intentionally left unutilised because it cannot be stored or delivered to the demand location.

²⁶ Curtailments are based on China's officially reported utilisation rates.



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In the United Kingdom, wind curtailment was around 3.8 TWh in 2020, but this had increased to 10 TWh in 2025 (Harper, 2026; Montel, 2026). In Chile, curtailment represented 14% of potential output of variable renewables (ACERA, 2026). Grid limitations have been key drivers of this curtailment, though system constraints and periods of renewable excess relative to demand also played a role.

Meeting the tripling target will require a significant and rapid increase in investments in grid modernisation, reinforcement, extension and resilience, in addition to addressing the historical under-investment in grids in some regions. This will require accelerating infrastructure permitting procedures, and digitalising and modernising grid infrastructure, enabling higher volumes of renewable generation, distributed energy resources and further electrification in end-use sectors. Under IRENA's revised 1.5°C Scenario, meeting these goals requires annual grid investments of approximately USD 902 billion to 2030 (IRENA, 2026d). Against this, the Global Energy Storage and Grids Pledge – issued at COP29 in Baku and reinforced under the Belém Action Mechanism at COP30 – calls for a doubling of grid investment by 2030 (UNEZA, 2025), the addition or upgrading of over 25 million kilometres of transmission and distribution lines, and 1 500 GW of storage globally. Current trajectories fall short: annual investment in transmission and distribution grids stood at around USD 450 billion in 2025 and while it is set to rise further in 2026, it will still leave a significant shortfall to the requirements of the Pledge (BNEF, 2025d; IEA, 2026f).

Grid reinforcement and expansion, as well as greater system flexibility, will help to limit technical curtailment based on grid constraints, ensuring renewable energy is integrated more efficiently (IRENA, 2026d). However, not all curtailment is due to technical constraints.

Economic curtailment arises where it represents a cost-effective outcome when supply exceeds demand, export and storage charging capacity, and is often reflected through low or negative prices. While in many markets curtailment of solar and wind power remains low (typically under 3% of their generation), in relatively isolated markets or those supplying large geographic areas with low population density, grid constraints can have more significant impacts, resulting in growing curtailment due to an inability to export or store excess power (Beyond Fossil Fuels *et al.*, 2025; IEA, 2025c).

Grid connection is becoming a binding constraint on deployment. Globally, around 2 500 GW of renewable, storage and large-load projects at advanced stages are waiting in connection queues (IEA, 2026h). National registers, which count projects from the point of initial application, are larger still, although reforms are now trimming them – US grid connection requests fell from a 2024 peak of 2 290 GW to 2 060 GW at the end of 2025 as speculative projects withdrew, with only 549 GW holding a draft or executed connection agreement, and median time from request to operation now exceeds five years (Rand *et al.*, 2026). The United Kingdom's 722 GW queue

(which exceeds its 2030 targets by around a factor of four) was reduced to a 283 GW delivery pipeline after the system operator re-screened every project against readiness and system-need criteria, which removed speculative applications that were blocking viable ones (Knight Frank, 2025). The composition of grid connection queues is also evolving: active gas capacity in US queues rose 86% in 2025 to 253 GW on rising data centre demand, while solar, storage, and wind all fell. Renewables still represent most of queued capacity, but gas is a growing proportion of a shrinking queue (Rand *et al.*, 2026).

Elsewhere, the backlog persists; more than 340 GW of projects hold connection agreements across the European Union, whilst a further 700 GW of projects remain queued (Ember, 2026a). Where connection is granted more readily, the impact of the slow scale-up of investment in grids shifts from constraint to curtailment; India has awarded connectivity to 107 GW of projects awaiting integration, but transmission delays curtailed some 300 GWh of renewable generation on the interstate system in the first quarter of 2026 (Ember, 2026b; Gupta, 2026).

