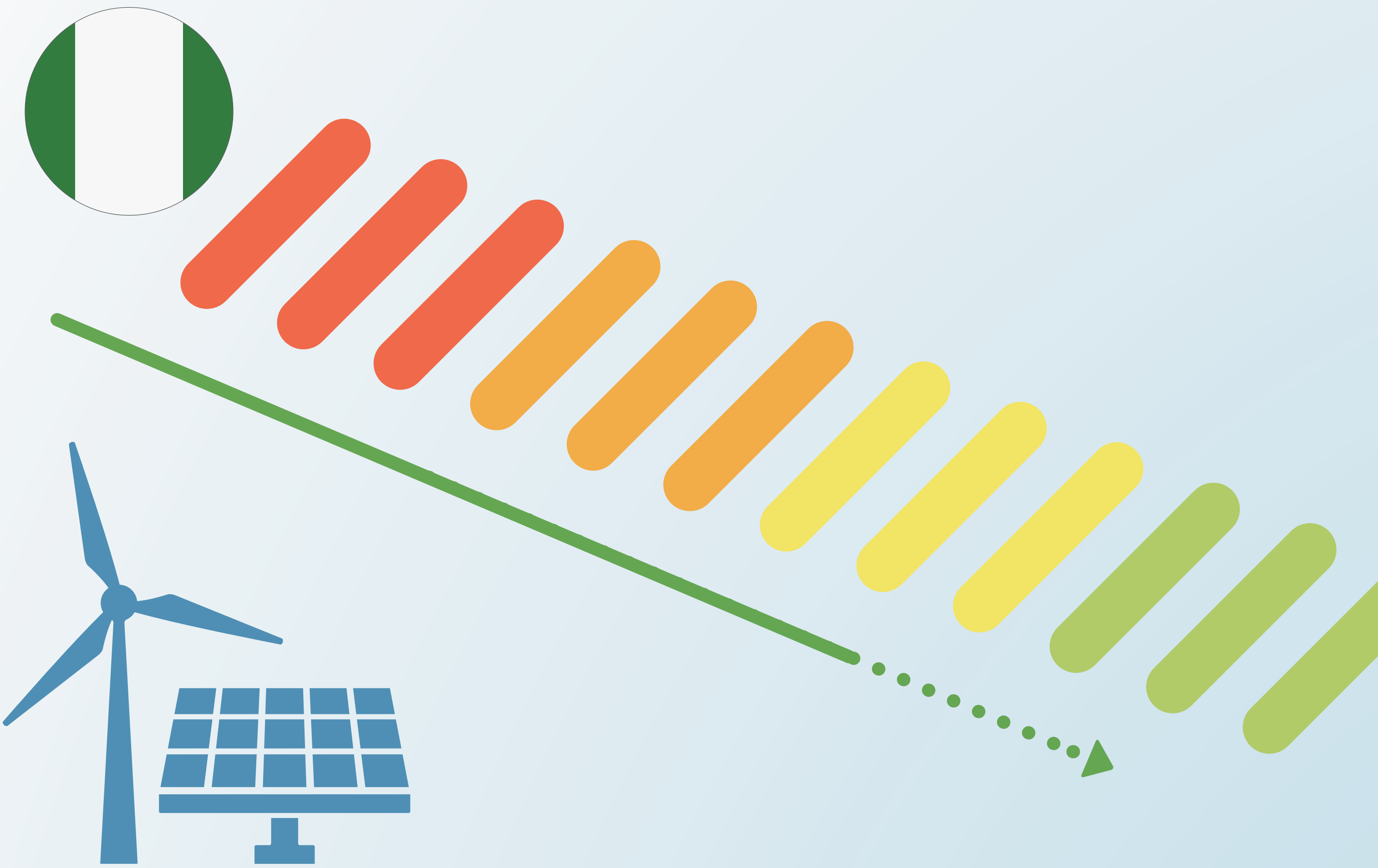


Climate Action Tracker

Wind and Solar benchmarks for a 1.5°C world

NIGERIA

February 2026

CLIMATE ANALYTICS

NEW CLIMATE INSTITUTE

Executive Summary

Context

- Nigeria has the largest population in the world without electricity, estimated at around 40% of the population in 2021.
- Electricity demand growth is set to soar in Nigeria, driven by robust economic growth and improving levels of electricity access.
- The current electricity system in Nigeria is dominated by gas-fired power plants and off-grid diesel generators.
- In this report, we explore the level of wind and solar that Nigeria would need to install as part of a global 1.5°C compatible pathway. Our benchmarks are also compatible with tripling renewables capacity by 2030.

Key findings

- To meet electricity demand growth while reducing reliance on diesel and gas in the power sector, wind and solar generation would need to grow to 60-90 TWh by 2030.
- Over 50 GW of wind and solar would be needed by 2030 (37 GW of solar and 17 GW of wind).
- A rapid rollout of renewables could help meet electricity demand and provide reliable, zero-carbon electricity to Nigerians, while avoiding continued reliance on diesel and gas.
- However, it will require large-scale investment to help accelerate renewables deployment and drive grid expansion. International support will be key in creating an enabling environment to catalyse private investment in Nigeria.

