CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Visualisation of South African Energy Data

April 2024

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1 ANNUAL ENERGY MIX

Energy production categorized by source for latest year up to **2024 Q1**. The **majority** of South Africa's electrical energy in 2023/24 was generated from **coal** (**73.8%** of total system demand), with **renewable energy** providing **8.7%**. The South African system was unable to provide **13.4%** of the electricity demand (i.e., mainly **load shedding**).

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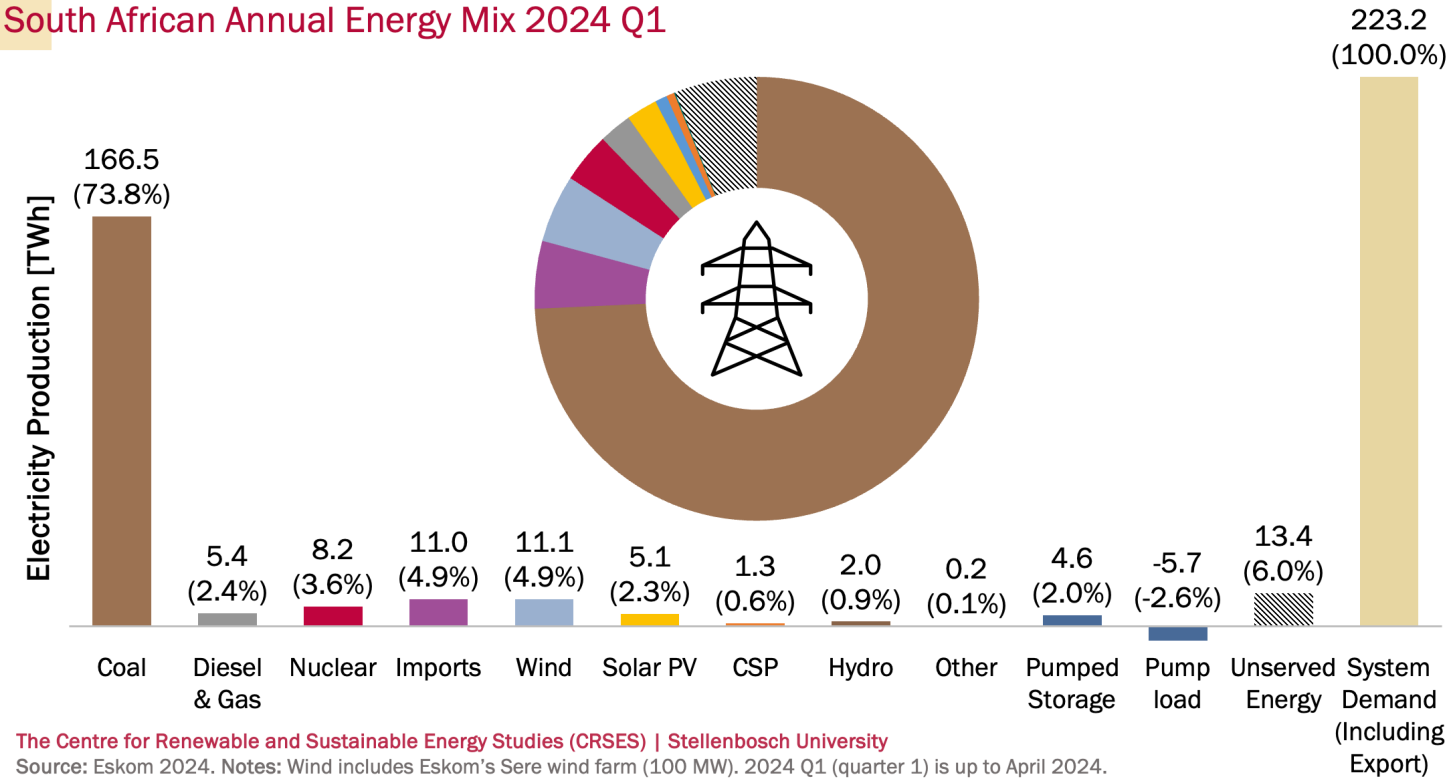
South African Annual Energy Mix 2024 Q1



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Source: Eskom 2024. Notes: Wind includes Eskom's Sere wind farm (100 MW). 2024 Q1 (quarter 1) is up to April 2024. Unserved Energy = Manual Load Reduction (MLR) (load shedding) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).