Across 20 EU countries, one in every two grid operators reports insufficient network capacity to connect upcoming wind and solar projects, against a gap of more than 120 GW between available grid capacity and anticipated renewable growth by 2030 (Ember, 2026a, 2026c). The gap is not confined to transmission; distribution networks carry most of the connection volume for rooftop, commercial and industrial solar, electric vehicle charging and heat pumps, and in several European markets are now the tighter constraint (AFRY *et al.*, 2026).

However, solutions exist that can be rapidly deployed to unlock grid capacity before new lines are built. Grid-enhancing technologies and more flexible connection arrangements could together free enough hosting capacity to connect 1 200–1 600 GW of advanced-stage projects worldwide (IEA, 2026h). At project level, hybridising existing hydropower sites across seven EU countries could add 25 GW of wind and solar behind existing connection points, accounting for around 18% of the roughly 138 GW expected in those countries between 2026 and 2030, and lifting average grid connection utilisation from 19% to 36% with wind, or 31% with solar.

Realising these measures depends on regulatory frameworks permitting hybrid configurations, like those which currently exist in Spain and Portugal (Ember, 2026c). Alongside such measures, sustained investment in network expansion and resilience remains necessary to connect and use new capacity over the longer term.

Flexibility

Power systems require flexibility across a wide range of timescales – from seconds and minutes to daily, weekly and seasonal levels – and geographies to continuously balance supply and demand in real time. This capability is fundamental to the secure and reliable operation of any power system.

Under IRENA's revised 1.5°C Scenario, in the period 2023–2030, the flexibility required by the power system will increase by 2.8 times for daily, 2.6 times for weekly, and 2.3 times for monthly needs (IRENA, Forthcoming). For the same period under existing plans,²⁷ the flexibility required by the power system will increase by 1.9 times for daily, 1.85 times for weekly, and 1.7 times for monthly needs.

27 As per the IRENA Planned Energy Scenario (PES).



Countries increasingly recognise the importance of flexibility and have been making significant progress in the deployment of flexibility solutions. Energy storage has remained the fastest scaled-up flexibility solution for power systems in the past few years.

Storage deployment alone, however, may not be the most cost-effective approach to address flexibility needs. In most cases, no single flexibility solution may be sufficient to cover all types of flexibility needs. Instead, a combination of solutions would be more effective in delivering the required system flexibility. Other solutions include demand participation and sector coupling, interconnections, dispatchable renewable generation, and thermal generation based on sustainable fuels. While a holistic assessment of all sources of flexibility is essential, it is equally important to recognise that flexibility solutions are highly system specific (IRENA, Forthcoming).

The increasing occurrence of negative prices in power markets, as well as renewable curtailments, is a signal of the need for more flexibility. In Germany, annual recorded hours for negative wholesale prices were increased from 301 in 2023 to 457 in 2024, rising further to 573 in 2025 (Bundesnetzagentur, 2026).

Flexibility changes how systems respond to these conditions rather than removing them. In Australia's National Electricity Market, batteries set the wholesale price in 32% of dispatch intervals in the first quarter of 2026 – becoming the most frequent price-setting technology – absorbing midday surplus and discharging into the evening peak (Australian Energy Market Operator, 2026a, 2026b).

Hard-to-abate sectors

Hard-to-abate industries rely on high-temperature heat and chemical reactions that depend heavily on carbon feedstocks. Therefore, to decarbonise these sectors, direct electrification needs to be complemented by indirect electrification and other technologies such as non-bio renewable fuels (including renewables-based hydrogen), biofuels, and carbon capture and storage (CCS) to reduce their carbon emissions.

To achieve the UAE Consensus goal, electricity consumption in steel, cement and chemicals industries should reach at least 21% of total final energy consumption by 2030 from 12% in 2023. Furthermore, hydrogen and biofuel need to increase from current negligible shares to around 5% and 9% by 2030, respectively. The revised scenario also targets a share of electricity in final energy consumption in hard-to-abate transport sectors of around 4% by 2030, up from negligible levels (below 1%) in 2023.

