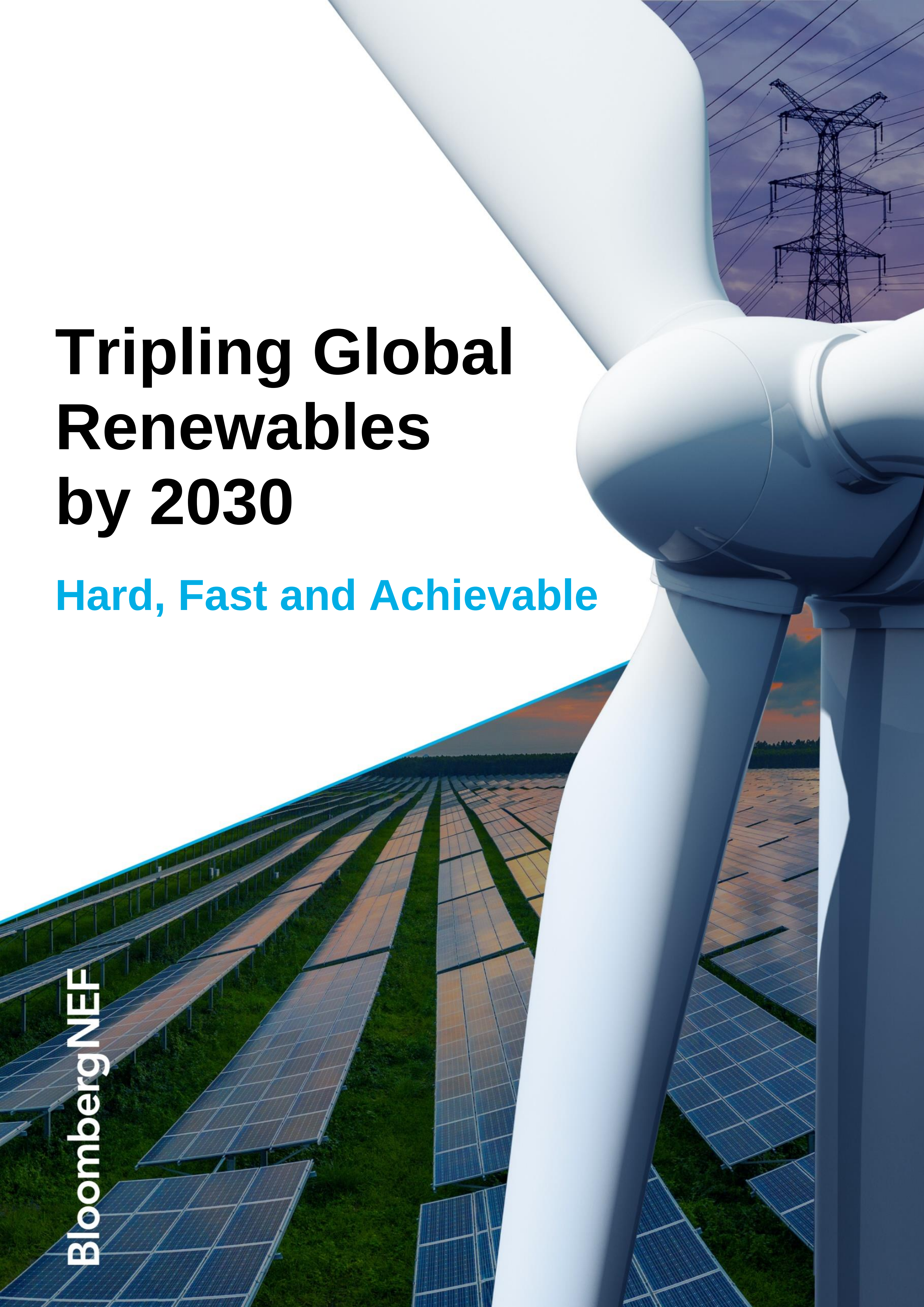
Tripling Global Renewables by 2030

Hard, Fast and Achievable



Contents

Section 1.		Executive summary	1
Section 2.		Tripling capacity as a goal for 2030	3
Section 3.		Is the world on track for this goal?	6
Section 4.		Regional pathways	11
	4.1	China	12
	4.2	Europe	13
	4.3	US	14
	4.4	Japan	14
	4.5	India	15
	4.6	Sub-Saharan Africa	16
	4.7	Middle East and North Africa (MENA)	17
	4.8	Indonesia	18
	4.9	Brazil	19
Section 5.		Solutions	20
	5.1	Barriers to access	20
	5.2	Auctions and offtakes	21
	5.3	Grids and infrastructure	22
	5.4	Permitting	23
	5.5	Market design	24
Appendices			25
Appendix A.		Methodology	25
About us			27

Section 1. Executive summary

11TW

Cumulative renewables capacity by the end of 2030 if 2022 capacity is tripled

16.1x

Energy storage capacity increase required to successfully integrate tripled renewables capacity

62%

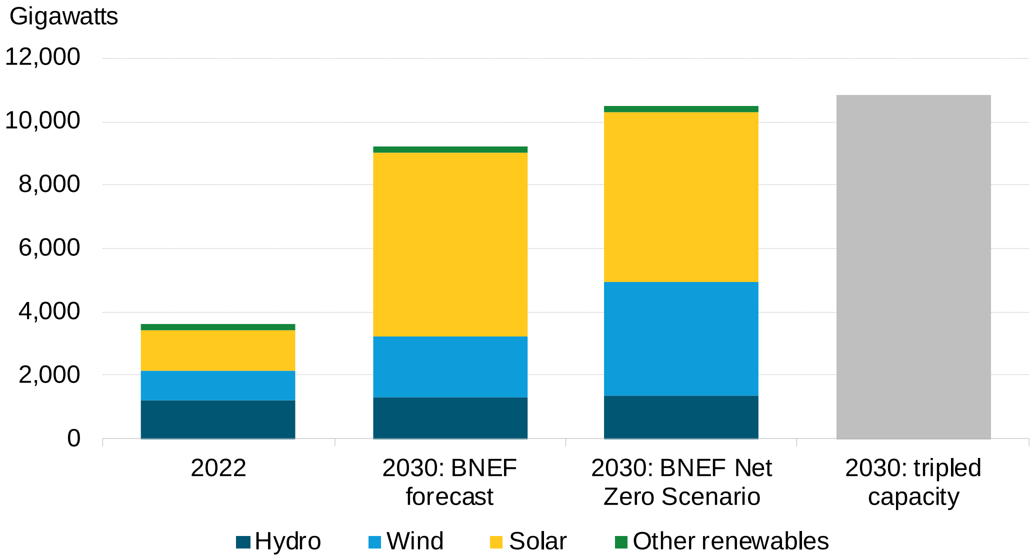
Emissions abatement between 2023 and 2030 expected to come from renewable power on a net-zero pathway

World leaders have been building momentum to triple global installed renewable energy capacity by 2030, from a 2022 baseline. This goal will take center stage at the United Nations climate summit in the United Arab Emirates this month as the COP28 Presidency seeks international agreement on it. The proposed pledge puts renewable energy at the forefront of upcoming negotiations and aligns with BloombergNEF's own analysis on a net-zero pathway. Achieving it will require global commitments to remove bottlenecks, particularly those affecting wind and power grids, that differ by country.

- **It's the right goal.** Tripling renewable energy capacity by 2030, to about 11 terawatts, is an important component of putting the world on track to reach net-zero emissions by 2050. By comparing this goal to BNEF's long-term scenarios, we find that a tripling of global renewables capacity is consistent with a pathway to global net zero by 2050, and that this increase in renewable power contributes a hefty 62% of total emissions abatement to 2030, against a no-transition scenario.
- **Tripling by 2030 will be hard, but achievable.** A tripling of the world's renewable capacity by 2030 entails a significant acceleration. The last tripling of renewable energy capacity took 12 years, and this next tripling must take eight. Wind and solar are now the cheapest sources of new generation in most countries, making such a goal more feasible than ever.
- **Industry and government must move fast.** Meeting the target would require a doubling of the rate of investment in renewable energy to an average of $1,175 billion per year between 2023 and 2030, from $564 billion in 2022. It also requires power grid investment to rise to $777 billion in 2030, nearly three times as much as was spent on grids in 2022, and deploying 720 gigawatts of batteries worldwide by 2030, which is 16.1 times the total deployed at the end of 2022. Supply chain capacity investment for solar, wind and batteries is sufficient, however, with some adjustment necessary for specific issues.
- **The technology mix matters – both solar and wind must scale up.** The world could most easily triple renewable capacity by relying primarily on solar. However, this would not generate enough clean energy to align with a net-zero path. BNEF's forecasts suggest that the required growth in solar is already on track to be achieved, while the required wind build will require concerted action to unlock. A diverse portfolio of renewable energy sources would be better for decarbonizing the global power mix than one that is substantially solar because of wind power's complementary generation profiles and higher capacity factors.
- **There are barriers that must be removed.** Economics is generally not what is holding renewables back, and deploying more can benefit regions with rapidly rising electricity demand. Scaling up the right mix of technologies will require measures that address barriers to access, enable competitive auctions and encourage corporate power purchase agreements. Governments also need to invest in grids, simplify permitting procedures for projects, and ensure that power and ancillary services markets function to incentivize a flexible power system that can make use of the new generation.

- **Contributions will differ around the world.** The aim to triple capacity is global and does not have to be met by each region individually. For regions that were earlier adopters of renewables, including China, the US and Europe, tripling is the right goal. Other markets, particularly those with a smaller renewable base and high levels of demand growth, such as south and southeast Asia, the Middle East and Africa, will need to more than triple capacity by 2030. Few are on track to more than triple today. Other markets, like Brazil, already have most of their power coming from renewable or low-carbon sources. Their contributions to a global tripling can be lower, while focusing more on decarbonizing industry, buildings, transport and agriculture, as well as the final 10-30% of electricity sector emissions that still rely on fossil generation.

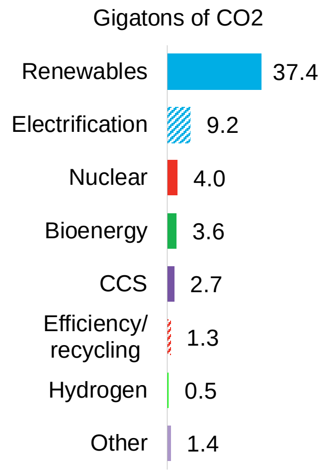
Figure 1: Global capacity of installed renewable energy, 2022 and 2030 in several scenarios



Source: BloombergNEF. Note: 'Other renewables' includes bioenergy, geothermal, solar thermal and marine.

