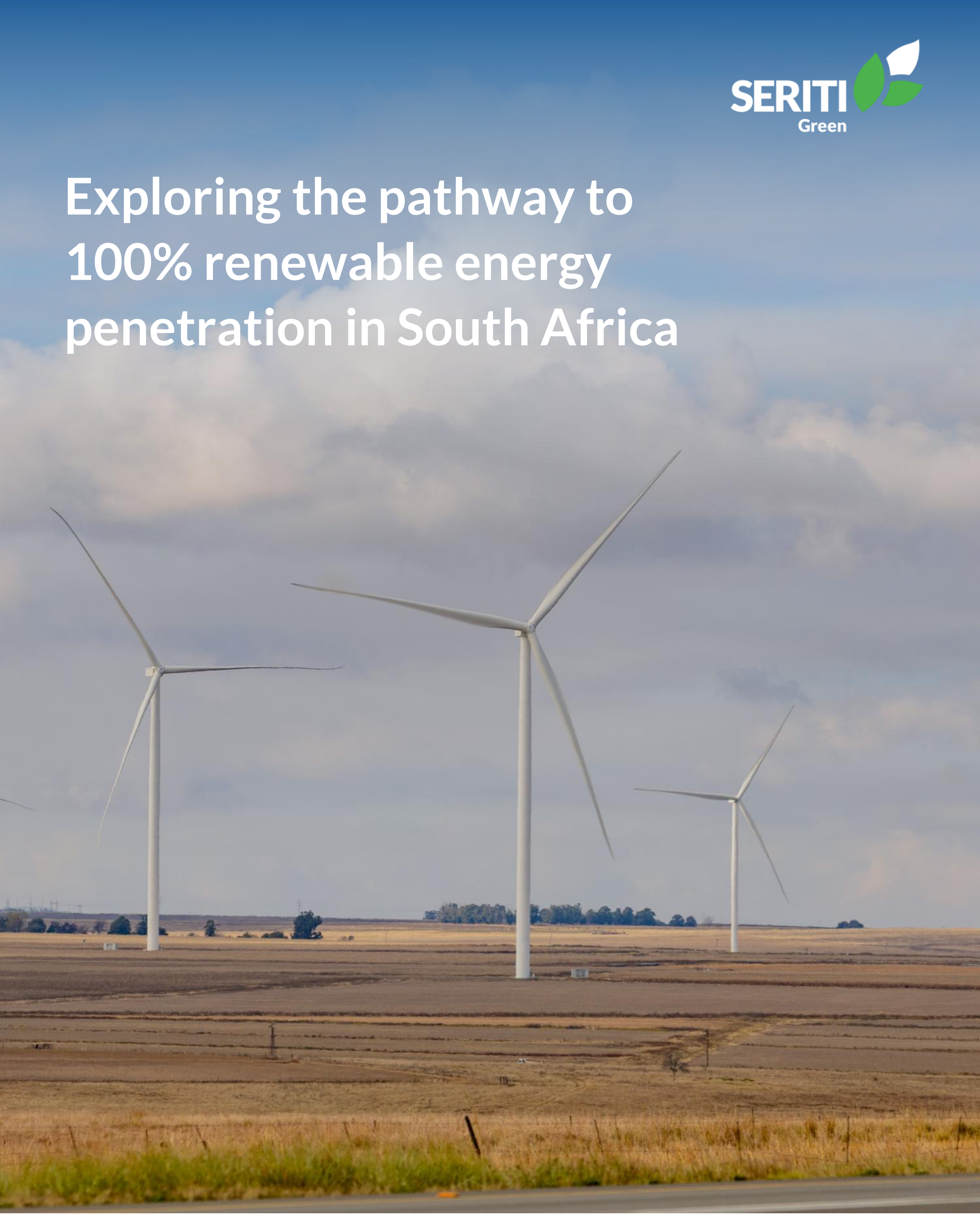
Exploring the pathway to 100% renewable energy penetration in South Africa



Monthly simulations of the South African electricity grid

July 2026

Exploring South Africa's renewable energy potential

Seriti Green's engineering team developed a simplified model of South Africa's energy balance to explore whether the national grid can realistically reach high levels of renewable energy penetration.