The shares in total consumption of clean hydrogen and derivatives, and biofuels, must also significantly increase from negligible levels in 2023 (well below 1% for clean hydrogen and derivatives, and biofuels) to around 1% for clean hydrogen and derivatives and 7% for biofuels by 2030.



Electric vehicles

In parallel with the uptake of EVs, global public charging infrastructure has expanded nearly sixfold, from 0.9 million charging points in 2019 to 5.2 million by the end of 2024. However, this expansion has not fully matched the pace of vehicle uptake, which grew by around 700% over the same period. This can partly be explained by the use of home charging for EVs, but it is clear that the pace of EV charger deployment needs to accelerate.

China remains dominant in charging deployment, accounting for some 70% of global stations (3.6 million of 5.2 million). The comparative shortfall is pronounced in Europe and the US, where charging infrastructure growth appears to be lagging behind the accelerating pace of EV adoption. By the end of 2024, around 55 million EVs were deployed globally, resulting in a ratio of 10.7 EVs per charging station. However, this ratio varies significantly around the world, with only China and a limited number of European countries (Belgium and the Netherlands) offering the highest availability of charging stations per vehicle, with others sitting below the global average of 10.7 EVs per charging station. The ratio of EVs to ultra-fast charging stations (above 100 kW) continues to widen globally, reaching a global average of 29.7 EVs per ultra-fast charging station (BNEF, 2025b).

The main factors contributing to inadequate charging infrastructure deployment are: costs and financing – higher upfront investment remains a barrier, particularly in emerging economies with constrained purchasing power; and grid and policy gaps – many regions face grid reliability issues and a lack of clear, long-term regulatory targets or phase-out mandates for internal combustion engine (ICE) vehicles.



Artificial intelligence and digitalisation

The rapid growth of renewable energy, distributed energy resources and electricity demand is making power systems more complex. Continued digitalisation and the increasing use of artificial intelligence (AI) can help manage this transformation by strengthening monitoring, forecasting, operational optimisation, end-user automation and transparency. Together, these functions can reduce electricity costs, improve security of supply, facilitate renewable integration, create value for consumers and strengthen business performance (IRENA, 2025a).

Dynamic congestion management can use real-time analytics and automated control to unlock latent network capacity and reduce renewable curtailment. In some tracked cases in Chile, Spain and the United States, this solution has reported an increase in utilisation factor of existing grid capacity of between 60% and 100% locally (IRENA, 2026e).

Digital energy management and virtual power plant solutions can also optimise distributed resources and flexible demand, with cases reporting double digit increases in solar photovoltaic energy delivery by avoidance of curtailments (IRENA, 2026e).

AI-supported predictive maintenance can identify emerging failures and improve the targeting of maintenance; recent analysis of a distribution system operator in Spain indicated that more than 100 faults are prevented each year across its network (IRENA, 2026e).

Meanwhile, the expansion of digital services and AI is increasing electricity demand from data centres and creating new requirements for power-system planning. Data centres are becoming major and fast-growing electricity consumers, while access to power is increasingly a constraint on their development. If appropriately planned and operated, however, they can also act as anchor loads for new renewable energy projects and support power-system flexibility and grid integration.

IRENA advocates a harmonised understanding of a green data centre – placing the sustainability characteristics of its electricity supply at the centre of the assessment, articulated around the core principles of additionality of renewable capacity, as well as temporal and geographical correlation between electricity demand and renewable generation.

These criteria are particularly relevant to delivery of the UAE Consensus. Linking data-centre demand to electricity from new or otherwise additional renewable assets can create a direct investment signal for renewable generation and reduce reliance on the reallocation of existing renewable supply. Temporal matching strengthens the relationship between consumption and renewable output, while geographical correlation links procurement to the relevant power system and its physical conditions. Granular certification can improve the transparency and verification of these relationships and provide investment signals for renewable generation and storage. IRENA's recent analysis of firm renewable power provision shows how hourly-matching of variable renewables has become both technically and commercially viable today (IRENA, 2026c).