Section 2. Tripling capacity as a goal for 2030

Figure 2: Cumulative emissions reductions in BNEF's Net Zero Scenario by measure, 2022-2030



Source: BloombergNEF Note: Reductions from fuel combustion by measure. CCS is carbon capture and storage.

Renewable power is critical to climate commitments

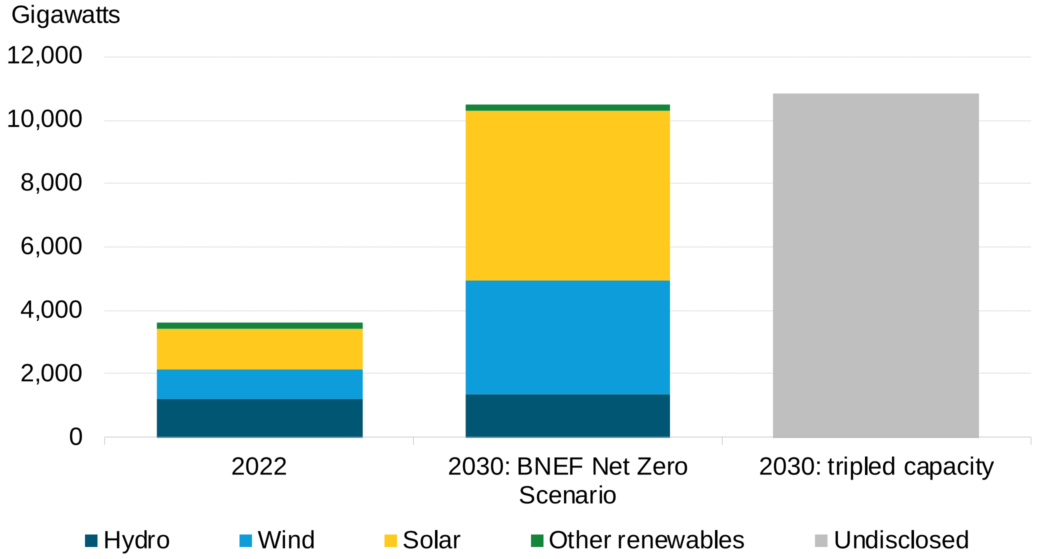
Renewable energy is key to achieving global climate commitments. The Net Zero Scenario of BloombergNEF's New Energy Outlook, which charts a pathway to net-zero emissions by 2050 while keeping global warming well below 2°C, sees renewable energy contributing 62% of all emissions reductions by 2030, compared to a counterfactual no-transition pathway (Figure 2). Electrification of end-use sectors, such as industry and road transport, contributes a further 15% of total carbon abatement.

The Presidency of COP28, which will be hosted by the United Arab Emirates, has been working to unite parties around a pledge to triple global renewable energy capacity to reach 11 terawatts (TW) by 2030. Such a commitment at COP28 would put renewable energy front and center of international efforts to address climate change.

Tripling renewables by 2030 is consistent with the Paris goals

The goal aligns with BloombergNEF's Net Zero Scenario, published in November 2022, which sees 10.5TW of renewable capacity by 2030 to stay on track for global net zero by 2050 and Paris-aligned climate goals (Figure 3). Our modeling suggests this leads to over 22,000 terawatt-hours (TWh) of renewable electricity generation globally in 2030, abating 9,300 million metric tons of CO_2 (MtCO2) in that year or 27% of 2022 power sector emissions, compared with 8,400TWh generated from renewables in 2022.

Figure 3: Global renewable energy capacity installed in 2022 vs 2030 under Net Zero Scenario or tripling renewables target



Source: BloombergNEF. Note: 'Other renewables' includes bioenergy, geothermal, solar thermal and marine.

The falling cost of renewables over the last two decades makes this a feasible goal, but there are headwinds. Solar deployment continues to skyrocket, but the wind industry has been shaken by high-profile contract cancellations and declining investment in assets at a global scale. Rising interest rates and greater costs of debt have also added to financing costs, while lagging grid buildouts have lengthened development timelines – putting 2030 clean energy ambitions at risk.

The last tripling took 12 years. The next needs to take eight.

A tripling of renewable capacity by 2030 would align with BNEF's Net Zero Scenario

The world has 3.6 terawatts of renewable energy capacity as of the end of 2022, comprising wind, solar, large- and small-scale hydro, geothermal, biomass and marine/tidal. This is equivalent in capacity to the full generation fleets of the US and China combined, and is three times the 1.2TW the world had at the end of 2010 (Figure 4). Most of this growth has been in wind and solar; solar capacity at the end of 2022 is 27 times what it was at the end of 2010, while wind has grown by a factor of five. This has largely been driven by reductions in cost and favorable policies in a positive feedback loop.

Figure 4: Global cumulative renewable energy capacity

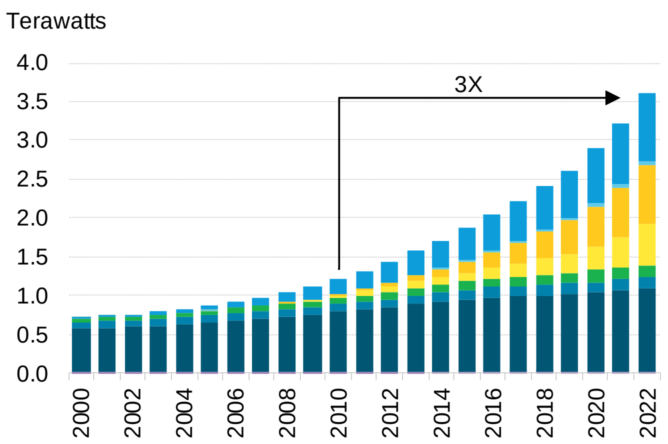
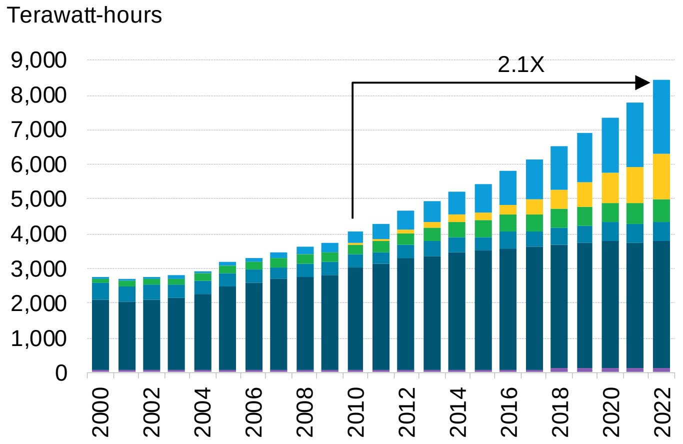


Figure 5: Global renewable energy generation



Source: BloombergNEF Note: PV capacity is tracked in MW(DC), ie the capacity of the panels. Generation data is likely to exclude that of some small solar plants which supply onsite electricity demand. Wind generation covers onshore and offshore, solar generation includes small-scale and utility-scale.

The next tripling must happen in eight years

While renewables capacity tripled from 2010 to 2022, the next tripling will have to be achieved faster. The last tripling of renewable energy capacity took 12 years, and this next tripling must take eight.

Both wind and solar must scale up

BloombergNEF's Net Zero Scenario sees over 22,000 terawatt-hours of renewables generation in 2030, largely from 5.3TW of solar and 3.6TW of wind. This is 2.6x as much renewable energy generation as in 2022, from triple the capacity.

While renewable capacity tripled between 2010 and 2022, recorded renewable energy generation only increased by a factor of 2.1 (Figure 5). This is because a lot of the new capacity was solar. And while solar is a major success story from the last decade and will be a huge player in the energy transition, it also has low capacity factors ranging from 30% in sunny Chile to about 11% in major markets like Germany and eastern China.

The global average capacity factor for solar in 2022, according to BloombergNEF data (which may well exclude some small-scale generation), was 13.2%, assuming the average new solar farm came online mid-year. In contrast, wind farms had a global average capacity factor in 2022 of 27.2% by the same methodology. Hydro plants ran at a global average of 40% in 2022, and geothermal at 68%. While new wind and hydroelectricity plants are likely to produce more electricity per megawatt due to technology improvements, low capacity factors are a structural feature of solar.

Solar alone can't get the world to net-zero emissions

Solar is cheap (it is usually the cheapest source of bulk electricity) and easy to site, making it a quick technology to deploy. Tripling global renewables capacity by 2030 could be achieved with solar alone. However, because of solar's low capacity factor and high seasonality, a rapidly-decarbonizing world that is overly reliant on solar while tripling renewables capacity will not see the same impact on electricity generation, nor emissions reductions, as one with a more diverse fleet of renewables.

There is even some danger that high solar generation in the daytime and in summer could cannibalize the returns of other clean power plants such as wind farms, preventing build and driving more fossil fuel use at night and in the winter. Addressing emissions requires a balanced deployment of clean power technologies, and consideration of the time of day and year when different sources are likely to be available – not merely tripling the capacity deployed. Wind and solar often have complementary output profiles, and solar generates more at times of year when hydro generation is often low. A mixed portfolio will also make it easier to remove the last 10-30% of emissions from the power sector.

Regional contributions will vary

The impact and ambition required to achieve the goal of tripling global renewables capacity differs around the world

The tripling goal is global and individual parties will determine how best to contribute.

For markets that were earlier adopters of renewables, tripling is the right goal to set domestically. In the US, Europe, Japan and China tripling renewable energy capacity by 2030 would align with a net-zero path based on BloombergNEF's scenario modelling.

For other regions, a goal of tripling renewables by 2030 is not sufficiently ambitious to set a pathway to net zero due to a small starting base, and may well be met simply by economic build. This is particularly true in south and southeast Asia, the Middle East and Africa, all of which need to set a steeper trajectory away from fossil fuels while meeting growing electricity demand. Ultimately, the falling cost of renewables means that the Middle East and Africa are already forecasted to triple renewables by 2030. The Nairobi Declaration, signed in September 2023 ahead of COP28 negotiations, acknowledges the need for greater ambition in its call for $600 billion of investment to achieve a 5x growth in Africa's renewables capacity, backed by a multilateral financing system.

Other countries need to do less, particularly those that already have a high contribution from renewable energy in their power system**.** For instance, Brazil saw over 85% of its generation coming from low-carbon sources in 2022 thanks to a large existing hydro fleet. In regions like this, enabling additional renewables build is important but the focus should be on finding ways to decarbonize industry, buildings, transport and agriculture, as well as the final 10-30% of electricity sector emissions that still rely on fossil generation.