Wind & solar
1.5°C benchmarks

	Generation capacity in **2022**	Generation capacity in **2030**
Total	**0.1 GW**	**54 GW**
Wind	**0 GW** Wind	**17 GW** Wind
Solar	**0.1 GW** Solar	**37 GW** Solar

Context

At COP28, governments agreed to triple global renewable capacity by 2030 globally to stay in line with 1.5°C. This report highlights the potential implications of this COP28 decision at the national level, focusing on **Nigeria**.

Wind and solar deployment is accelerating around the world. However, expected wind and solar capacity deployment under current policies falls short of what is needed for 1.5°C, and is concentrated mainly in a few regions.

Research is needed to understand the pace of wind and solar deployment that aligns with the highest plausible ambition and is compatible with 1.5°C

This project aims at answering the following questions:

- **How much wind and solar generation is needed (TWh) at the national level?**
- **How much wind and solar needs to be built (GW of capacity)?**
- **When does it need to be built by, and how quickly?**

Policy context

In its 2030 NDC, Nigeria is committed to reducing its emissions by 20% below BAU by 2030 (incl. LULUCF) unconditionally and will reduce its emissions by up to 47% below BAU by 2030, conditional on international support. It has also committed to reaching net zero between 2050 and 2070.

Nigeria's current renewable targets are to reach **6 GW of solar and 0.8 GW of wind by 2030**, as of the National Renewable Energy Action Plan.

Under current policies and market conditions, the IEA estimates that **solar capacity will reach 14 GW in 2030**, up from 97 MW (0.097 GW) of solar in 2022. Meanwhile, **wind capacity is not projected to grow at all**.

International support

The key analytical elements (high ambition country-level studies and downscaled 1.5°C compatible global pathways, see Methods) do not consider financing requirements.

Significant global resource transfers will be required in line with 'common but differentiated responsibilities and respective capabilities' to achieve these benchmarks.

We do not quantify the technical and financial support needed to achieve the wind and solar rollout presented in this report. This should be a country-driven exercise and some governments have already initiated such processes.

High-income countries will need to provide substantially increased climate finance to support emissions reduction abroad, in line with their 'fair share' of climate action.

Achieving these benchmarks in lower-income countries is therefore a global responsibility, rather than a domestic responsibility. Therefore, ambitious climate finance commitments and delivery are essential to support high ambition at the national level.

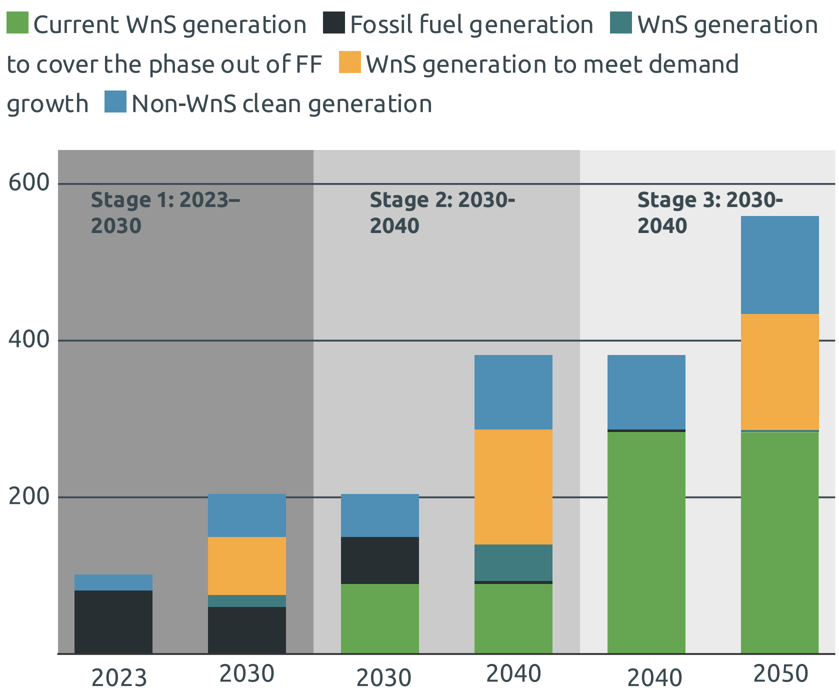
National enabling factors

Key enabling factors for ambitious wind and solar rollout include:

- **Institutional capacity.** A rapid build-out of wind and solar will require the governance and institutional capacity to develop, implement and enforce policy frameworks.
- **Just transition.** A just transition will be needed to take along all stakeholders, particularly those employed by the fossil economy.
- **Grid development.** Substantial increases in both transmission and distribution grid infrastructure will be necessary to integrate large-scale new wind and solar generation into the power system.
- **Fossil fuel phase-out.** Existing fossil fuel infrastructure often will need to be retired earlier than its economic lifetime. Policies need to be developed to achieve the early phase out of fossil fuel plants.
- **System flexibility.** Energy storage (diurnal and seasonal), flexible generation technologies such as hydro and geothermal, and increased demand side flexibility will all be crucial.
- **Market design.** Reform of market designs and regulation adapted to RE-based systems that incentivise and mobilise investments to install renewable energy at the scale needed (e.g., minimise cost of capital, ensure revenue certainty, etc).

Results

Stages of power sector decarbonisation



The stages of the electricity system transition in Nigeria

WnS = Wind and Solar

Figure 1 – Electricity generation in each stage in TWh

In a 1.5°C pathway, countries must add solar, wind, and other clean technologies to meet rising power demand while replacing phased-out fossil fuels. The evolution of the power capacity mix over successive decades varies across countries.