The model uses Eskom demand and generation data to compare hourly electricity demand against renewable generation, battery storage and backup generation requirements.

The model demonstrates that the majority of national electricity demand can be met with renewable energy, supported by as little as ten hours of battery storage. In this scenario, there is limited reliance on dispatchable backup generation.

What the model assumes

The model is based on the following key assumptions:

20GW

Wind capacity installed (including the 4GW currently operational.

25GW

Solar PV installed (including the 2.6GW currently operational. This can include a mix of utility-scale and rooftop solar; existing embedded generation is already accounted for in Eskom's demand data.)

20GW / 200GWh

Battery installed energy storage (enough to supply average demand for 10 hours).

Transmission constraints are excluded & therefore "balance" is a realistic description of the model.

Medupi (4 764 MW), Kusile (4 800 MW), and Koeberg (1 860 MW) are retained. These plants will not be decommissioned before the 2050s for coal and the 2040s for nuclear. As Eskom reports generation only in aggregated 'Thermal' and 'Nuclear' categories, coal output is scaled to represent the capacity share of Medupi and Kusile (~25%).

Capacities of other renewable energy generators are assumed to remain the same. This is composed of 600MW CSP, variable and pumped hydro (which have maximum generation of about 600MW and 2.9GW respectively), and "other RE" categorised by Eskom to be about 50MW).

What the model assumes

The model is based on the following key assumptions:

- A distinction has been made between currently installed and future wind and solar assets.
- We assume that new wind generation will be appropriately spread around the country and not concentrated in the Cape provinces as is currently the case.
- We have thus generated a composite generation profile using Erra5 (ECMWF(European Centre for Medium-Range Weather Forecasts) Reanalysis 5th Generation) data from 5 locations in South Africa.
- Shortfalls after BESS discharge will need to be met by dispatchable generation. This is assumed to be a combination of open or closed cycle gas turbines. This is peak capacity that is rarely dispatched.
- The IRP 2025 has a 5 200 MW allocation for Nuclear up to 2039. For the purpose of this simulation, it has been assumed that this will not be built.

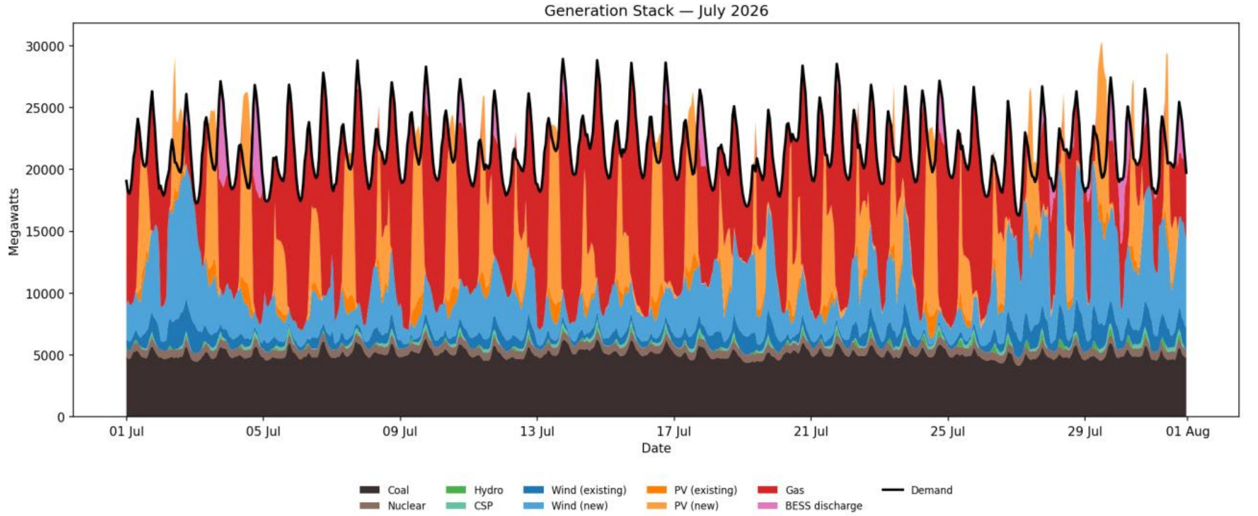
Simulation methodology

The model plots hourly electricity demand against renewable generation.