Nominal installed capacity for the latest year up to **2024 Q1. No additional** utility-scale installed generation **capacity** was added in **2023**. Note that the figure below however excludes embedded and private generation.

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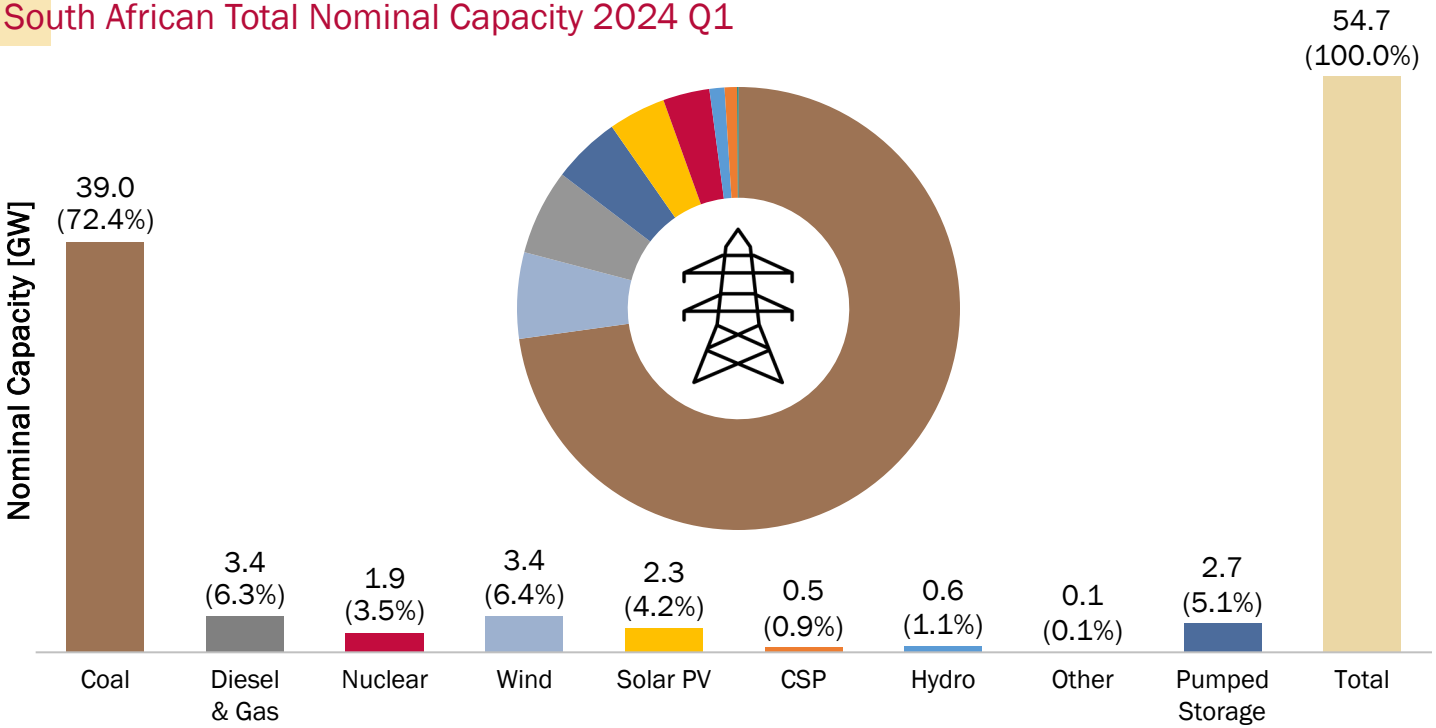
South African Total Nominal Capacity 2024 Q1



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Source: Eskom 2024. **Notes:** Total nominal installed capacity = Eskom capacity + IPPs. 2024 Q1 (quarter 1) is up to April 2024.