Section 3. Is the world on track for this goal?

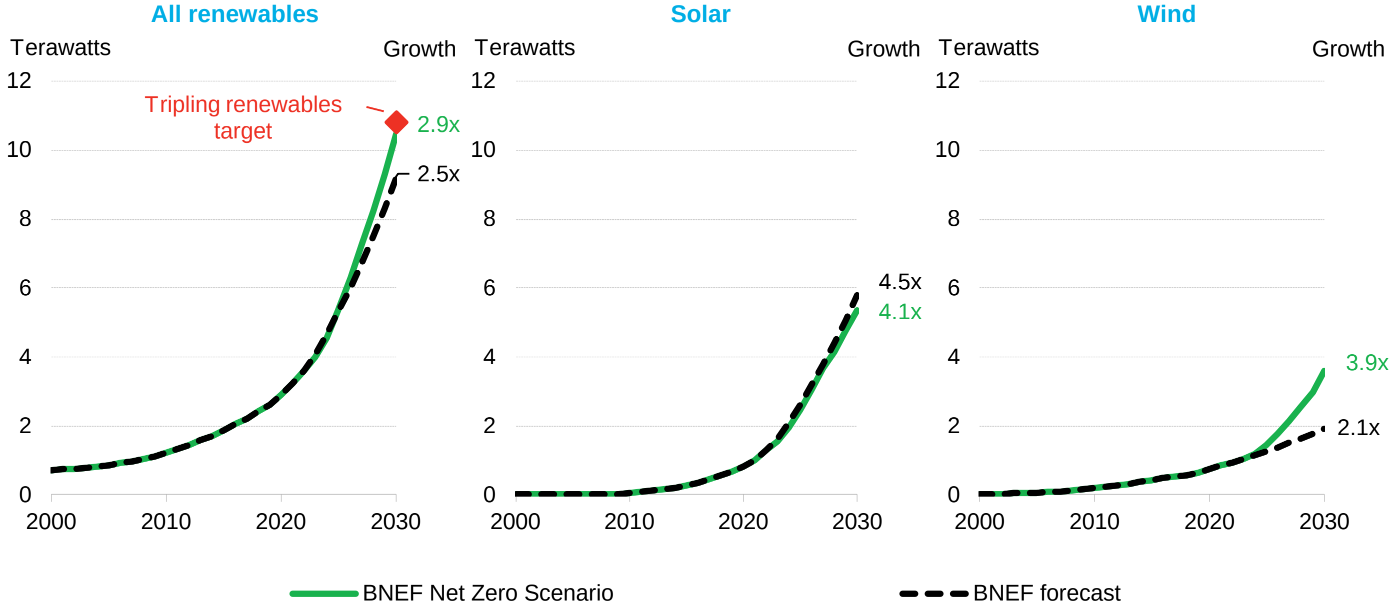
The short answer: no

BloombergNEF forecasts 9TW of renewables capacity in 2030 – less than tripling today's fleet

The COP28 Presidency's ambition to triple global renewables capacity by 2030 means reaching 11TW of installed capacity. Meeting the target would require renewables build at a compound annual growth rate of 14.9% from the end of 2022 to 2030 (Figure 6). This goal aligns with what is needed under BloombergNEF's Net Zero Scenario.

Meanwhile, as of October 2023, BloombergNEF expects 5.8TW of solar and only 1.9TW of wind to be built by 2030. These forecasts are based on current policy, economics, project pipelines and likely regulatory and infrastructure developments in each country. Adding in planned build of other clean power technologies like hydro and biomass, BNEF forecasts a mere 9TW of renewables capacity in 2030 – still 2.5x the amount at the end of 2022, but a far worse outcome in terms of generation and decarbonization.

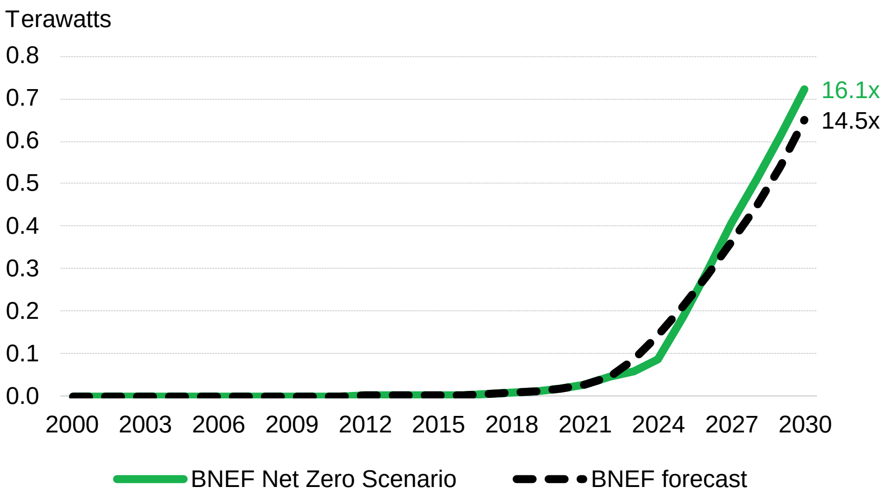
Figure 6: Global renewable energy capacity forecasts versus Net Zero Scenario



Source: BloombergNEF. Note: Renewables here includes large hydro. Values on right-hand side are capacity growth from 2022-2030.

Scaling up renewables also requires significant investment into grids and storage. In BloombergNEF's Net Zero Scenario, annual investment in the power grid rises to $777 billion in 2030 in real 2022 dollars, nearly 3x as much as was spent on grids in 2022. Meanwhile, 0.72TW of battery storage capacity is installed by 2030 to help manage the intermittent power generation, 16x more than is installed today. As of October 2023, BloombergNEF forecasts that around 0.65TW of energy storage capacity will be deployed worldwide by the end of 2030, which is roughly 10% less than in our Net Zero Scenario (Figure 7).

Figure 7: Global energy storage capacity forecasts and growth



Source: BloombergNEF. Note: Values on right-hand side are capacity growth from 2022-2030.

How the world can get on track

Governments must commit to tackling various barriers to renewables if they are serious about tripling the capacity deployed

Solar and wind are the cheapest source of electricity in most countries, so what is holding them back is generally not bulk economics. Five key challenges hinder renewable energy deployment:

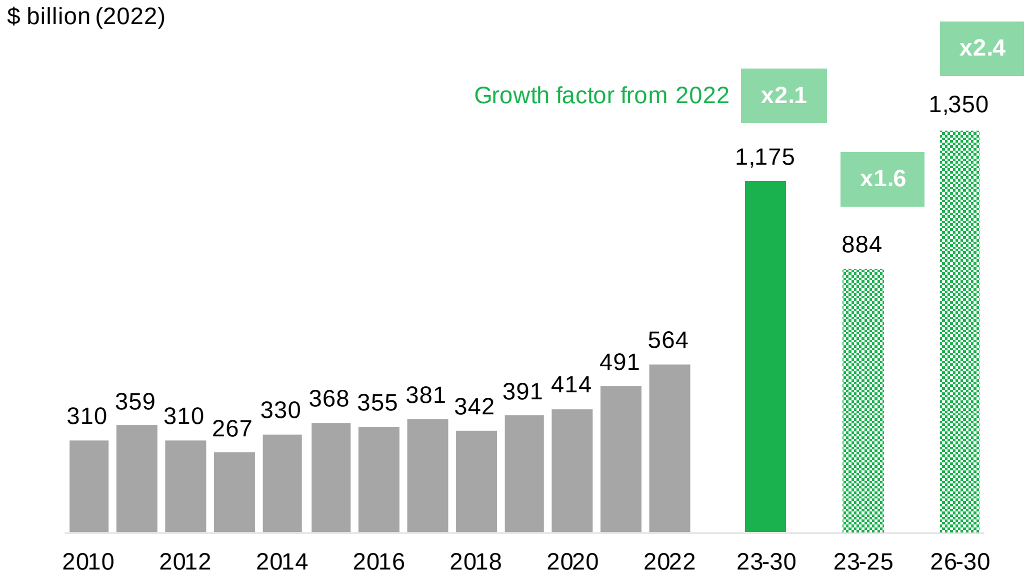
- **Barriers to access** such as licensing requirements and uncertainty around land ownership make it difficult for developers to build pipelines, while continued government subsidies for fossil fuels reduce the ability of renewable generation to compete on cost. Both can hold back the establishment of a financeable project pipeline, reducing capital mobility particularly to emerging markets and developing economies.
- **Auctions and offtakes** for clean power must also be improved and expanded. Offtake agreements for power at fixed or predictable prices, and auctions to allocate these contracts, can be powerful tools for helping developers to get projects built. However, they must also be designed for the long-term good of the power system, and to ensure sustainable prices by allowing strong competition between developers.
- **Grid infrastructure** is not currently keeping pace with the deployment of clean power. Many markets are underinvesting in their grids, leading to curtailment of power from built projects, and long connection queues and high costs to connect further projects.
- **Permitting** delays are also adding significantly to project development timelines and construction uncertainty. Prolonged and unpredictable appeals processes, a lack of staff to process permits at the municipal level, repetitive work for environmental impact studies and a lack of centralized geospatial and biodiversity data add to the challenges faced by developers. The Energy Transitions Commission estimates that solar and wind project development in Europe takes 4-12 years due to permitting and grid connection challenges.
- **Power market design** is critical to ensuring a low-carbon power system. Competitive price signaling for generation and demand enables a more diverse supply mix, efficient use of dispatchable resources including storage and flexible demand, and more corporate power purchase agreements. Competitive and standardized ancillary service markets are also important for managing the grid and ensuring renewables integration.

Overcoming these is key to achieving a tripling of renewables capacity and will require coordinated and increased ambition from government. More on the potential solutions can be found in Section 5. Further analysis and policy recommendations on how to achieve the COP28 Presidency's push to triple renewables can also be found in the October 2023 report *Tripling Renewable Power and Doubling Energy Efficiency by 2030: Crucial Steps Towards 1.5°C* from the COP28 Presidency, IRENA and the Global Renewables Alliance (GRA).

Annual investment into renewable energy must at least double

In BloombergNEF's Net Zero Scenario, the buildout of renewable energy assets sums to a $9.4 trillion investment opportunity between 2023 and 2030. Wind (both onshore and offshore) makes up 68% of this, while small-scale and utility-scale solar is a further 29%. In total, this could mean a 2.1x increase in annual investment for renewable power.