At various points, renewable generation exceeds demand and is stored in batteries. Where supply falls short, stored energy helps balance the system.

- The chart shows the hourly generation mix for July 2026.
- The dark line shows the country's total energy demand, fluctuating between 17 and 25GW. Due to rooftop solar, energy demand in the middle of the day is generally lower than other times (commonly known as the "duck curve“, which is already forming in SA).
- During some hours energy production via solar or wind is shown to be above this line. This over generation is generally used to charge energy storage, however excesses beyond the storage capabilities are curtailed.
- Existing and new wind and solar have been differentiated in the chart - for this example, it has been assumed that the profiles are the same.
- The purple shows BESS discharge. Gas is only used when the total deficit in the look-ahead period (16 hours) is greater than the battery capacity.

Renewable energy simulation generation stack



How the system behaved in July 2026

Renewable performance varies based on weather conditions and demand patterns.

Even during periods of lower wind output, the system remains stable through the combined role of solar, storage and limited backup generation.

Results

July was the year's toughest month, a sustained winter wind drought pushed renewable penetration to its lowest yet (53.5% of residual) and required an 18 GW gas peak. Critically, storage could not compensate with no midday surplus to assist, doubling the battery did not change the outcome. That's the winter story in a nutshell, there's little renewable resource to store, so extra battery capacity just sits idle.

Scenario Sensitivity

Two mixes were compared at equal total capacity (45 GW): a solar-heavy build (20 GW wind / 25 GW solar) and a wind-heavy build (25 GW wind / 20 GW solar). The wind-heavy mix performed better in July (56.9% vs 53.5% residual penetration and a lower gas peak). This is because winter demand peaks at night when solar cannot contribute and no battery size can bridge a multi-day wind drought.

Despite this, we adopt the solar-heavy scenario as our base. We believe this better reflects reality: the national pipeline is 121 GW solar vs 83 GW wind and Bid Window 7 reassigned all unallocated wind capacity to solar as it can connect quicker. Wind sites with grid connection are also few pending clarity on curtailment rules. Modelling the solar-heavy scenario is therefore the practical decision but does highlight the issue of winter reliability.

Key outcomes for the month

- Renewable penetration (residual) 53.5%
- Renewable penetration (total) 39.7%
- RE curtailment 0.0%
- Peak gas requirement 18 GW
- Total gas energy dispatched 5 553 GWh