Annual **electricity production** from **coal** as a percentage of total production continued to **decrease** in 2023, with a corresponding **increase** in **unserved energy**. Note that there is a slight **downward trend** in national **energy requirements**.

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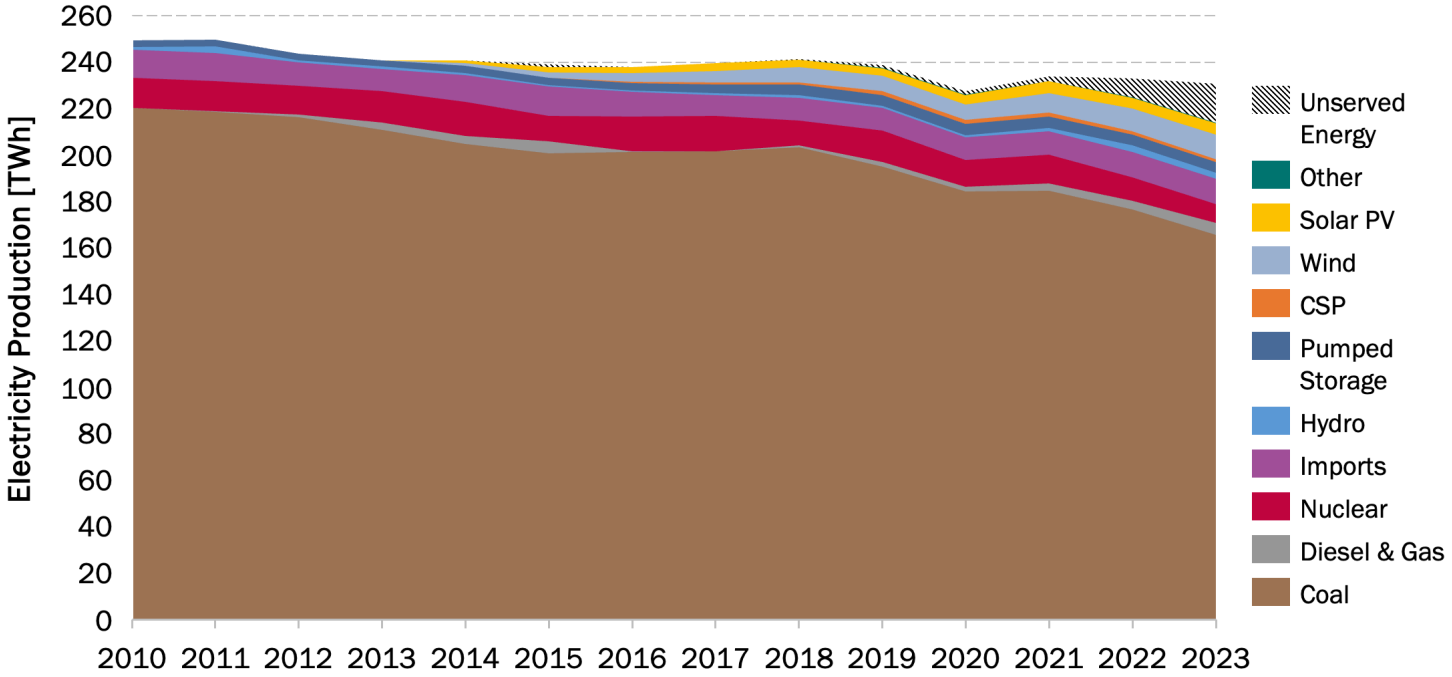
South African Annual Electricity Production 2023



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Source: Eskom 2024. Notes: Unserved Energy = Manual Load Reduction (MLR) (load shedding) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).

Multi-year comparison of peak demand up to **2024 Q1**. Electricity **peak demand** and **energy production** both trended **downwards** since **2010**.