Figure 8: Annual global renewable power investment to 2030 in BNEF's Net Zero Scenario



Source: BloombergNEF. Note: Renewable power includes onshore wind, offshore wind, solar PV, geothermal, hydro and bioenergy. Green bars are annual average investment over that period.

Wind and solar make up 97% of renewable energy investment from 2023 to 2030

BloombergNEF tracked a total of $564 billion invested in renewable energy during 2022, largely through asset finance of utility-scale projects and consumer spending on small-scale solar. In our Net Zero Scenario, this ramps up to $884 billion per year from 2023 to 2025, a 57% increase. Annual investment rises a further 53% to $1.35 trillion per year in the second half of the 2020s, more than doubling last year's level (Figure 8). Solar investment during 2022 was already sufficient for what is required to the end of the decade. Wind, however, requires 4x growth from 2022 levels on average from 2023 to 2030 to align with a net-zero pathway.

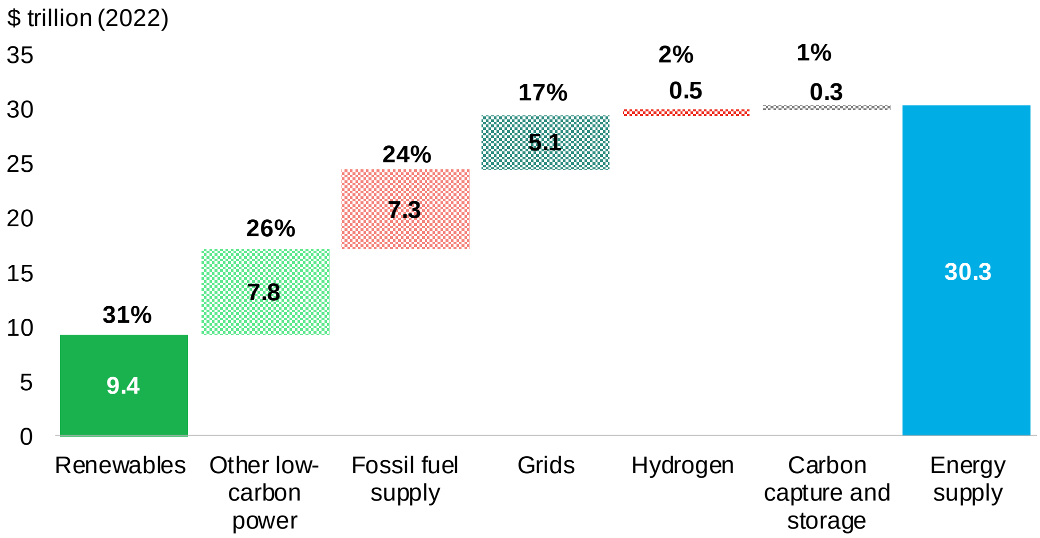
The capital outlay to triple renewable capacity this time will be almost twice the $4.9 trillion invested during the tripling between 2010 and 2022, where investment levels grew from $310 billion to $564 billion in real 2022 dollars.

The net-zero investment numbers required to triple renewable capacity by the end of the decade are also comparable with other commonly-referenced climate scenarios. The International Energy Agency's (IEA) Net Zero Emission pathway and the orderly Net Zero by 2050 scenario from the Network for Greening the Financial System (NGFS) see capital outlays sum to $8.6 trillion and

$11.5 trillion across 2023-2030, respectively. Annually, this translates to $1.1 and $1.4 trillion, indicating growth factors ranging 1.9 to 2.5 times higher than 2022 levels, in line with BNEF's 2.1.

In the broader picture, the $9.4 trillion investment opportunity for renewable power accounts for only 31% of the overall $30.3 trillion required for energy supply – assets that generate or store energy – in the 2023-30 period in BloombergNEF's Net Zero Scenario. Another $7.8 trillion will need to be invested in other low-carbon power, $7.3 trillion for fossil fuel processes, and $5.1 trillion on grids (Figure 9). While investment in hydrogen and carbon capture and storage are just $0.8 trillion in total to 2030, these sums are critical to scale up those technologies to be a bigger part of the solution to 2050.

Figure 9: Energy supply investment in BNEF's Net Zero Scenario from 2023 to 2030, global



Source: BloombergNEF. Note: Other low-carbon power includes, abated fossil fuels plants, pumped hydro, nuclear, solar thermal, and battery storage and hydrogen gas turbines. Fossil fuel supply includes the entire value-chain segments for oil, gas and coal and fossil fuel-based generation.

The global supply chain must grow by the end of the decade

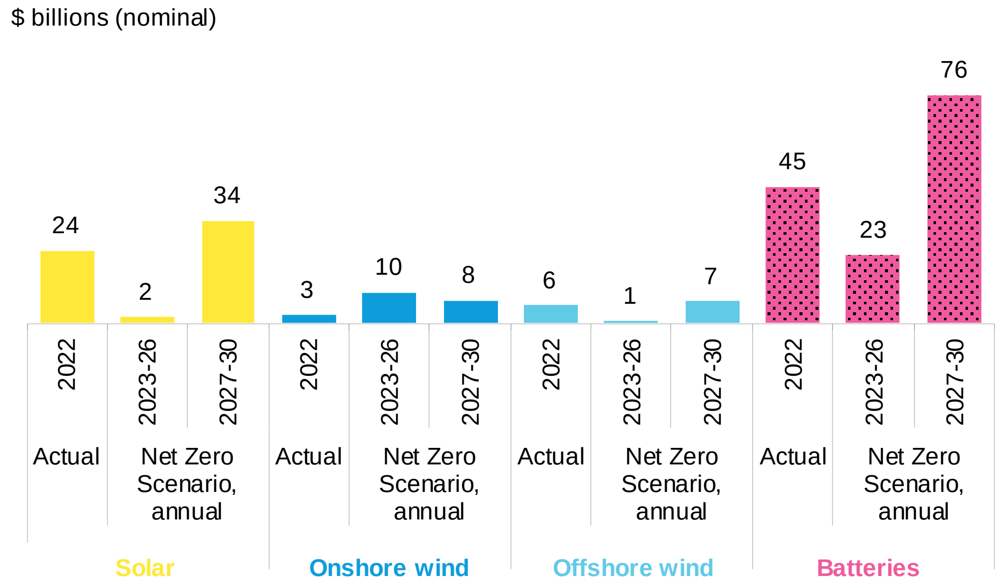
The existing factory base for solar, and current and planned battery factories, is more than sufficient to meet near-term projections

Solar, wind and battery factories representing $78 billion in capital spending came online in 2022. BNEF's Net Zero Scenario sees investments in the supply chain rising 60% to $125 billion per year by the end of the decade to achieve a near-tripling of renewable energy capacity installed (Figure 10).

The existing factory base for solar, and current and planned battery factories, is more than sufficient to meet this projection in the near term, meaning that for the next few years the tripling renewables target will not require a major scale-up in the supply chain.

While investments in the supply chain are needed in a net-zero path later this decade, current rates of investment look sufficient to meet these needs, and future factory investment will likely overshoot them. The required investment levels do not, for instance, account for the duplication of supply chains – an inevitability as policies prioritize resilience and job creation. For instance, the world's battery cell factory pipeline is already far higher than our projected near-term demand, and solar module makers are under severe margin pressure due to oversupply.

Figure 10: Clean energy factory investment, 2022 actuals vs average annual spend required for BNEF's Net Zero Scenario



Source: BloombergNEF. Note: Accounts for operational factories, but not closures nor retrofits of existing fleet.

Section 4. Regional pathways

Few markets are currently on track for their contributions to the global 2030 goal, as defined by BNEF's Net Zero Scenario. According to our latest forecasts, the US, Europe, Japan, India and Indonesia are projected to fall short of a tripling of renewables capacity by 2030, and also short of what's needed for a net-zero aligned pathway. While the Middle East and Africa are on track to triple, or more than triple, their renewables capacity by 2030, these countries need to contribute far more to align with Paris climate goals. Of the countries BNEF examined, only China is on track to deploy sufficient renewables by 2030 to align with both BloombergNEF's modelled net-zero path and a push to triple renewables capacity globally. Even China risks doing so with too great a reliance on solar over other technologies. Table 1 provides a summary on regional progress toward tripling renewables capacity by 2030 and a Paris-aligned pathway.

Table 1: Regional assessment of global renewables tripling goal

Contribution to global target	Region	Renewables capacity, 2022	On track for 2030 contribution?	BNEF Take
Need to triple or nearly triple renewables capacity by 2030	China	1,236GW	Yes	China is expected to triple its renewables capacity by 2030; however, it risks being over-reliant on solar in doing so. Encouraging greater development of wind will be essential.
	Europe	663GW	No	Europe needs to approximately triple its renewable capacity by 2030 to align with net zero. However, the region is set to miss this goal by a third. Long development timelines due to grid and permitting bottlenecks, and challenges expanding offshore wind faster to make up for sluggish onshore growth, are key limiting factors.
	US	385GW	No	The US is behind on renewable capacity deployment relative to its net-zero goals and President Biden's climate targets. Even with the Inflation Reduction Act, the country will struggle to meet a net-zero path unless it can improve bottlenecks around permits and grids.
	Japan	119GW	No	Japan needs to approximately triple its renewable capacity by 2030 to align with net zero, but the nation is set to miss this target by half.
Need to more than triple renewables capacity by 2030	India	177GW	No	India is not on track to triple renewables by 2030, nor would this be sufficient to align with a net-zero path. India needs to quadruple renewables capacity by 2030 to align with BNEF's Net Zero Scenario.
	Sub-Saharan Africa	48GW	No	BloombergNEF sees Sub-Saharan Africa's renewables base tripling by 2030, largely thanks to solar. However, this is from a small base; more will need to be done to manage emissions, especially given governments' plans to add more fossil-fuel power to meet rising electricity demand and make use of domestic resources.
	Middle East & North Africa (MENA)	36GW	No	BNEF sees the MENA region tripling its renewables base by 2030, largely thanks to solar. However, with 328 gigawatts of fossil fuel-fired power generation installed, this will be insufficient to align with net-zero.