From now until 2030, Nigeria would need to add13 GW of wind and 30 GW of solar capacity to meet growing demand alone. Another 2.6 GW of wind and 6.1 GW of solar will be needed to displace the share of fossil fuels in the electricity generation mix.

Power sector transformation and the increasing participation of variable renewable energy (VRE) – mainly wind and solar – in a country's power mix gives rise to a set of technical challenges linked to the integration of VRE sources. Six phases can be distinguished here, from phase 0 (pre-development with negligible amount of VRE shares) to phase E (with over 80% VRE shares). More information about these phases can be found in Annex A.

Meeting the benchmarks for 2030 will put Nigeria in Phase C, with wind and solar making up 44% of the generation mix. Periods in which VRE dominates system behaviour become increasingly frequent. A key operational challenge is maintaining system stability during sudden disruptions in supply or demand. Curtailment of VRE may become necessary to preserve system security. Without structural adjustments, integration constraints of VRE into the system may slow further increases in renewable energy shares despite additional installed capacity.

Figure 1 and Table 1 both show the stages of the transition to a decarbonised power sector in terms of the volumes of existing wind and solar and what is needed to displace fossil fuels and meet demand increases. Figure 1 shows the stages in terms of electricity generation, and Table 1 shows it in terms of generation, capacity and share of the electricity mix.

Table 1: Stages of the electricity system transition detailing how much generation capacity of wind and solar will be needed to displace fossil fuels in the system and meet growing electricity demand

	2023	→	2030	→	2040	→	2050
Grid integration phase (share of variable renewable energy in total electricity generation)							
Phase	Phase 0		Phase C		Phase D		Phase D
Share of VRE	**< 5%**		**< 40%**		**< 70%**		**< 70%**
Share of electricity generation							
Wind & Solar	**0.1 %**		**44 %**		**74 %**		**78 %**
Other renewables	9 %		27 %		25 %		22 %
Fossil Fuels	**80 %**		**29 %**		**1 %**		**0 %**
Generation capacity							
To displace fossil fuels		**+8.8 GW**		**+34 GW**		**+2 GW**	
Wind & Solar	**2.2 GW**	**+7.4 GW/yr**	**54 GW**	**+15 GW/yr**	**200 GW**	**+10 GW/yr**	**300 GW**
To meet demand increase		**+43 GW**		**+110 GW**		**+100 GW**	
Generation							
Total	**100 TWh**	100%	**200 TWh**	90%	**380 TWh**	47%	**560 TWh**
Wind & Solar	0.1 TWh		90 TWh		280 TWh		430 TWh
Generation Capacity of VRE (variable renewable energy)							
To displace fossil fuels			2.6 GW		2.6 GW		0.7 GW
Wind capacity	**1 GW**		**17 GW**		**27 GW**		**61 GW**
To meet demand increase			13 GW		8.3 GW		33 GW
To displace fossil fuels			6.1 GW		31.5 GW		1.4 GW
Solar capacity	**1.1 GW**		**37 GW**		**170 GW**		**230 GW**
To meet demand increase			30 GW		100 GW		65 GW

Note: Numbers are rounded to two significant figures, which may contribute to minor differences in totals. The calculations assume that wind, solar, and other renewables contribute equally and proportionally to displacing fossil fuels and meeting demand growth.

Future electricity demand

Electricity demand in Nigeria is highly uncertain, with a large component of off-grid generation which is hard to estimate. We take electricity demand from the IRENA study commissioned by the Nigerian Government on a renewable roadmap for Nigeria, focusing on the Transforming Energy Scenario. This study estimates that electricity demand in 2015 was slightly below 120 TWh, with around 100 TWh of this demand being met by fossil fuels, largely off-grid diesel generators. In this scenario, total electricity generation in Nigeria grows more than five times by 2050 relative to 2015 levels, reaching 560 TWh. This is driven by economic development and increased electrification. Off-grid systems provide around ~25% of electricity demand in 2050.

However, there is a significant range in the studies in terms of the expected electricity generation in 2050 ranging from 400 TWh to 1200 TWh. This would affect the needed growth of wind and solar significantly. Our demand estimate is in the lower range of that estimated by country-level studies.

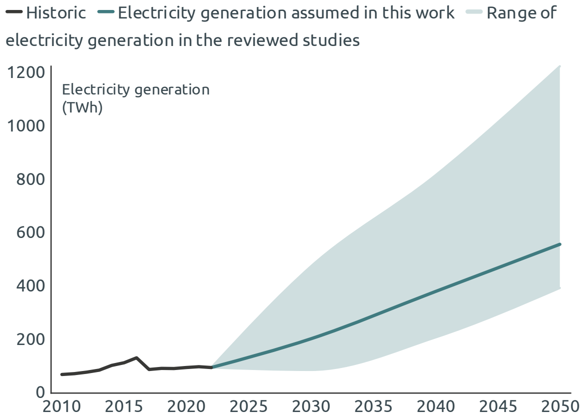


Figure 2 – Total electricity generation in TWh

Electricity generation grows around five times in Nigeria over 2022–2050

The solid line shows the electricity generation projection used to develop the benchmarks

Pace of fossil fuel phase-out needed

The rate of fossil fuel phase-out is set by the overlap between country-level studies, downscaled 1.5°C compatible global pathways and the global milestones of the IEA's Net Zero roadmap, in which Nigeria achieves a clean power system by 2045.