The definition can be complemented by grid-friendly deployment models adapted to national circumstances. Co-located renewable generation, storage and flexible operation can limit net imports at the connection point. Locating data centres where sufficient hosting capacity is available can avoid worsening congestion, while flexible-load models can adjust computing, cooling or storage demand in response to system conditions. Such approaches should remain subject to system reliability, grid-code, cost-allocation and verification requirements.

By linking rapidly growing AI-related electricity demand with additional renewable supply and more system-responsive operation, green data centres can support both digital development and the energy transition.



WORKFORCE, SKILLS AND INCLUSION

IRENA's jobs data shows that the renewable energy sector employed 16.6 million people, either directly or indirectly, in 2024, showing an increase from 16.2 million in 2023. This included 7.2 million jobs in solar PV, followed by 3.7 million in bioenergy, 2.3 million in hydro and 1.9 million in the wind sector (IRENA and ILO, 2026).

Job distribution remained geographically concentrated in just a few countries with 44% of the global total – 7.3 million people – in China alone due to its large-scale deployment and manufacturing capacity. This was followed by the EU, with 1.8 million jobs; Brazil with 1.4 million; India with 1.3 million and the United States with 1.1 million. These countries together accounted for three-quarters of jobs worldwide owing to their roles as leading global actors in areas such as equipment manufacturing, installation and related services.

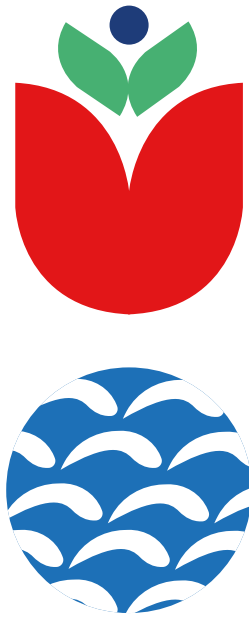
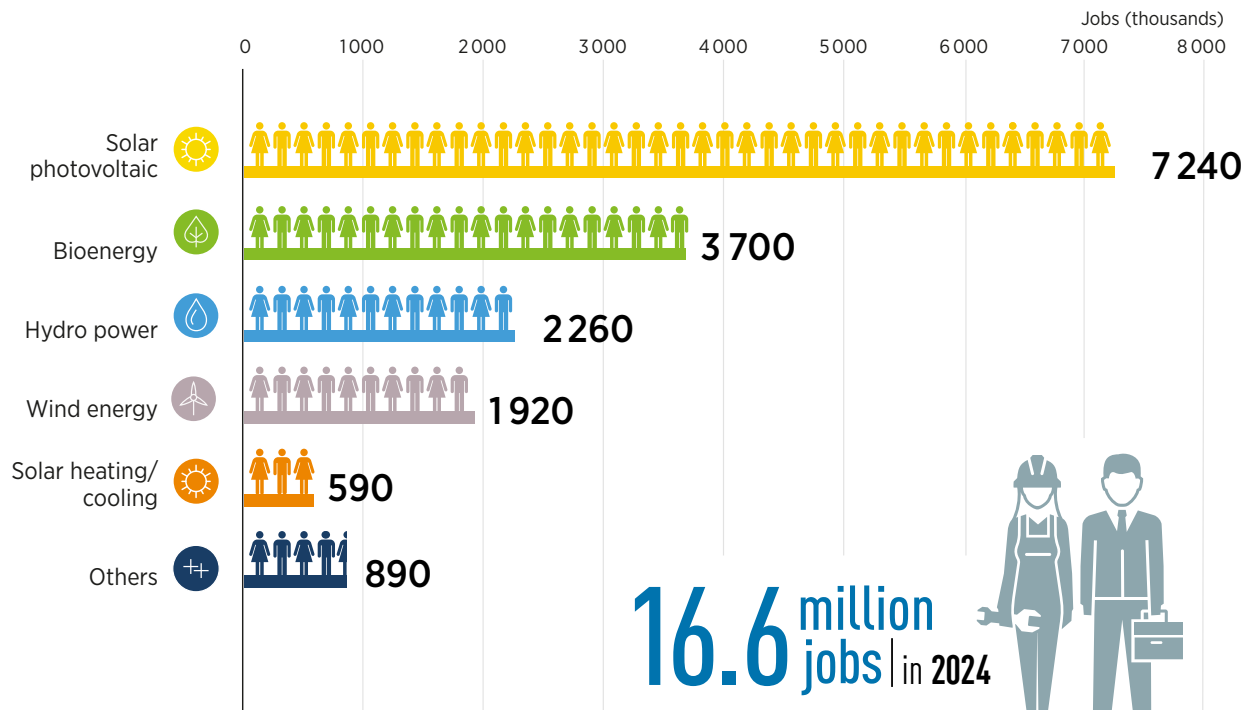