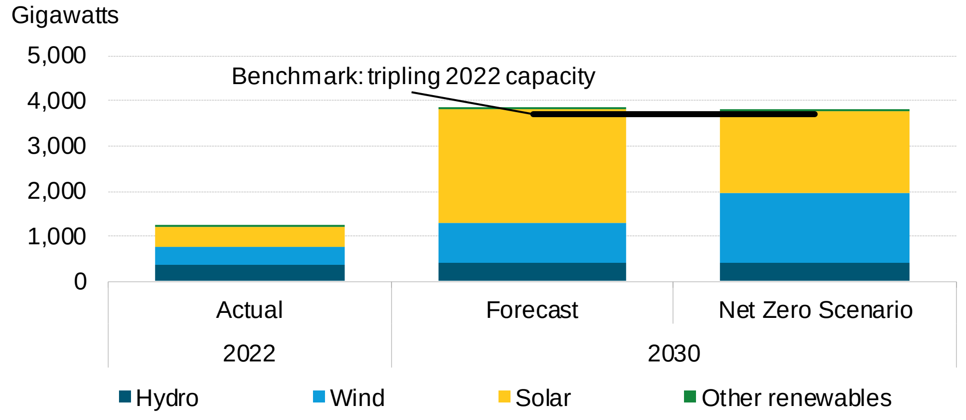
Contribution to global target	Region	Renewables capacity, 2022	On track for 2030 contribution?	BNEF Take
	Indonesia	13GW	No	Indonesia is not on track for BloombergNEF's Net Zero Scenario, which sees the renewable energy fleet growing 7.6x by 2030, compared to an expected doubling in our forecasts.
Less than tripling is sufficient	Brazil	181GW	No	Brazil is not set to triple renewables by 2030; however, given that 85% of its generation mix is already low carbon thanks to a large hydro base, a better goal here might be to focus on reducing carbon emissions outside the power sector, such as in industry, transport and agriculture, while maintaining the clean electricity grid.

Source: BloombergNEF. Note: GW = gigawatts. A Net Zero Scenario was not run for Brazil, Sub-Saharan Africa nor Middle East & North Africa.

4.1 China

China has the world's largest base of installed renewables, with 1.2TW of existing capacity; tripling this would take the country to 3.7TW. This is in line with what is needed for the Net Zero pathway, and less than BNEF's forecast of 3.9TW – although 2.5TW of that is low-capacity-factor solar that is unlikely to generate enough to align with a net-zero path (Figure 11).

Figure 11: China renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario



Source: BloombergNEF

As in many other markets, BNEF expects there to be plenty of solar in China in 2030, but for the country to have less wind capacity additions than the Net Zero Scenario would suggest. The capacity factor of solar in China is typically low (11-14%), because while the western provinces are sunny, much of the capacity will be on rooftops in eastern provinces close to electricity demand. China's National Energy Administration (NEA) has accelerated rooftop solar deployment through bulk purchasing schemes in 676 counties, where state-owned developers are issued the remit to build solar and share revenue or savings with the rooftop owners. Large-scale solar and wind is being deployed through the 'energy megabase' program, but this depends on expansion of the long-distance electricity transmission grid.

In addition to constructing ultra-high-voltage transmission lines, China is working to expand its offshore wind framework to national, not just provincial, waters and looking to develop floating wind. Both measures support additional wind build near China's coastal population centers. China also mandates storage attachments at utility-scale projects in most provinces – which could help manage the generation output of BNEF's forecasted capacity mix to better align with net zero. For more, see *New Energy Outlook: China* (paywall: web | terminal).

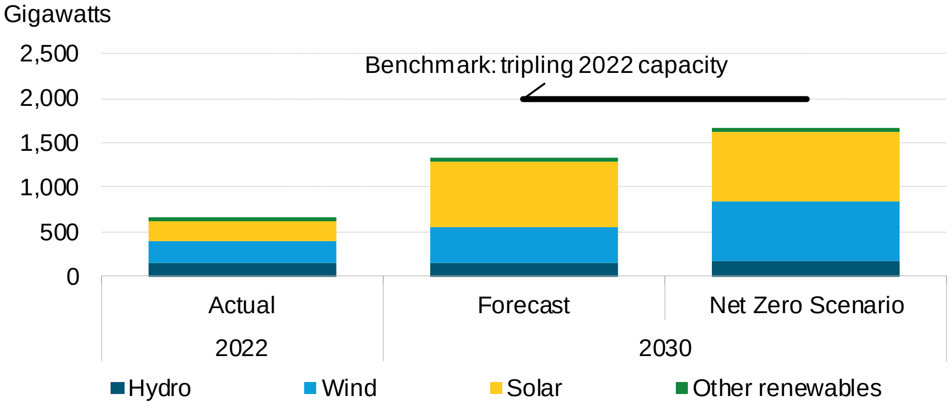
4.2 Europe

Europe is well ahead of most of the world on renewables deployment, with 663 gigawatts (GW) of renewables generating 33% of electricity in 2022 (source). Tripling this to 2TW by 2030 is therefore more ambitious than BNEF's forecast (Figure 12), and exceeds the level required to be on BNEF's path to net zero by 2050.

The European Union targets are already close to the tripling-renewables goal. The EU updated its Renewable Energy Directive in September 2023 to reach 42.5% of final energy consumption from renewables, which BNEF estimates would require a tripling of wind and solar capacity by 2030. To deliver on this new target, which has been increased from 30%, the EU urgently needs to solve its permitting and grid bottlenecks, and demand-side flexibility problems, that are holding back a more rapid rollout of renewables.

Although BNEF's solar analysis team expects European countries to meet or exceed most targets set to date, wind build is expected to fall behind. Germany, for example, is not awarding planning permission to nearly enough onshore wind farms to build the 12GW/year it needs to hit its 115GW goal by 2030. Wind is not usefully substituted by solar in northern Europe, because it blows in the winter, when demand for heat and light is much higher than in the summer.

Figure 12: Europe renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario



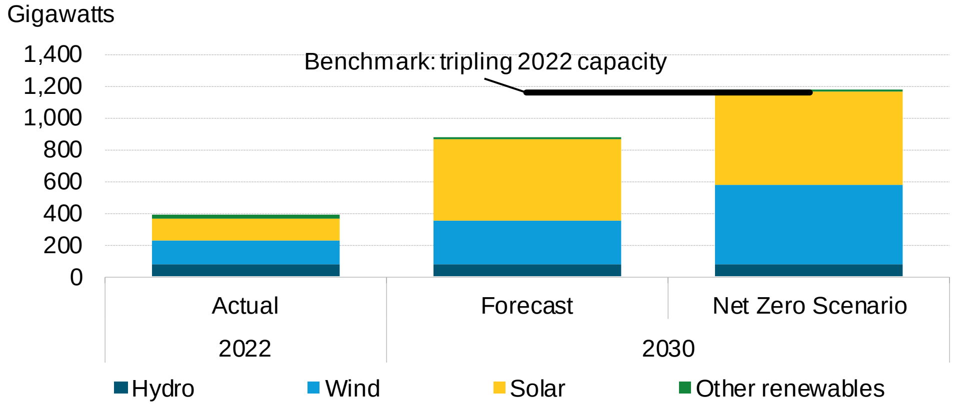
Source: BloombergNEF Note: Europe is the EU-27 plus Norway, Switzerland and UK.

This is only one side of the equation, and Europe will also need to increase storage and demand-side flexibility in the system so that power can be stored or used when the sun and the wind are available. Otherwise, power prices will crash at times of high renewable energy generation, suppressing further build and causing system problems. See *EU's New Renewables Target Requires Tripling of Capacity* (paywall: web | terminal).

4.3 US

The US has 385GW of renewables, mostly solar and wind. The Inflation Reduction Act (IRA), passed in August 2022, sets out generous support for wind and solar deployment and manufacturing, as well as other parts of the energy transition such as electric vehicles, grids, heat pumps and hydrogen.

Figure 13: US renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario



Source: BloombergNEF

Although the IRA is possibly the largest package of clean energy support ever passed by a government, it is pumping money into a market that is held back by non-economic factors. Complex solar trade restrictions ensure that solar modules are twice the price in the US than in Europe or any market that trades freely with China. Permitting regulations and a lack of investment and clarity in regional and local electricity grids hamper both wind and solar deployment. BNEF forecasts that the US will not triple its renewable energy capacity by 2030, but that such a tripling would be close to the Net Zero Scenario for the country (Figure 13).

The US government is taking steps to debottleneck the transition. Transmission lines such as TransWest Express, Champlain Hudson Power Express and Grain Belt Express have benefited from fast-tracked permit approvals, and further reforms are underway. These will need to succeed for the US to triple its renewables capacity by 2030 and get on track for net zero.

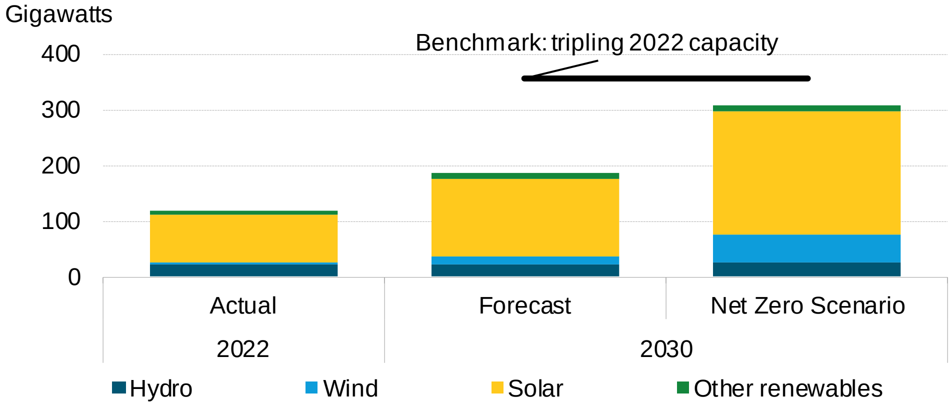
4.4 Japan

Japan has already had several subsidy-driven solar build booms in the last 30 years, and so already had about 84GW of solar at the end of 2022. Consequently, tripling its renewables capacity by 2030 would take it slightly above the Net Zero Scenario (Figure 14).

Japan's government plans for further decarbonization rely on nuclear restarts and wind, as well as gradually replacing coal and liquefied natural gas fuels for thermal power plants with clean ammonia and hydrogen. However, these plans do not align with a net-zero scenario and BNEF's forecasted renewables build for the country is also far behind this goal.

BloombergNEF's Net Zero Scenario sees 49% of power generation coming from renewable sources by 2030, compared to 21% in 2022. Improving grid connection timelines and permitting processes, arranging auctions that assist developers with land and grid connection risks, a clearer and longer-term auction calendar and more support directed to less-developed technologies like geothermal would all be essential steps to unlocking clean power deployment in the country.