To align with 1.5°C, fossil fuels must exit the Nigeria power sector before 2045.

Nigeria's current electricity system is dominated by gas-fired power. Under these benchmarks, gas generation would fall 10–41% by 2030 relative to 2015 levels.

To align with 1.5°C, fossil fuels must exit the Nigeria power sector by 2045, even as electricity demand grows rapidly

Nigeria would need to achieve clean electricity by 2045

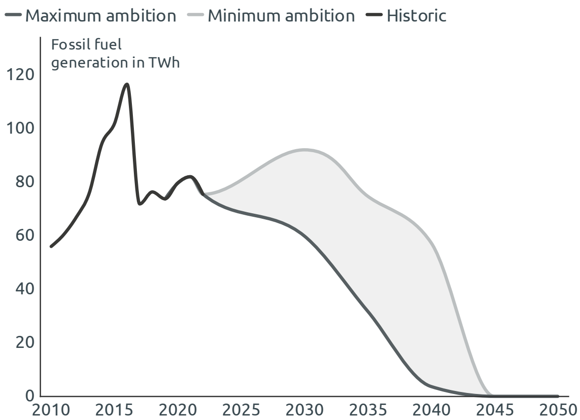


Figure 3 – Fossil fuel generation in TWh

Gas phase-out in Nigeria

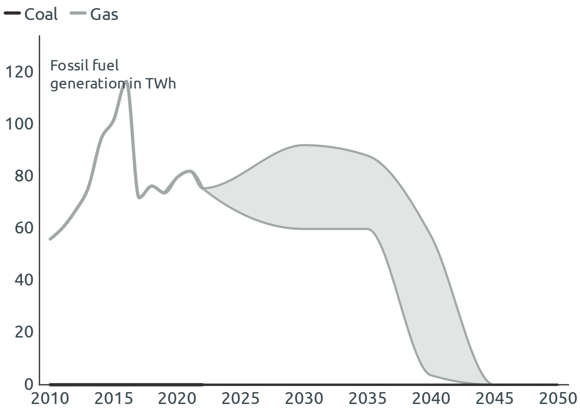


Figure 4 – Fossil fuel generation by fuel type in TWh

The role of other clean electricity generation

While wind and solar will be the workhorse of the energy transition, other clean electricity generation may play a role. We estimate the role of non- wind and solar clean electricity generation* (largely hydro, biomass, nuclear and geothermal) from country-level studies.

In our modelling, we assume that generation from clean technologies other than wind and solar in Nigeria would reach 54 TWh by 2030 and 125 TWh by 2050. This is provided by large-scale hydropower, which grows on average to over 40 TWh in 2030 in the country-level studies, and some biomass and solar CSP.

Total wind and solar generation needed to align with 1.5°C

The wind and solar rollout is then calculated by combining projected electricity demand growth, the fossil phase-out necessary to align with 1.5°C, and the assumed generation from other clean technologies.

To align with 1.5°C, wind and solar generation in Nigeria would need to reach between 57 and 90 TWh by 2030, and over 400 TWh by 2050.

This is broadly aligned with the IRENA TES study in 2030, which deploys 84 TWh of wind and solar by this date. However, in the long-term our benchmarks are more ambitious than the IRENA study, as they achieve a full phase-out of fossil fuels in the power sector before 2050, which the IRENA study does not achieve.

To align with 1.5°C, wind and solar generation would need to grow rapidly in Nigeria

Wind and solar generation needs to grow to 60-90 TWh by 2030 in Nigeria

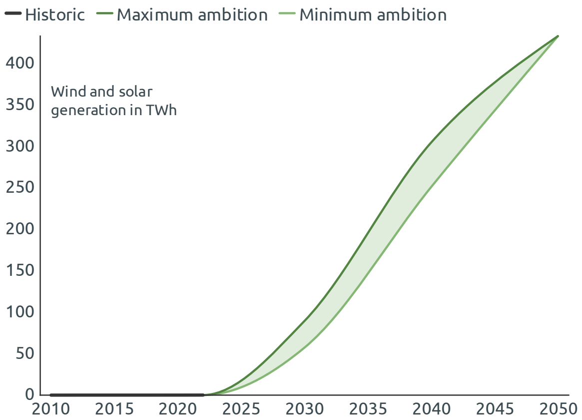


Figure 5 – Wind and solar electricity generation in TWh

Wind and solar could provide around 80% of electricity generation in Nigeria by 2050

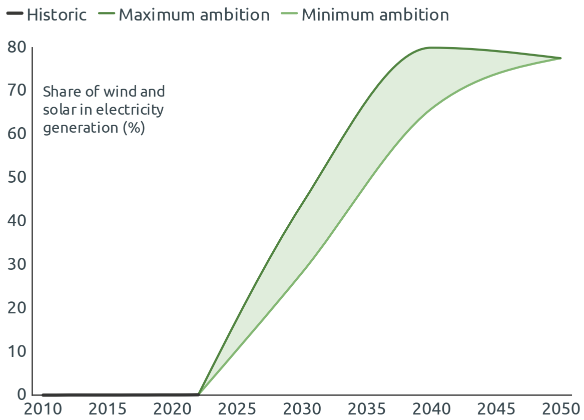


Figure 6 – Wind and solar electricity generation share (%)

* We do not consider CCS in the power sector, as we do not consider CCS a viable source of large-scale emissions reductions in the power sector.