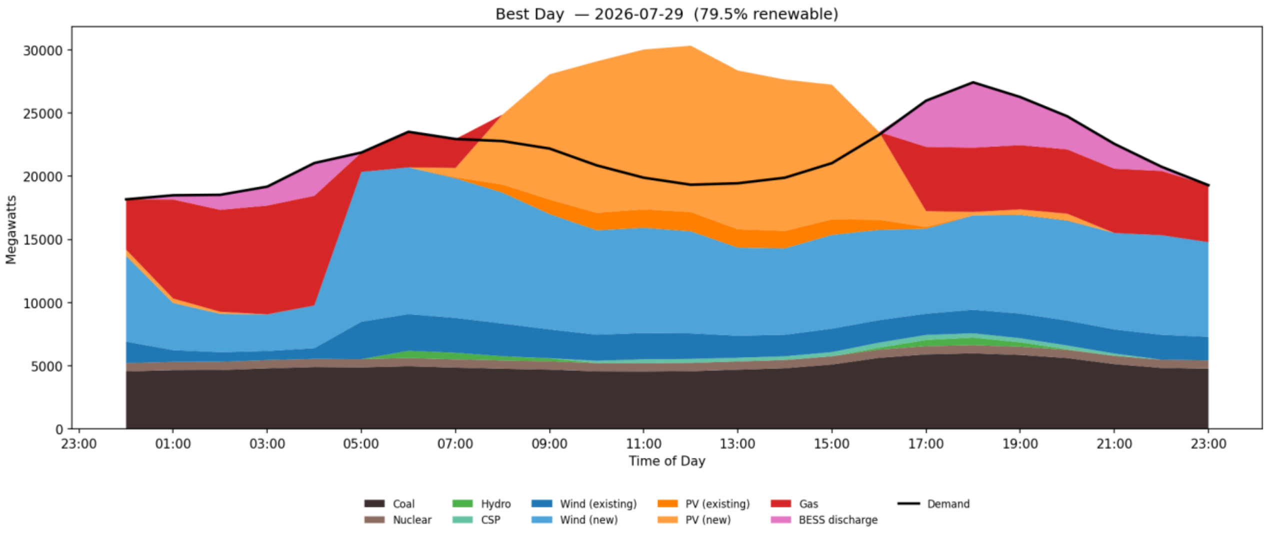
Historical results

The simulation has been run on a monthly basis since January 2026. To date:

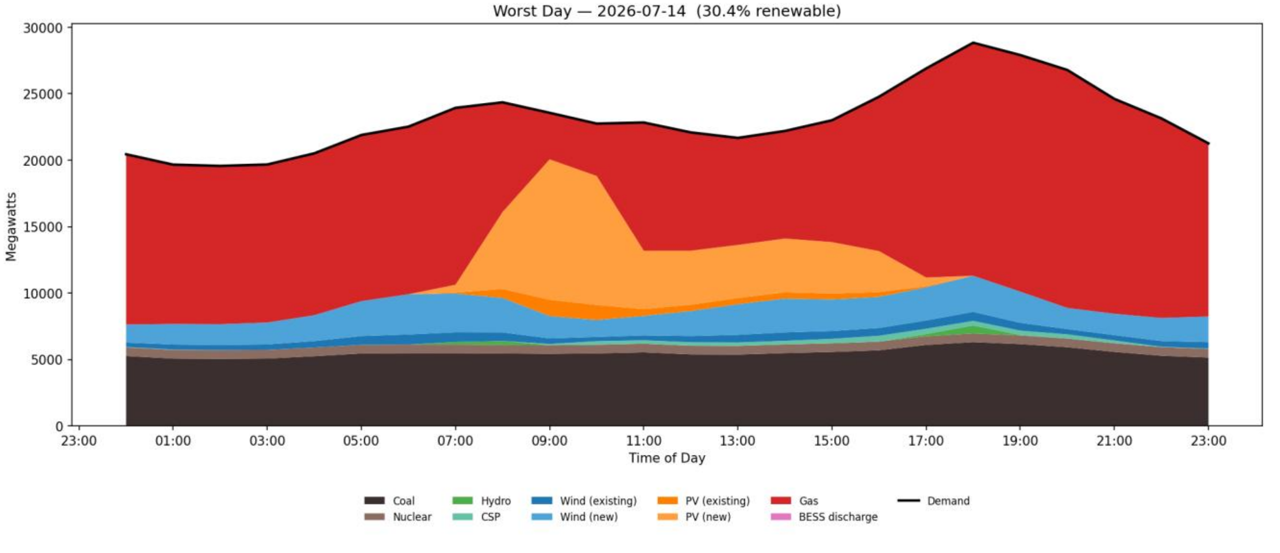
- 73.4% of residual demand has been met with renewable energy.
- Over 61 days have been fully 100% renewable powered.
- The worst day in the simulation required a peak gas input of 18 GW. While this defines the backup capacity that must be available, only 5,553 GWh of gas energy was dispatched during the month, reinforcing its role as an infrequently used reliability resource rather than a primary source of electricity.