Figure 14: Japan renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario

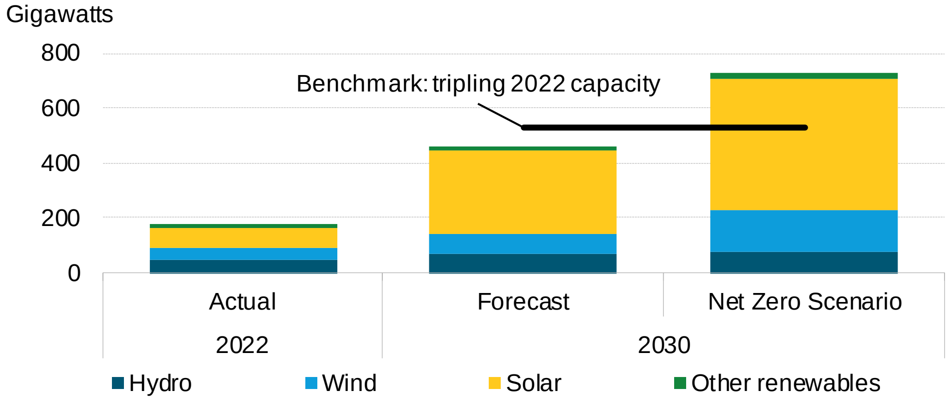


Source: BloombergNEF

4.5 India

India has 177GW of renewables installed. BNEF forecasts show a 2.6x growth in installed capacity by 2030, falling short of our modelled net-zero path (Figure 15). BNEF's Net Zero Scenario also has a large amount of new solar in India, partly because much of the additional power demand will be due to air conditioning and hence have a demand profile matching solar generation profiles quite well.

Figure 15: India renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario



Source: BloombergNEF

India's government is taking substantial measures to accelerate renewables deployment, including innovative auction designs for peak power, round-the-clock power and firm dispatchable power, all of which require different combinations of wind, solar and energy storage. In April 2023, India's Ministry of New and Renewable Energy (MNRE) announced that it would hold tenders for 50GW of clean energy capacity every year from financial year (FY) 2024, running April 2023 to March 2024, to FY2028. At least 10GW of this will be for wind power. An average of 15GW of renewables capacity was auctioned annually in the last five fiscal years. The increase in tender volumes is intended to help India realize its ambition of having 500GW of cumulative installed capacity from non-fossil-fuel sources by 2030, which given the government counts solar capacity in MW(AC), which is 20-30% lower than MW(DC), would be roughly a tripling (Appendix A.4). See *2H 2023 India Renewables Market Outlook* (paywall: web | terminal).

Investment in power system flexibility is crucial to back up and enable rapid electrification of new demand sectors in India and to decarbonize the power mix. This includes investment in batteries, pumped hydro and dispatchable clean power capacity – the latter of which the round-the-clock auctions serve to support. Markets to support flexibility, including India's announced overhaul of ancillary services, are also vital.

4.6 Sub-Saharan Africa

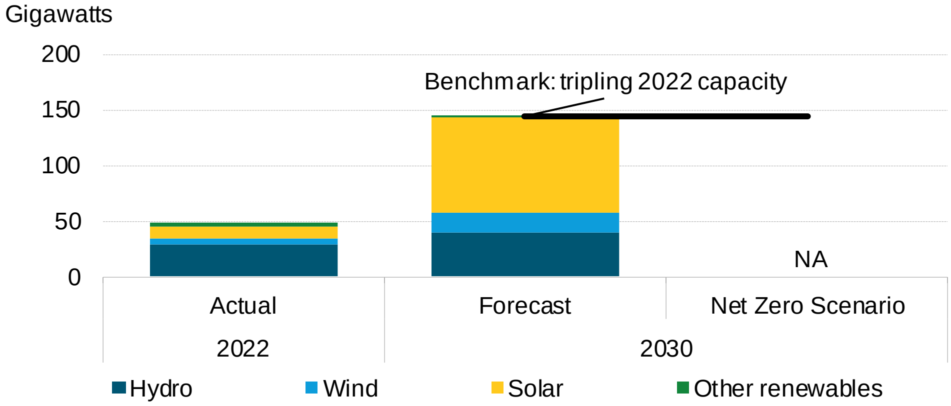
Sub-Saharan Africa is still early on in its energy transition. But renewable technologies have the potential to transform the region: mass deployment of new, low-cost clean technologies should trigger billions in investment, expand energy access to millions, and help mitigate the worst effects of climate change. Yet despite the region's abundant renewable resources, it has limited installed capacity today: in a market with a total of 137GW of on-grid capacity, just 48GW is renewable. Expanding this base is critical not just for the energy transition, but also for ensuring the region's population of 1.1 billion are able to increase their access to and consumption of electricity by 2030.

BloombergNEF's forecasts are for the region to slightly exceed a tripling of its renewables capacity by 2030, reaching 146GW (Figure 16). However, this relies heavily on solar build in just two countries, Nigeria and South Africa, where visibility on the current situation is better than is typical for the region.

In South Africa, the coal plants belonging to state utility Eskom are old and have not been adequately maintained, and so 'load shedding' or planned rolling blackouts are a daily experience for homes and businesses. The government acknowledges the electricity problem and is taking a wide range of measures to increase generation, including lifting the threshold size for a private generator to connect to the grid without a generation license to 100MW in 2021, and removing the threshold entirely in January 2023. This is driving a solar and battery boom in 2023, and the problem of blackouts is not expected to be solved quickly.

In Nigeria, the government spent $10 billion on fossil-fuel subsidies in 2022, and removed a long-standing subsidy on imported gasoline in May 2023. This drastically increased the cost of running the country's estimated 70 million private gensets, which cost Nigerians about $22 billion in fuel each year. The grid is unreliable, and solar and storage has become an economically favorable option. We estimate that 21.5GW of mostly small-scale solar could be installed in the country by 2030, potentially setting an example for other African countries seeking to cut fossil fuel subsidies now that solar and storage has fallen in price.

Figure 16: Sub-Saharan Africa renewables capacity, 2022 vs. 2030 BNEF forecast



Source: BloombergNEF Note: A Net Zero Scenario was not calculated for this region.

If indeed these two countries see a boom of almost-unsubsidized solar, they are unlikely to be the only ones in the region to take this path. However, a slew of policy-, infrastructure- and finance-related barriers have artificially inflated the costs of clean technologies or made them difficult to deploy across the region. Governments can do more to support a greater flow of capital toward local renewable energy projects by encouraging consistent clean power procurement (for instance, through clear and reliable auctions and tenders that are open to independent power producers), by supporting grid buildouts through clear development plans, and by enabling domestic financiers to thrive with monetary reforms. See *Scaling-Up Renewable Energy in Africa: A NetZero Pathfinders Report*.

4.7 Middle East and North Africa (MENA)

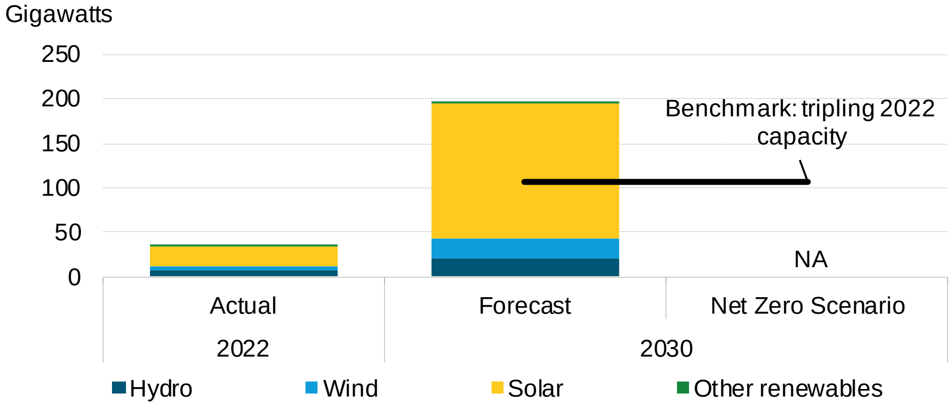
The MENA region has only 36GW of renewables at present, but BloombergNEF expects capacity quintuple by 2030 (Figure 17). We expect substantial solar build in the United Arab Emirates, Saudi Arabia, Israel, Egypt and Morocco under already-established programs, and solar is the cheapest source of bulk electricity for most of the region.

Countries in the region have their own targets, some of which would result in a substantial buildout of renewables, though the pandemic in 2020 and higher solar module prices in 2021 and 2022 caused a slowdown in build and a pragmatic pause in auction activity. There is relatively little wind activity to date, though more is planned.

The United Arab Emirates government, which is hosting COP28, updated its National Energy Strategy in 2023 to include a target of tripling renewable energy capacity to 14GW by 2030, and raising the percentage of clean energy in the total energy mix to 30% by 2031. Dubai and Abu Dhabi have built over 6GW of large solar complexes through a succession of regularly scheduled auction rounds, and continue to allocate major contracts.

In 2019, Saudi Arabia set a renewables target of 27GW by 2024 and 58.7GW by 2030, but has a history of revisions to targets. In 2023 the solar market is accelerating again, with Saudi infrastructure firm ACWA Power now holding a portfolio of over 12GW of solar in the country for near-term construction, with power contracts awarded by the Saudi Public Investment Fund (PIF).

Figure 17: Middle East and North Africa renewables capacity, 2022 vs. 2030 BNEF forecast

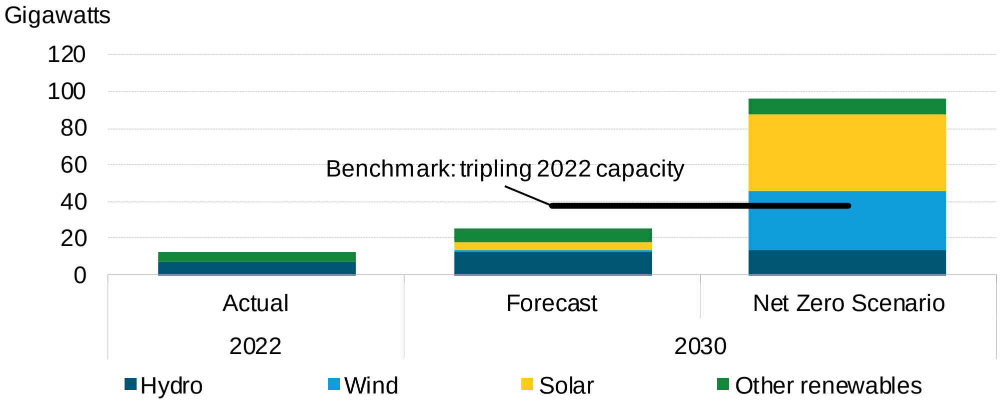


Source: BloombergNEF Note: A Net Zero Scenario was not calculated for this region.