Possible splits between wind and solar

The relative share of wind and solar deployment will vary depending on how various factors develop in the future. We explore one key uncertainty, the relative cost of solar and wind electricity generation (see methods). When accounting for this uncertainty, we see a range of possible future generation mixes between wind and solar.

We highlight the median of the range as our **central benchmark**, but do not suggest that this is the only possible breakdown into wind versus solar. In the central benchmarking scenario, solar becomes the main source of generation, providing on average twice as much generation as wind in the electricity mix by 2050. This will require a rapid uptake of non-fossil flexibility options.

In this scenario, **Nigeria would need to deploy over 50 GW of wind and solar by 2030 to align with 1.5°C**. By 2050, total wind and solar capacity would need to reach towards 300 GW. Due to its higher capacity factor, greater wind deployment would reduce total capacity requirements.

International support, including concessional and grants-based climate finance will be critical in achieving this rate of deployment.

Nigeria needs to reach over 50 GW of wind and solar installed capacity by 2030 to align with 1.5°C

Solar capacity would reach 37 GW in Nigeria by 2030 in a 1.5°C-aligned scenario

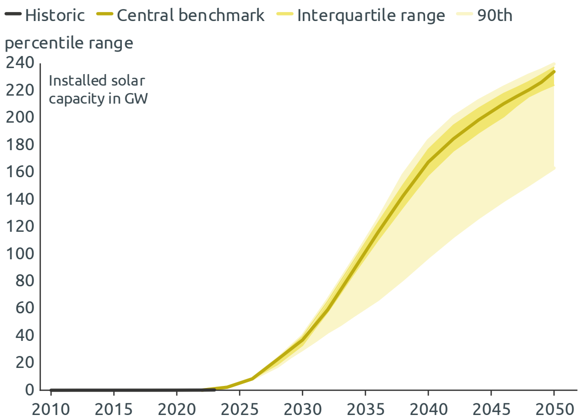


Figure 7 – 1.5°C compatible capacity benchmarks for solar in GW

Wind capacity would reach 17 GW in Nigeria by 2030 in a 1.5°C-aligned scenario

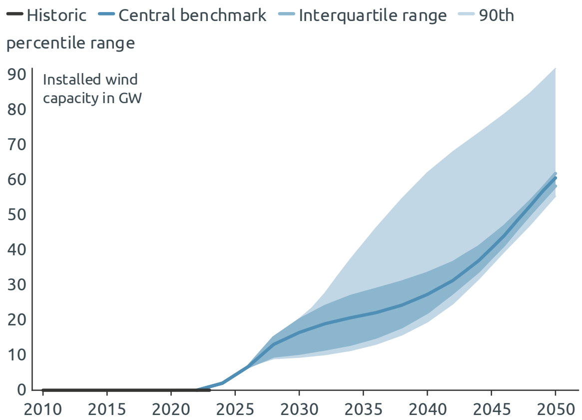


Figure 8 – 1.5°C compatible capacity benchmarks for wind in GW

The following table shows the wind and solar deployment needed to align with the central 1.5°C compatible benchmark produced. 2022 is historical data. All benchmark data from 2030 onwards is reported to two significant figures.

Table 2: Wind and solar electricity generation and capacity (2022–2050)

Scenario	Variable	Unit	2022	2030	2035	2040	2050
Central 1.5°Cbenchmark	Solar generation	TWh	0.1	44	130	210	290
Central 1.5°Cbenchmark	Wind generation	TWh	0	37	48	64	150
Central 1.5°Cbenchmark	Solar capacity	GW	0.1	37	100	170	230
Central 1.5°Cbenchmark	Wind capacity	GW	0	17	21	27	61

Table 3: Benchmarks translated into CAT format

Variable	Ambition	Unit	2030	2035	2040	2045	2050
Share of coal	Minimum	%	0	0	0	0	0
	Maximum	%	0	0	0	0	0
Share of gas	Minimum	%	45	30	15	0	0
	Maximum	%	29	20	0.9	0	0
Share of renewables	Minimum	%	55	70	85	100	100
	Maximum	%	71	80	99	100	100
Share of wind and solar	Minimum	%	28	44	60	78	78
	Maximum	%	44	54	74	78	78

Comparison to current rollout and country target

Under current policies and market conditions, deployment of both wind and solar in Nigeria is falling behind the levels needed for 1.5°C.

This highlights the urgent need for international support to help address barriers to renewables rollout in Nigeria, and ensure that Nigeria can benefit from a transition to a renewable powered electricity system.