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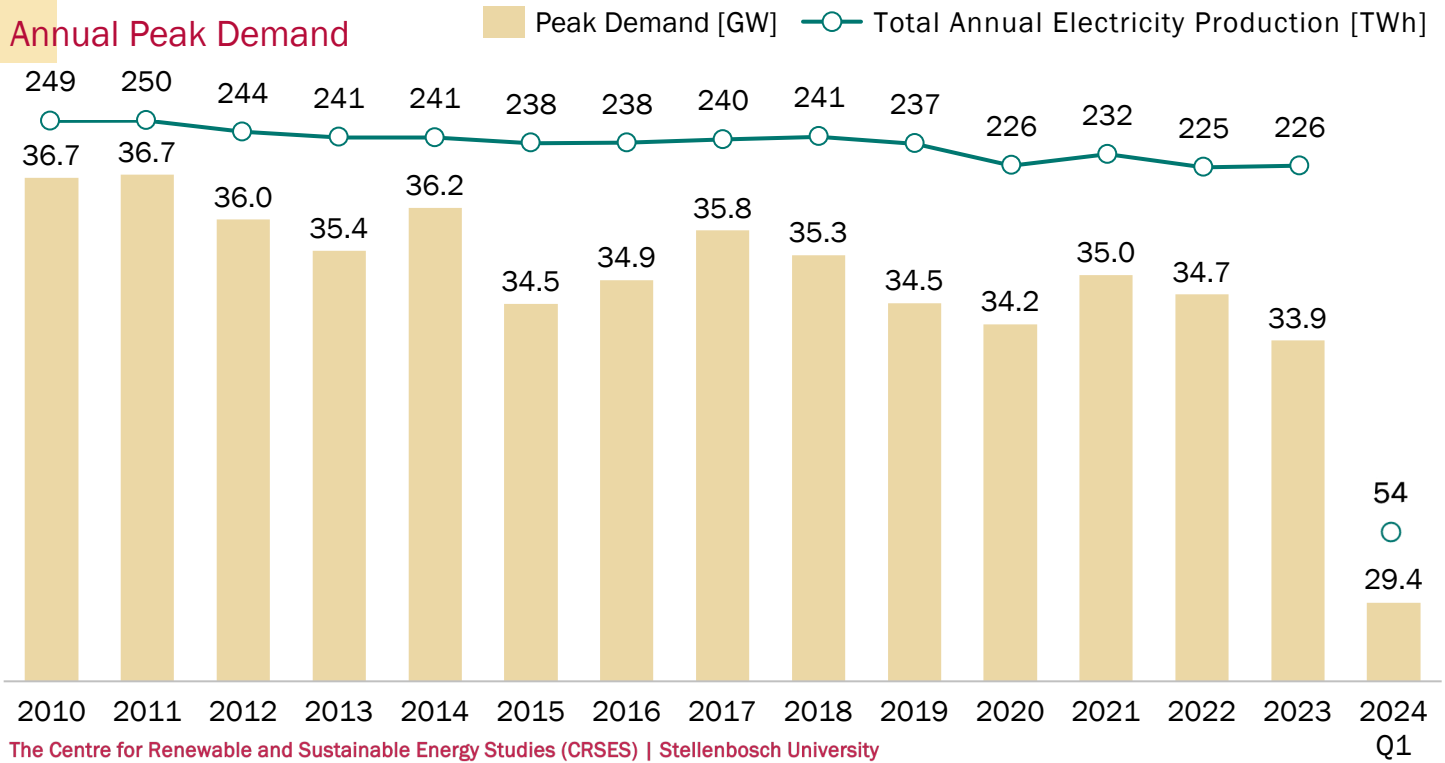
Annual Peak Demand



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Source: Eskom 2024. **Notes**: 2024 Q1 (quarter 1) is up to April 2024.

Unserved Energy = Manual Load Reduction (MLR) (load shedding) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).