4.8 Indonesia

Indonesia, the fourth-largest country in the world by population, has yet to really begin its renewable energy transition. At the end of 2022, it has just 13GW of renewables, mostly hydro geothermal, and biomass, and tripling this would deliver just 38GW (Figure 18). The BNEF forecast for wind and solar deployment to 2030 is modest, because the government has no firm policies to support these sectors and local coal remains cheap. The Net Zero Scenario, however, calls for 97GW of renewables by 2030.

Figure 18: Indonesia renewables capacity, 2022 vs. 2030 BNEF forecast and Net Zero scenario



Source: BloombergNEF

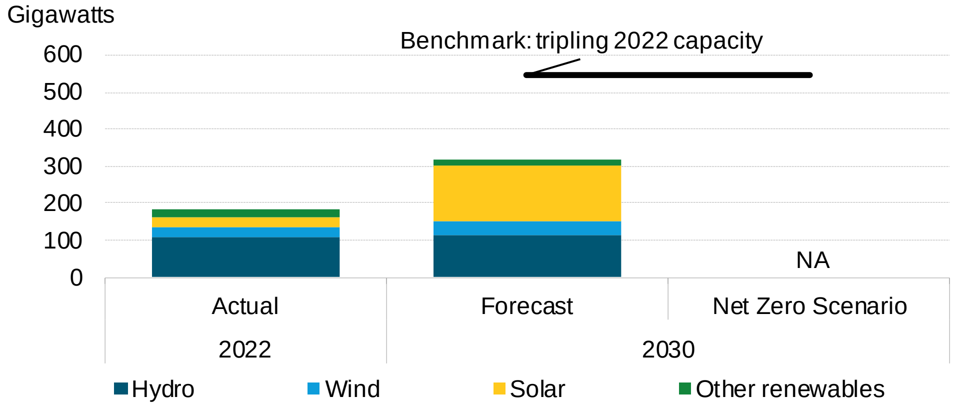
Indonesia's government has identified more than 1,000 projects to be supported by the Just Energy Transition Partnership, or JETP, a $20 billion joint public-private financial package proposed by International Partners' Group (primarily G-7 countries) and financial institutions signed onto the Glasgow Financial Alliance for Net Zero (GFANZ). The Indonesian government has proposed prioritizing the JETP funding for transmission infrastructure, however the final investment plan has not yet been agreed by all stakeholders. Stronger decarbonization targets, reduced subsidies toward coal and the removal of barriers to market participation are also important steps for Indonesia to take – whether to achieve a tripling of capacity or the 7.6-fold increase needed to align with net zero.

4.9 Brazil

Brazil has 181GW of renewable energy capacity, of which 110GW is high-capacity-factor hydro. Tripling this to 544GW by 2030 would beat BloombergNEF's forecast and would also be far more renewable energy than the country realistically needs: over 85% of its power generation already comes from clean sources, mainly hydro (Figure 19).

A major driver of Brazil's current and expected renewables deployment is a net metering program for solar, which incentivizes projects up to 5MW, which can sell through the grid to multiple sites belonging to the same company. However, small-scale solar support cost BRL2.8 billion ($0.6 billion) in 2022, and energy sector regulator Aneel estimates that this will nearly double in 2023 to BRL5.4 billion ($1.13 billion). While current plans to make solar plants pay a share of grid costs are unlikely to seriously impact the favorable economics of net metered solar, BloombergNEF expects more extensive reforms to the program.

Figure 19: Brazil renewables capacity, 2022 vs. 2030 BNEF forecast



Source: BloombergNEF Note: A Net Zero Scenario was not calculated for this region.

Staying on track for net zero for Brazil would require a focus on integrating the additional renewables and adding carbon capture to the remaining natural gas power generation in the country's power fleet. Additional transmission lines and storage capacity would also enable greater wind development.

Section 5. Solutions

This section further explores how governments can address these to meet their contributions to a global tripling of renewables, beyond simply relying on subsidy. We focus on five key areas where intervention could have the most impact (Figure 20).

Figure 20: Solutions to renewable energy deployment

Source: BloombergNEF

5.1 Barriers to access

Tripling renewables by 2030 entails some basic work to make sure that clean power developers can build projects. This includes ensuring renewables compete on an equal footing with fossil fuel-based generation by removing subsidies for coal and gas, removing licensing and regulatory barriers to private sector participation in power plant ownership and development, and clarifying the ownership of land on which projects are to be built.

1. **Remove subsidies for fossil fuels.** Many markets still offer subsidies to fossil fuel-based power generation, with the G-20 governments and state-owned enterprises providing some $693 billion in 2021, based on BloombergNEF analysis. For instance, Indonesia subsidizes coal use in its power sector, while many African countries such as Senegal and Angola still subsidize gasoline – which is then used instead of solar and storage for on-site backup power generation to ensure supply resiliency. This can make it difficult for renewable energy to compete economically, resulting in potentially wasteful use and production of fossil fuels, and investment into long-lived, emission-intensive equipment and infrastructure. Even though many of these subsidies intend to help low-income households and other vulnerable consumers, they tend to disproportionately benefit the wealthy. Such support can lead to double subsidization and an inefficient allocation of government revenues if renewable energy support schemes are then introduced.
2. **Smooth paths to generation licensing.** Many markets require would-be renewable energy and storage project developers to acquire complicated and unnecessary licenses to build and connect projects. This can range from a double licensing standard on battery storage, which may have to apply for both generation and consumption licenses or may not have a defined role in government regulations, to rules that require owners of grid-connected power plants to qualify as a utility, which often brings particularly onerous rules and regulations that fall beyond the remit of power generation.
3. **Clarify land ownership.** A lack of clear land ownership rights can hold back renewable energy projects. This can be especially difficult in emerging markets and developing

economies, leading to lengthy development cycles or shallower project pipelines. While often discussed alongside other permitting challenges, an inability to acquire and prove rights to land represents a fundamental barrier to clean power development.

5.2 Auctions and offtakes

Long-term offtake contracts for clean power are an important way to accelerate clean energy deployment, by shifting power price risk from project owners onto utilities and state power firms. These contracts may act as a form of hedge for the buyer as well, for example in the energy crisis of 2022 when the natural gas price rose and drove up power prices around the world, leaving buyers in long-term renewables contracts much better off. Due to the falling costs of solar and wind over the last decade, long-term contracts can often be agreed at prices comparable with fossil fuel-generated power and acceptable to the buyer and the developer. The certainty around revenue allows developers to arrange debt finance at lower interest rates than if the project were exposed to power price risk, which brings down the levelized cost of energy of the project as well.

Often offtake contracts are awarded in auctions, where project developers submit bids on various criteria, usually primarily price. Competition between developers ideally means that the offtakes are awarded in a cost-effective manner, if the auction is well-designed.

There are several concrete steps that governments can take to ensure that auctions and offtakes are sufficient to incentivize renewables deployment.

1. **Design auctions to de-risk projects.** In most renewable energy auctions, developers have to find their own sites and grid connection when they bid for the power contracts offered in the auction. This means developers do a lot of work for no guaranteed reward. While this is part of a developer's job, it is inefficient and can result in auctions being undersubscribed. Taking over pre-bid work, as India has done in some solar auctions and Germany and the Netherlands has done on some offshore wind tenders, or guaranteeing winners a grid connection, would accelerate renewables deployment this decade. In markets where developers buy equipment in US dollars but earn revenue in local currency, auctions designed to manage currency or inflation risk can also increase rapid build, as was effectively done in Vietnam.

   Providing visibility on future auctions is also essential for developers looking to participate in new markets, like Sub-Saharan Africa, and to give supply chains a sufficient signal to build out capacity, particularly in newer areas like offshore wind. Sticking to an auction calendar – for example by avoiding last-minute changes and cancelations – is also important for building investor certainty.

2. **Include diversification criteria.** If auctions only award power contracts on a price-per-megawatt-hour basis, solar will win almost all capacity, and this would not be good for a diverse energy mix. Well-designed auctions should include criteria that enable higher-cost solutions to compete. These can include carve-outs for specific technologies, a multiple for power produced at the most useful times, or complex availability and capacity factor requirements like India's "24/7 auctions," which encourage a mixture of solar, wind, batteries and even fossil power for emergencies.

3. **Allow and encourage corporations to sign power purchase agreements.** This allows firms to meet their net-zero targets and renewable energy procurement voluntary commitments, while incentivizing additionality. It is also an effective way for buyers and

sellers to hedge commodity price risk. A trustworthy green certificate market can also allow small and medium enterprises to participate both as buyers and sellers.

4. **Mitigate offtaker risk.** The offtake counterparty itself needs to be credible and able to meet its obligations, so that banks will be willing to finance the project with low-cost debt. In some places, the existing government structures do not meet these criteria, and reinforcement is useful. The Solar Energy Company of India (SECI) was set up in 2011, in part to be the auction counterparty and reduce the risk of projects relying on Indian distribution companies for payment. Sovereign risk guarantees, where the government backstops the offtaker's liability to pay, can be used but are only as robust as the issuing government. Development banks also often provide debt of first recourse, to reduce the risk that underpayment will hurt the returns of commercial banks and hence encourage them to participate in deals.

5.3 Grids and infrastructure

BloombergNEF estimates that to align with a net-zero pathway, grid investment needs to match renewables investment dollar for dollar (see *Europe Needs Clean Power and Grid Balance* (paywall: web | terminal)). That means that for each dollar spent on clean power deployment, a further dollar must be spent on the transmission and distribution grids. Currently, the ratio globally is far below that: a mere 50 cents is spent on grids for every dollar of global renewable energy investment.

The lack of grid infrastructure is leading to extremely long queues for grid connection. In Europe, it can currently take up to eight years to get a connection permit for the grid. This means that a project proposed in 2023 would not be able to connect in time for the COP28 target. BNEF estimates that nearly 600GW of renewables were in the connection queues of five key European states at the end of 2022 – enough to double capacity on their own. In the US, projects in grid queues are already sufficient to triple the country's renewable capacity by 2030.

There are several steps governments can take to ease this bottleneck to renewables build.