FIGURE 12 Jobs by technology in 2024

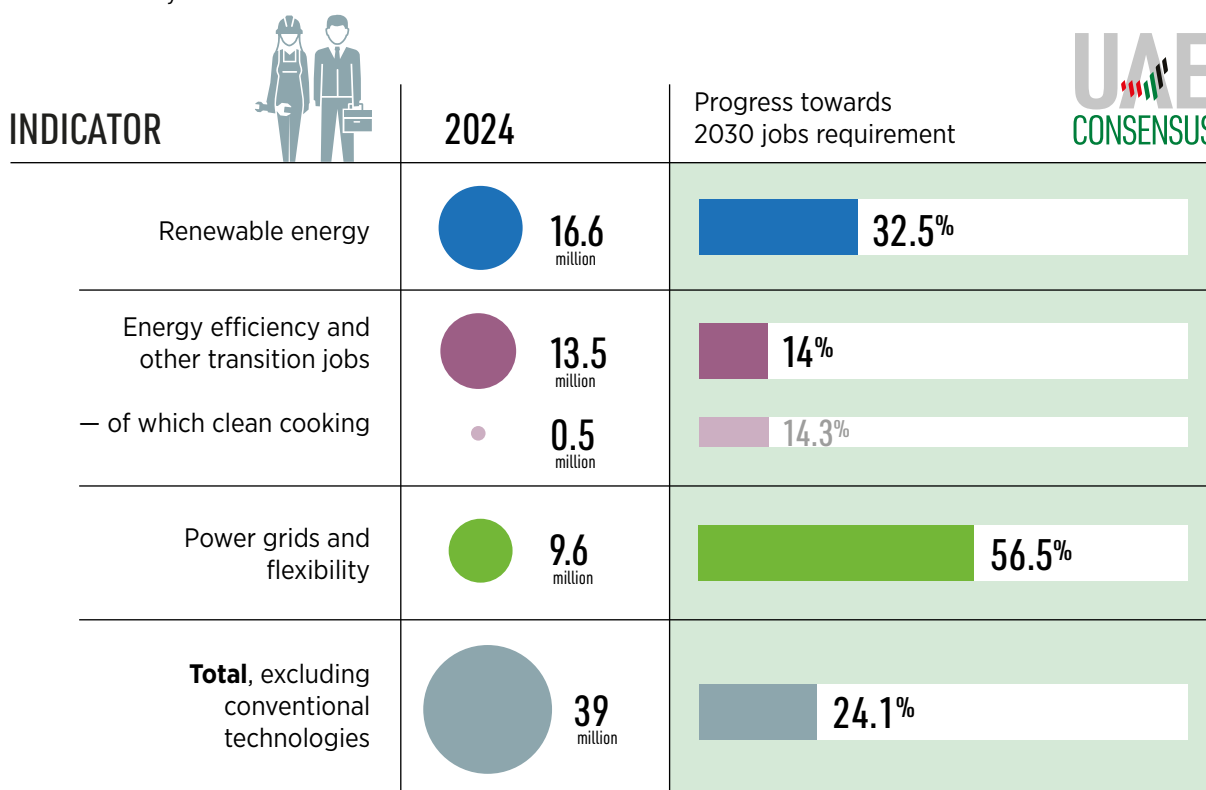


The uneven distribution of jobs is indicative not only of diverging ambition levels, investment flows, infrastructure and enabling policies but also of skilled labour gaps. As demonstrated in IRENA's Call to Action on Skilling for the Energy Transition, addressing skill shortages along energy transition supply chains requires targeted measures and commitments to build the future talent pipeline as well as re-skill current workers (IRENA, 2026f).