Nigeria's rollout of wind and solar needs accelerating to align with 1.5°C

In Nigeria, current rollout of solar is lagging behind 1.5°C-aligned levels

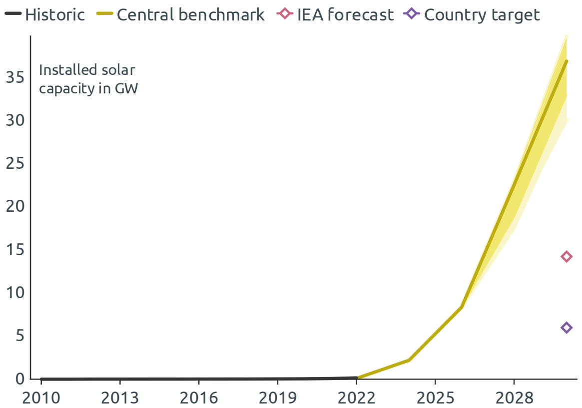


Figure 9 – Installed solar capacity in 2030 compared to targets and current policy projections in GW

In Nigeria, current rollout of wind is lagging behind 1.5°C-aligned levels

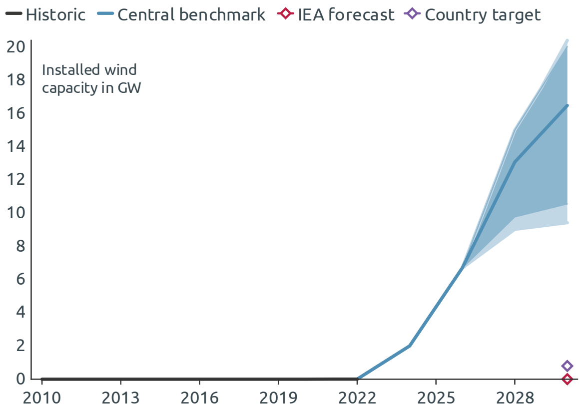


Figure 10 – Installed wind capacity in 2030 compared to targets and current policy projections in GW

The target data was last pulled from Ember in January 2025. The current policies data was last pulled from the IEA in June 2025.

Wind and solar capacity additions in Nigeria accelerate particularly post-2030

Nigeria would need to add on average 4.1 GW/yr of solar capacity until 2030, and 9.8 GW/yr by over 2030–2050

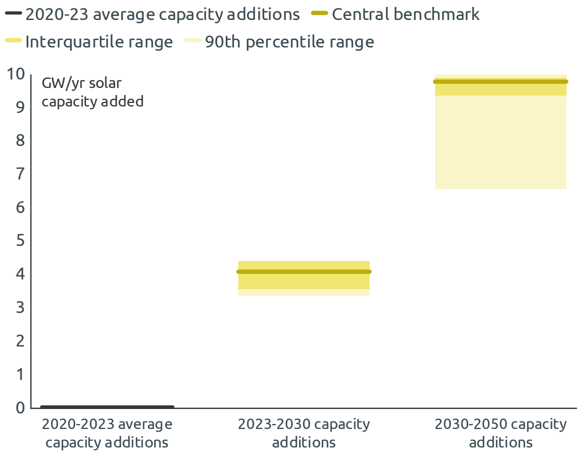


Figure 11 – Solar capacity additions per year in GW/y

Nigeria would need to add on average 1.9 GW/yr of wind capacity until 2030, and 2.1 GW/yr by over 2030–2050

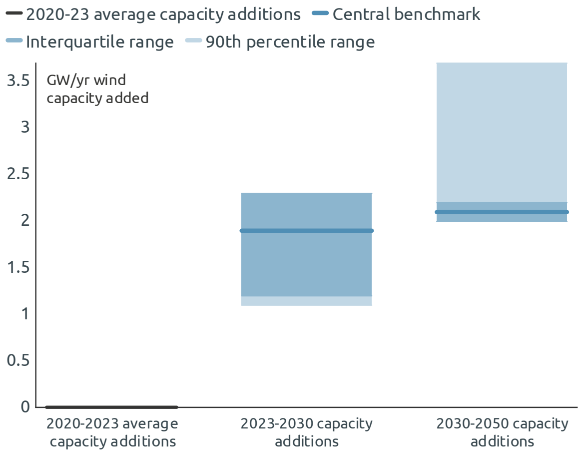


Figure 12 – Wind capacity additions per year in GW/y

Comparison with other studies

We compare the wind and solar generation seen in our analysis to that in the literature review of country-level studies. In particular, we highlight the results of modelling from the IRENA Transforming Energy Scenario (TES), which achieves an accelerated rollout of renewables in Nigeria.

There is one outlying study, Ishaya et al, 2020, which has much higher rollout than the benchmarks, or other studies. This is due to the much higher demand assumptions in this study, which assumes that electricity demand in Nigeria will grow to over 1200 TWh in 2050, compared to the 560 TWh assumed by these benchmarks.

Focusing on the other studies, we see that the rollout of solar seen in our benchmarks is broadly aligned with the wider literature. However, that there is greater rollout of wind in our benchmarks than in other studies reviewed.

Our solar rollout broadly aligns with literature, while our benchmarks deploy more wind than the literature studies