Performance across different days

Best Day - 29 July 2026 (79.5% Renewable Energy)



Worst Day – 14 July 2026 (30.4% Renewable Energy)



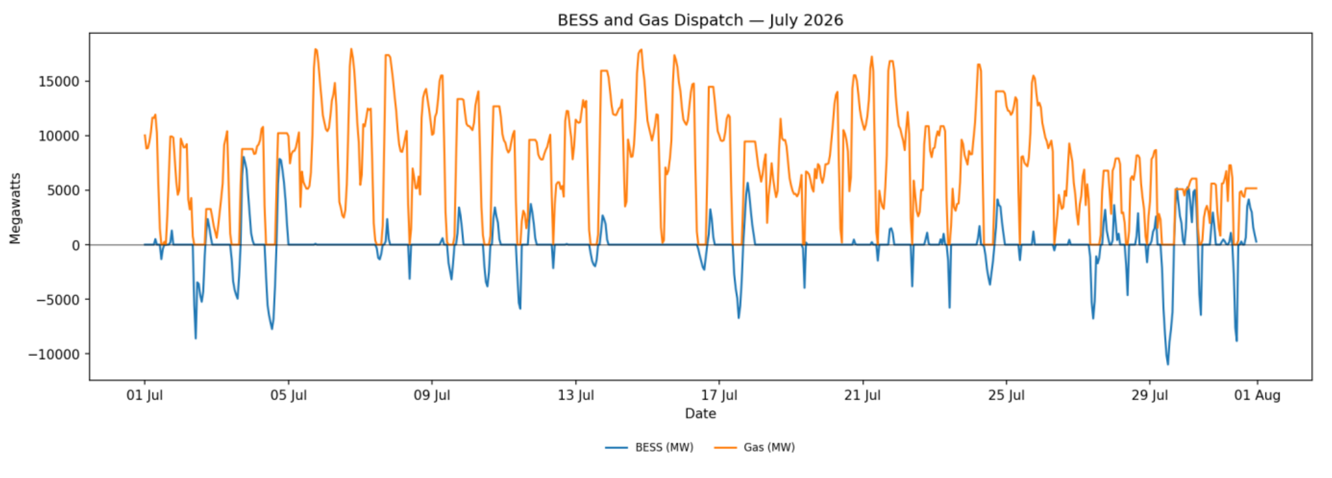
The role of storage and backup

Battery storage plays a critical role in stabilising the system.

Backup generation is only used when storage cannot fully meet shortfalls. In this model, gas acts as system support rather than a primary energy source. The BESS charging and discharging can be cross-referenced with the chart below.

July demonstrated the fundamental limit of battery storage. A battery excels at intra-day shifting, moving midday solar into the evening peak, but is powerless against a multi-day winter wind drought. With little solar surplus to charge from and demand peaking after dark, the 200 GWh battery sat largely idle: doubling it from 100 to 200 GWh changed July's outcome by essentially nothing. The winter deficit is an energy-over-days problem that only firm wind or seasonal storage can solve.

BESS and Gas Dispatch



What this means for South Africa's energy future

In July 2026, the model showed:

53.5%
renewable penetration of residual demand

39.7%
renewable contribution to the total mix

0.0%
renewable curtailment

18GW
peak gas requirement

5,533 GWh
gas energy dispatched

The simulation has been run monthly since January 2026 with the following results

73.4%
of residual demand was met with renewable energy

More than
61 days
were fully powered by renewables

Conclusion

July exposed the limit of a storage-only strategy. Even with a large battery, a solar-heavy grid cannot ride through a multi-day winter wind drought: this is because the deficit falls after sunset and lasts longer than any battery can cover.

Key takeaway

A high-renewable South African grid is not aspirational, it is achievable. What July shows is that reaching it depends less on how much we build than on building the right balance of wind, solar and firm capacity

The question facing the industry is no longer whether this is possible.

It is how wisely, and how quickly we move.