Renewable energy value chains offer employment opportunities in a wide range of occupations, including trades such as plumbers and electricians, as well as machinists and engineers, construction workers, sales personnel, planners and administrators and many other roles. Employers are also seeing the emergence of new digital energy jobs as well as a transformation of the skillsets required in existing roles. Implementing measures to equip the workforce for a digitally enabled energy transition will be vital, particularly when it comes to addressing the digital divide and ensuring that developing countries are not left behind.

Workforce development measures must also place inclusion at the core. The renewable energy workforce still remains highly male-centric with women holding only one out three jobs (IRENA, 2025b). Meanwhile, young people aged 25 and under, represent 40% of the world's population at a time when many countries grapple with high youth unemployment. Equal access to training, hiring and career advancement for underrepresented groups, including women, youth, persons with disabilities and other minorities is not only a matter of equity but also allows the renewable energy sector to tap into a wider pool of talent and experience.

FIGURE 13 Current energy transition jobs and requirements to meet the tripling of renewable capacity by 2030



Meeting the 11.2 TW renewable power capacity target by 2030 will require a corresponding scale-up in the workforce needed to deliver, operate and support this expansion. Renewable energy employment in 2024 represents around 32.5% of the roughly 51 million jobs estimated to be required by 2030 (Table 1). The employment seen in 2024 varies considerably across technologies, at around 60% or more of the 2030 requirement in hydropower and geothermal, while solar stands at around 48% and wind at 36%.

Across the wider energy transition, total employment of around 39 million jobs represents around one-quarter of the estimated 161.7 million jobs that will be needed by 2030 – showing the scale of workforce development required alongside renewable capacity expansion.

However, even with record renewable capacity additions in 2024 (IRENA, 2026a), employment grew by only 2.3% or around 0.4 million, reflecting factors such as economies of scale, automation and productivity improvements. Gains in these areas could therefore continue to help deliver part of the additional capacity addition needed to reach the tripling goal with fewer workers than a simple proportional scaling of current employment would imply.



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APPENDICES

APPENDIX I: Changes in national power market organisational structures (January 2025 – June 2026)

REFORM	COUNTRY	DETAILS
Opening or expansion of competitive electricity market access	Brazil 	Law No. 15 269/2025 further opens the electricity market to consumers served below 2.3 kV, starting with industrial and commercial consumers. In consideration of tariff affordability and energy security, the law requires consumer communication measures, tariff segregation between regulated and free-market consumers, and reference prices.
	Pakistan 	Pakistan is shifting away from the long-standing single-buyer model toward direct bilateral trading and wheeling auctions. ²⁸ The Competitive Trading Bilateral Contract Market (CTBCM) achieved commercial operation on 22 January 2026, while the Independent System and Market Operator (ISMO) issued guidelines for the first Wheeling Auction slated for 2026.
	Philippines 	Rate Case (RC) Resolution No. 22, Series of 2025 stipulates that consumers with average monthly demand of at least 100 kW may directly choose their retail electricity supplier or aggregate demand to enter the competitive retail market.
	South Africa 	Electricity Regulation Amendment Act 38, which came into force in January 2025, establishes an open market platform for competitive electricity trading.
	Viet Nam 	Decree No. 57/2025/ND-CP, enacted in March 2025, formalises direct electricity trading between renewable energy power generation units and large electricity consumers.
	Zambia 	In February 2025, the Electricity Open Access Framework was established, which enables non-discriminatory access to the national transmission and distribution networks through the electronic Electricity Open Access platform.
Organised wholesale market / unified national electricity market reform	China 	The comprehensive Energy Law, effective January 2025, codifies for the first time at the national level the objective of establishing a unified energy market system (Article 6). This signals a move away from fragmented rules across provinces towards a more integrated, open and regulated market framework. This was followed by two policies on ancillary market and spot market development from the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) in April 2025. By the end of 2025, China had basically achieved full coverage of provincial electricity spot markets, marking the official beginning of a unified national electricity market system.
	Sri Lanka 	The Sri Lanka Electricity (Amendment) Act, No. 14 of 2025 stipulates plans for a “National Electricity Market”, which may include a competitive wholesale spot market, a competitive wholesale contract market, a competitive ancillary-services market, and a retail electricity market. The Law mandates the National System Operator to formulate market models and implementation timelines.