1. **Create central plans for grid expansion, including interconnectors.** Grid plans can be designed to match the amount of renewables capacity targeted by 2030. These plans can preselect corridors for new grid development, thereby providing greater certainty for renewables site selection. They can also lay out the role of new hardware deployment and non-wire solutions, like digitalization and flexibility, in achieving greater grid capacity. A 10-year plan prepared by a body that has the authority to sanction projects would be ideal, coupled with a 2050 grid vision that guides the development of that overall grid architecture.

   Inter-regional networks can be a vital part of this, both in island nations like the UK, Indonesia and Japan, or regions with vast land masses like the US and China. Interconnected systems are more resilient to extreme events and supply energy more affordably to end-users. But they are difficult to build without the support of deliberate, coordinated interregional planning coupled with centralized permitting capabilities.

2. **Enable anticipatory grid investment.** Most markets take a risk-averse approach to grid investment. Operators can create plans, but new capacity often needs to be needs-tested by a regulator, who will not allow those projects to be funded from regulated revenues if there is uncertainty. This can be particularly detrimental to markets where the regulator does not believe renewable energy targets will be met or where electrification of new end uses in transport, buildings and industry is hard to predict. Allowing projects to meet differentiated

needs-testing thresholds can help projects progress in the face of uncertainty, assuming the meet environmental and construction permitting requirements.

3. **Encourage private sector participation.** This is essential for modernizing infrastructure, introducing innovation and moving more quickly. It offers a solution to public sector budget constraints, especially in developing economies, by attracting funds and expertise. This includes merchant and independent transmission lines, developed by non-incumbent participants. For such models to be successful, a balance of revenue certainty for investors and robust oversight is necessary, alongside clear cost allocation. Whereas in developing markets, private sector participation is focused on attracting investment due to capital constraints, in more liberalized markets, like the UK, private sector participation can also create g a competitive environment where innovation is encouraged.
4. **Manage grid queues effectively.** There are several ways to improve queues for projects applying to connect to the grid. Requiring projects to hit defined milestones to remain in a queue can reduce speculative bids for projects that are likely to fail even if they do get a grid connection, and which would be a waste of time to assess. Transparent processes and timeframes, better coordination between transmission and distribution operators, and streamlining data flows across departments can also help reduce connection timelines, while connect-and-manage programs can allow projects to access the grid while major upgrades to transformers and substations are still underway.

5.4 Permitting

Permitting can add years to renewable project development timelines. In Europe, permitting can take 10 or more years for offshore wind, four to nine years for onshore wind and one to four years for solar (which tends to have a lower impact on its surrounding environment). Designating projects as having an ‘overriding public interest’, as introduced by the European Union in 2022, or allowing for automatic approval/exemption if applications are not reviewed or rejected within a certain period of time, is one way to speed up the process.

Permitting processes play an important role, filtering out projects that are significantly detrimental to the local environment or communities. Some sites should never be built on for social or ecological reasons. However, every effort should be made to clarify and improve existing processes to identify suitable sites. These can include:

1. **Streamlined permitting processes**. Establishing one-stop-shops for permitting applications, enabling information-sharing between departments through digitalization and reducing the number of duplicated processes (eg, having to submit information with only slight differences to multiple departments) can go a long way to improving the speed of renewable project permitting. For instance, in 2020 Denmark established a one-stop-shop for offshore wind permitting, borrowed from past measures used to support North Sea oil production.
2. **Staffing local government departments**. Many departments involved in the permitting for power plants were set up to handle a handful of large thermal power plant applications, not hundreds or thousands of distributed renewable energy projects each year. Staffing levels must increase to reflect this new paradigm. The need for sufficient employment extends to courts and judges, to ensure that permitting appeals and legal challenges can be heard in a timely manner.
3. **Clarifying appeals and stakeholder engagement**. To ensure renewable energy scales, it is essential that local communities and stakeholders are identified and involved. Often, the opacity of the process means that appeals and legal challenges appear either late in the

development cycle or with an unclear timeline toward resolution. Measures to ensure that legal cases are heard by judges within a certain number of months (as was done in France), to specify the number of appeals that can be made, or to specify the time period in which legal challenges can be submitted, are all measures that can help the development process.

4. **Improved data and site designations**. Governments, non-profits and non-governmental organizations can help establish central databases with essential geospatial data, including information on biodiversity, landscape, easements and land use from nearby populations. This data can be hard to find, and efforts to collect it may be duplicated by multiple players in the selection of sites and completion of environmental impact assessments. Once the data is in a central place, governments could also use it to conduct initial environmental surveys for developers, to predesignate energy development zones in regions that are likely to have a limited impact on wildlife and local communities. Governments can also set more appropriate easement requirements, which dictate siting distances for wind farms from specific types of sites or buildings, and are often set conservatively.

5.5 Market design

Effective market design is critical both to ensure that renewable energy can compete with existing fossil fuel fleets and be built on a cost-effective basis. It is also essential to ensuring the power system itself can handle increased renewable penetrations or achieve 24/7 production of low-carbon generation.

1. **Competitive price signals.** Renewables are currently the cheapest source of new generation in markets equivalent to 82% of global electricity generation, according to BloombergNEF (see *1H 2023 Levelized Cost of Electricity Update* (paywall: web | terminal). However, many markets, especially those with powerful state-owned vertically integrated regional monopolies or high levels of regulation, do not take economics fully into consideration when building out their generation portfolios. Those markets that do bring in competitive price signals for both capacity development and dispatch tend to see a greater deployment of solar and wind.
2. **Renewables integration.** Power market design is also critical to the ability to handle increased penetration of wind and solar. In addition to a competitive dispatch signal, markets need to ensure that flexible low-carbon loads are encouraged through either scarcity pricing in a wholesale market, dynamic tariffs to encourage power users to load shift, or capacity payments that consider carbon intensity. Ancillary service markets, which competitively tender key grid services as the share of non-spinning generation rises, should also be initiated and standardized to encourage the scale-up of energy storage system deployment.
3. **Long-term targets, emissions pricing and regulation.** A carbon price sets an immediate premium for renewable power over the local price of fossil. However, to drive decarbonization, prices need to be high enough and credible for the long term, while concessions to participants (such as free permits) should not be too generous. A coal power ban is another way for governments to promote clean power, while a net-zero target signals to investors that renewable energy power plants are likely to be favored over fossil plants by future policy. These are two major ways for governments to encourage investment in renewable energy, in addition to auctions and corporate PPAs as discussed in Section 5.2.

Appendices

Appendix A. Methodology

A.1. Technology coverage

The analysis in this report defines renewable energy as solar, wind, hydropower, geothermal, bioenergy and marine. This is similar to the technology coverage for the International Energy Agency (IEA), which we compare in Table 2.

Table 2: Renewable technology coverage comparison

Category	BloombergNEF	IEA
Solar PV	• Small-scale PV (residential, commercial PV plants smaller than 1MW or largely for onsite consumption), large-scale PV (PV plants >1MW or mainly feeding into the grid)	• PV-distributed, PV-utility
Wind	• Onshore wind, offshore wind	• Onshore wind, offshore wind
Hydropower	• Large hydro, small hydro	• Reservoir, run-of-river
Other renewables	• Geothermal, bioenergy, solar thermal, marine	• Geothermal, bioenergy, solar thermal, marine (tide and wave)

Source: BloombergNEF, IEA

A.2. Data sources

The renewable capacity data in this report comes from three sources:

- **Historic data (2000-22)** is derived from BloombergNEF's *Power Transition Trends 2023* (paywall: web | terminal). This annual report examines trends in global generation, capacity, and emissions. It is based on data collected by BNEF analysts on six continents from primary sources in 140 markets, along with aggregated data from the rest of the world.
- **Net Zero Scenario (2023-30)** is a model result drawn from BloombergNEF's *New Energy Outlook 2022 report* (paywall: web | terminal). The Net Zero Scenario (NZS) describes an economics-led evolution of the energy economy to achieve net-zero emissions in 2050 and limit global warming to well below 2ºC with no overshoot or major reliance on carbon removal technologies after 2050. BNEF did not publish country-level scenarios for markets such as Brazil, Sub-Saharan Africa, and MENA.
- **Forecast data (2023-30)** reflects BloombergNEF's latest renewable installation outlook by 2030. The current wind and solar forecasts can be viewed here, and this analysis used the forecasts as of October 2023. For technologies that we do not produce regular forecasts for (geothermal, hydropower, marine, bioenergy), we rely on announced project pipelines.

A.3. Regional groupings

Table 3 shows how countries are categorized by region.

Table 3: Country coverage by region

Region	Countries
Europe	Austria Belgium Bulgaria Croatia Cyprus Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Italy Latvia Lithuania Luxembourg Malta Netherlands Norway Poland Portugal Romania Slovakia Slovenia Spain Sweden Switzerland UK
MENA	Algeria Bahrain Egypt Iran Iraq Israel Jordan Kuwait Lebanon Libya Morocco Oman Qatar Saudi Arabia, Syria Tunisia United Arab Emirates Yemen
Sub-Saharan Africa	Angola Benin Botswana Burkina Faso Cameroon Cape Verde Central African Republic Chad Congo Congo (Dem. Rep.) Côte d'Ivoire Djibouti Equatorial Guinea Ethiopia Gabon Gambia Ghana Guinea Kenya Liberia Madagascar Malawi Mali Mauritania Mauritius Mozambique Namibia Niger Nigeria Rwanda Senegal Seychelles Sierra Leone Somalia South Africa Swaziland Tanzania Togo Uganda Zambia Zimbabwe

Source: BloombergNEF

A.4. Photovoltaic capacity

BloombergNEF tracks PV in MW(DC), also known as MWp, ie the capacity of the solar modules, rather than the capacity of the inverter or grid connection which is in MW(AC). It is much easier to estimate plant capex, land use, and output from the DC capacity, and it is the historic standard in Europe and China. Some grid operators, however, collect data in AC capacity and this is then reported by research organizations. In 2023, the DC capacity is usually 1.2-1-3x the AC capacity, depending on plant design and market. AC is alternating current; DC is direct current.

About us

Contact details

Client enquiries:

- Bloomberg Terminal: press <Help> key twice
- Email: support.bnef@bloomberg.net

Meredith Annex	Head of Clean Power	mannex1@bloomberg.net
Jenny Chase	Specialist, Clean Power	jchase12@bloomberg.net
Yiyi Zhou	Specialist, Clean Power	yzhou139@bloomberg.net
Claudio Lubis	Analyst, Oil	clubis@bloomberg.net
Sanjeet Sanghera	Head of Grids	ssanghera5@bloomberg.net
Victoria Cuming	Head of Global Policy	vcuming@bloomberg.net

Copyright

Disclaimer