Electricity generation from solar: comparison with literature in Nigeria

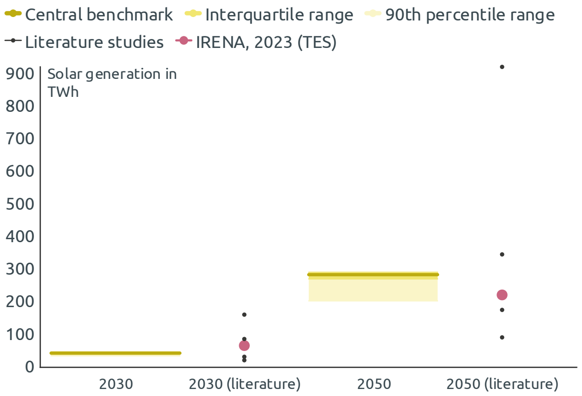


Figure 13 – Solar electricity generation in TWh

Electricity generation from wind: comparison with literature in Nigeria

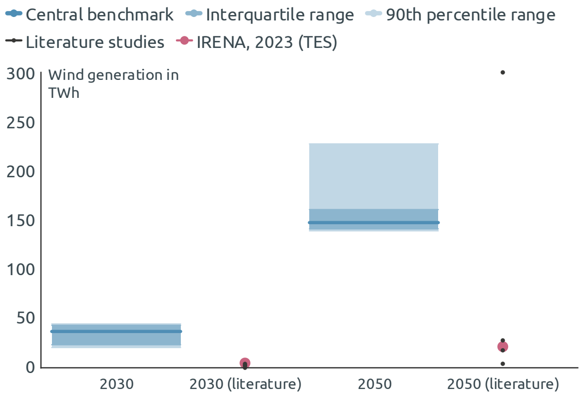


Figure 14 – Wind electricity generation in TWh

In Nigeria, our benchmarks generally suggest that solar will provide more generation than wind

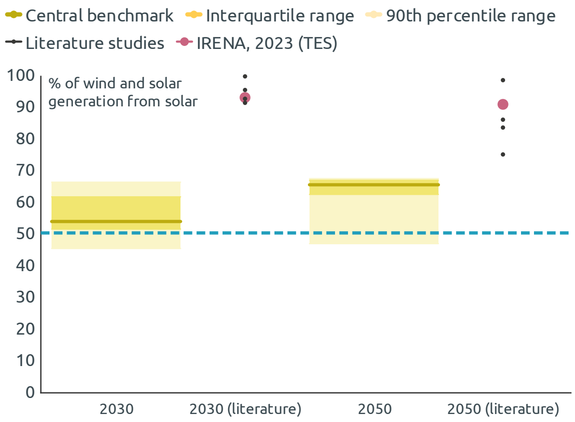


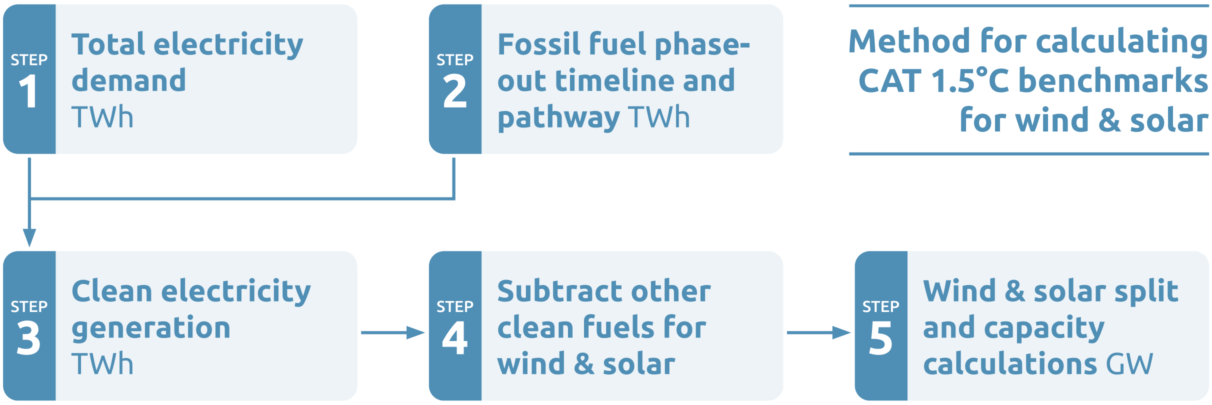
Figure 15 – Generation split between wind and solar (%)

Share of wind and solar generation that comes from solar: comparison with literature in Nigeria

The area above the blue dashed line represents a power system in which solar provides more electricity generation than wind

Methodology

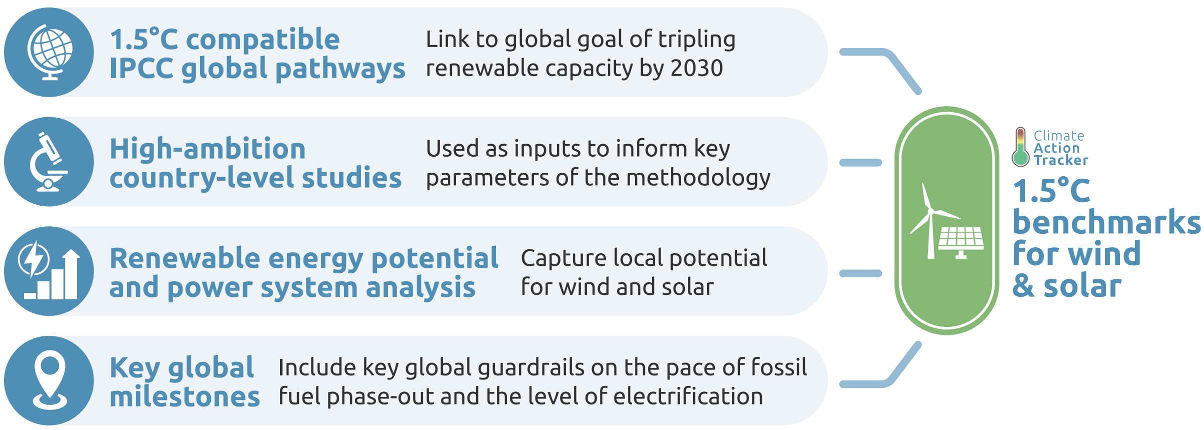
Summary of our method



Our method takes a series of steps to calculate the wind and solar generation needed for 1.5°C, and the resulting capacity deployment. The key methodological steps are highlighted below.