28 Wheeling auctions refer to a market arrangement where private generators can bid for grid access rights to deliver electricity to private consumers.

REFORM	COUNTRY	DETAILS
Competitive procurement reform 3	Peru 	An amendment to Law No. 28 832 in January 2025 updates Peru's procurement framework by making electricity supply tenders technology-neutral. It also introduces more flexible tender design by allowing distributors to procure electricity by time blocks and contracting power and energy separately or jointly. This could allow renewables to compete more effectively in the periods where they are most cost-competitive, while capacity or firm-supply needs can be procured separately.
	Sri Lanka 	As of March 2026, the Ceylon Electricity Board (CEB) has been unbundled into six distinct state-owned companies, responsible for electricity generation, transmission, distribution and system operations. This reform is notably tied to the country's IMF bailout programme.
Unbundling 4	South Africa 	Electricity Regulation Amendment Act 38, which came into force on 1 January 2025, establishes a Transmission System Operator for the first time.
	China 	NDRC/NEA Document No. 136, issued in January 2025, requires on-grid electricity from wind and solar projects to fully participate in electricity markets, with on-grid prices formed through market transactions. The reform also calls for changes to spot and medium- and long-term market rules to facilitate renewable participation. Alongside market-based trading, it establishes a price settlement mechanism: for eligible generation, differences between market prices and a mechanism price are settled outside the market. For new projects commissioned from 1 June 2025, the volume covered by this mechanism is determined provincially and the mechanism price is set through competitive bidding.
Renewable energy market integration and pricing reform 5		

Sources: (Camara dos Deputados, 2025; Climate Cooperation China, 2025a, 2025b; Energy Regulatory Commission, n.d.; Government of South Africa, 2024; MINEM, 2025; NEA, 2026; NEPRA, 2026; Official Gazette, 2025; Samarawickrama, 2026; Sichone, 2025).

APPENDIX II: Fiscal Incentives for renewable power (July 2025 – June 2026)

FISCAL INCENTIVE	COUNTRY EXAMPLE	
Accelerated depreciation and investment allowances	Italy 	Accelerated depreciation for qualifying investments made between January 2026 and September 2028 to produce renewable energy for self-consumption.
	Spain 	Freedom of amortisation for renewable energy facilities extended until December 2026.
Domestic indirect and consumption taxes	Kenya 	Continuation of VAT exemption for all solar manufacturing equipment [The Finance Act, 2025].
	Nigeria 	VAT exemption for renewable energy equipment [Nigeria Tax Act, 2025].
	Sierra Leone 	Goods and Services Tax exemption for mini-grid renewables and solar home systems [The Finance Act 2026].
Import and customs duty relief	Kenya 	Continuation of Import Duty waivers for all solar manufacturing equipment [The Finance Act, 2025].
	Sierra Leone 	Custom Duty exemption for solar panels and solar home systems [The Finance Act 2026].
Investment and production tax credit	Canada 	Extended its Clean Technology Investment Tax Credits to include waste-to-electricity in addition to solar, wind, and hydro [Budget 2025 Implementation Act, 2026].
	Nigeria 	Tax Credit on investment in the renewable energy sector [Nigeria Tax Act, 2025].
	United States 	Phased out the investment and production tax credits for solar and wind [OBBBA, 2025].
Tax exemptions and holidays	Bangladesh 	Tax exemption for renewable energy project owners [SRO 400-Ain/Aykor-54/2024].
	Kenya 	Continuation of Investment Deduction Allowances [The Finance Act, 2025].

Sources: (Alexander, 2026; Government of Canada, 2026; Canada Revenue Agency, 2026; EY Global, 2026; Federal Republic of Nigeria, 2025; Global Law Experts, 2026; J.v.G. Technology GmbH, 2025; People's Republic of Bangladesh, 2024; Pisciotta, 2026; Republic of Sierra Leone, 2009, 2025).

APPENDIX III: Fiscal Incentives for energy efficiency improvement in end uses (July 2025 – June 2026)

FISCAL INCENTIVE	COUNTRY EXAMPLE	
Accelerated depreciation and investment allowances	South Africa 	150% investment allowance on qualifying investment in EV production, effective from March 2026.
Direct capital grants and rebates	Canada 	Purchase subsidy up to CAD 5 000 (c. USD 3 600) effective from February 2026.
	Germany 	Purchase subsidy for EVs from January 2026, ranging from EUR 3 000 to EUR 6 000 (c. USD 3 500-7 000).
Domestic indirect and consumption taxes	China 	5% Purchase tax introduced for EVs from January 2026.
	Ireland 	VAT on heat pump installations reduced from 23% to 9% from January 2026.
Import and customs duty relief	Brazil 	Import Tax raised for EVs (e.g. 25% for BEVs) from July 2025.
	Indonesia 	Import Duty exemption for completely built-up EVs ended in December 2025.
	Mexico 	Import Tax raised to 50% from January 2026.
Investment and production tax credit	Italy 	Budget 2026 continued Investment Tax Credits (up to 50%) for home renovation.
	South Africa 	Extended Tax Incentives for investment in energy efficiency measures by five years (until December 2030).
	United States 	Terminated several Tax Credit schemes in 2025.

Sources: (Alexander, 2026; Antara, 2025; Citizens Information, 2026; DoF, 2025; DTIC, 2025; European Alternative Fuels Observatory, 2026; Hove, 2026; Mann, 2025; Marco Grigis, 2026; Republic of South Africa, 2025; Transport Canada, 2026).

APPENDIX IV: Carbon compliance mechanisms (July 2025 – June 2026)

INSTRUMENT	JURISDICTION	ENFORCED ON	PRICE ²⁹ (USD/tCO ₂ eq)	SECTORS ³⁰
Carbon tax	Minneapolis 	January 2026	5.00	Electricity and Heat, Industry
	Serbia 	January 2026	4.64	Electricity and Heat, Industry
	Mauritania 	August 2025	20.00	Mining and Extractives
ETS	Japan 	April 2026		Electricity and Heat, Industry, Mining and Extractives, Transport, Aviation
	India 	October 2025		Industry, Mining and Extractives
	Viet Nam 	August 2025		Electricity and Heat, Industry

Sources: (Montalbano, 2025; World Bank, 2026a, 2026b).

Note: USD/tCO₂eq = US dollars per tonne carbon dioxide emissions equivalent.

²⁹ On 1st April 2026.

³⁰ For the sector definitions, please refer to the World Bank publication State and Trend of Carbon Pricing 2026, pages 56-57.

APPENDIX V: Bilateral agreements under Article 6.2 (July 2025 – June 2026)

BILATERAL TYPE	NUMBER	HOST	BUYER
Implementation Agreement	11	Dominican Republic, Georgia, Mongolia, Morocco, Pakistan, Philippines, Senegal, Thailand, Viet Nam, Zambia	Norway, Republic of Korea, Singapore, Sweden, Switzerland
Memorandum of Understanding	10	Bolivia (Plurinational State of), Brazil, Ethiopia, Malawi, India, Oman, Sweden, Viet Nam,	Japan, Republic of Korea, Singapore, Switzerland

Source: (UNEP-CCC, 2026b).

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