1. We project future electricity demand in the country.
2. We calculate the pace of fossil fuel phase-out needed to align with 1.5°C.
3. Bringing these trajectories together defines the level of clean electricity generation required to meet electricity demand growth while phasing out fossil fuels in the power sector.
4. We project non-wind and solar clean electricity generation based on country-level literature. This allows us to identify the wind and solar generation necessary to align with 1.5°C.
5. Having produced this wind and solar generation trajectory, we feed it into a simplified electricity system model (PyPSA), which calculates for a given set of cost assumptions around wind and solar, a split into wind versus solar and the associated capacity requirements.

Overlap of different elements



Our method focuses on the overlap between different elements. By looking at the range of fossil fuel phase-out which is outlined in both high ambition country-level studies and downscaled 1.5°Ccompatible global pathways, and is informed by key global milestones, we identify benchmarks which are both consistent with a global least cost pathway to limiting warming to 1.5°C but are also aligned with national–level modelling.

Combining multiple different analytical elements can help identify the most robust path to achieving a zero-carbon energy system.

For more details see the Methods Annex.

List of scenarios selected

Table 4 – Country level studies for Nigeria

Study	Publication	Scenario selected
Oyewo et. al, 2018	Pathways to a fully sustainable electricity supply for Nigeria in the mid-term future	BPS-3
Ishaya et al, 2020	Renewable Energy scenarios for sustainable electricity in Nigeria	REN-3
IRENA, 2023	Renewable Energy Roadmap Nigeria	PES TES
DDP-Nigeria, 2024	Deep Decarbonization Pathways for Nigeria's Low Emission Development up to 2060	RES

Annex A

Phases of grid integration

The grid integration phase is adapted from a de Vivero et al. report detailing a qualitative assessment framework for power system transformation and an IEA report on integrating solar and wind. We use the share of VRE sources in electricity generation to classify countries into a phase. More information about the characteristics and key challenges of each phase can be found in the report.

Phase 0 (less than 5% annual VRE share): we assign this phase when wind and solar make up 0-5% of a country's electricity generation mix. Installed VRE capacity is limited, and the impact on power system operation is negligible. Integration does not require significant operational or structural changes.

Phase A (between 5% and 15% annual VRE share): we assign this phase when wind and solar make up 5-15% of a country's electricity generation mix. Conventional power system operation remains largely sufficient for day-to-day system management. However, system planning must anticipate higher future VRE shares. This includes improving forecasting tools, integrating forecasting into dispatch decisions and moving toward shorter scheduling intervals and more real-time system operation.

Phase B (between 15% and 25% of annual VRE share): we assign this phase when wind and solar make up 15-25% of a country's electricity generation mix. The contribution of VRE varies significantly over time, with periods of very low output and periods of high penetration. This variability increases the need for operational flexibility. Enhanced coordination between system operators, network operators, and distribution system operators becomes critical to maintain system efficiency and security.

Phase C (between 25% and 40% of annual VRE share): we assign this phase when wind and solar make up 25-45% of a country's electricity generation mix. Periods in which VRE dominates system behaviour become increasingly frequent. A key operational challenge is maintaining system stability during sudden disruptions in supply or demand. Curtailment of VRE may become necessary to preserve system security. Without structural adjustments, integration constraints of VRE into the system may slow further increases in renewable energy shares despite additional installed capacity.

Phase D (between 40% and 70% of annual VRE share): we assign this phase when wind and solar make up 45-80% of a country's electricity generation mix. Periods in which VRE availability exceeds demand occur more frequently than in earlier phases. Ensuring system stability while continuing to increase renewable penetration requires additional measures, such as expanded demand response, stronger interconnections and large-scale energy storage. Market design and regulatory frameworks become increasingly important to enable these solutions. Although particularly critical in this phase, many of these measures should begin in earlier phases (B and C) to provide long-term investment signals and facilitate a smoother system transformation.

Phase E (more than 70% share of annual VRE share): we assign this phase when wind and solar make up 80-100% of a country's electricity generation mix. The power system reaches very high VRE penetration. The primary challenge becomes ensuring adequacy during extended periods of low wind and solar availability. Addressing this requires long-duration energy storage, sector coupling allowing for export and import of power between economic sectors in the same country and extensive electricity trade both within regions and between countries.

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Acknowledgments
We would like to thank the wider CAT team for their work on country assessments, which contributed to this briefing.

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The Consortium

The Climate Action Tracker (CAT) is an independent scientific analysis produced by three research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

climateactiontracker.org

Climate Analytics is a non-profit institute leading research on climate science and policy in relation to the 1.5°Climit in the Paris Agreement. It has offices in Germany, the United States, Togo, Australia, Nepal and Trinidad and Tobago.

climateanalytics.org

NewClimate Institute is an independent non-profit organisation that develops solutions to tackle climate change and drives their implementation worldwide. Through research, policy advice and knowledge sharing, we aim to raise the ambition for climate action and support sustainable development.

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