Renewable energy installed **capacity** and **energy production** are **increasing** in South Africa, but still constitute a **small portion** of the **total capacity** and **energy mix**. **CSP** costs are **high** and have more **variability** than **wind** and **solar PV** costs, which are both on a stable **downward trend**.

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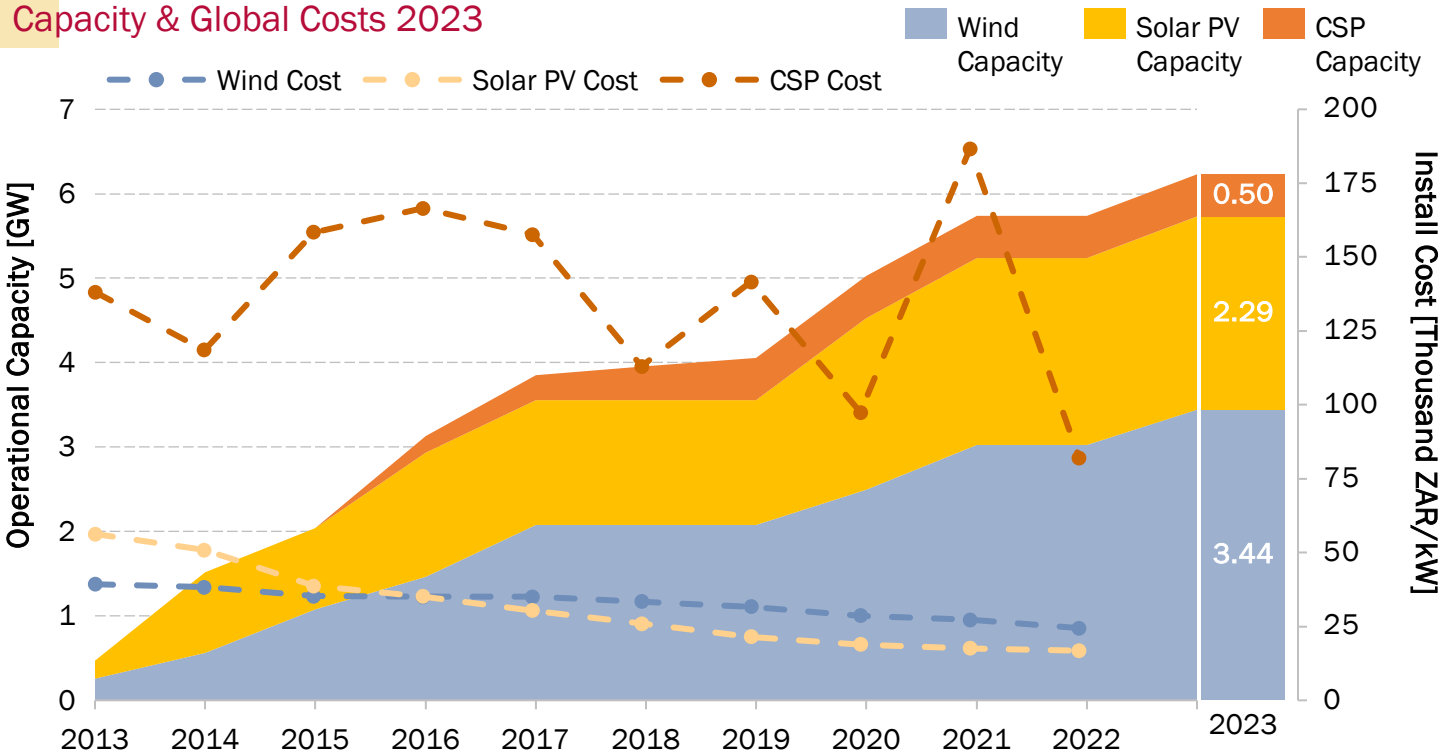
Capacity & Global Costs 2023



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Source: Eskom 2024 | IRENA 2023. **Notes:** Costs are in 2023 value. Solar PV capacity is at the point of common coupling.

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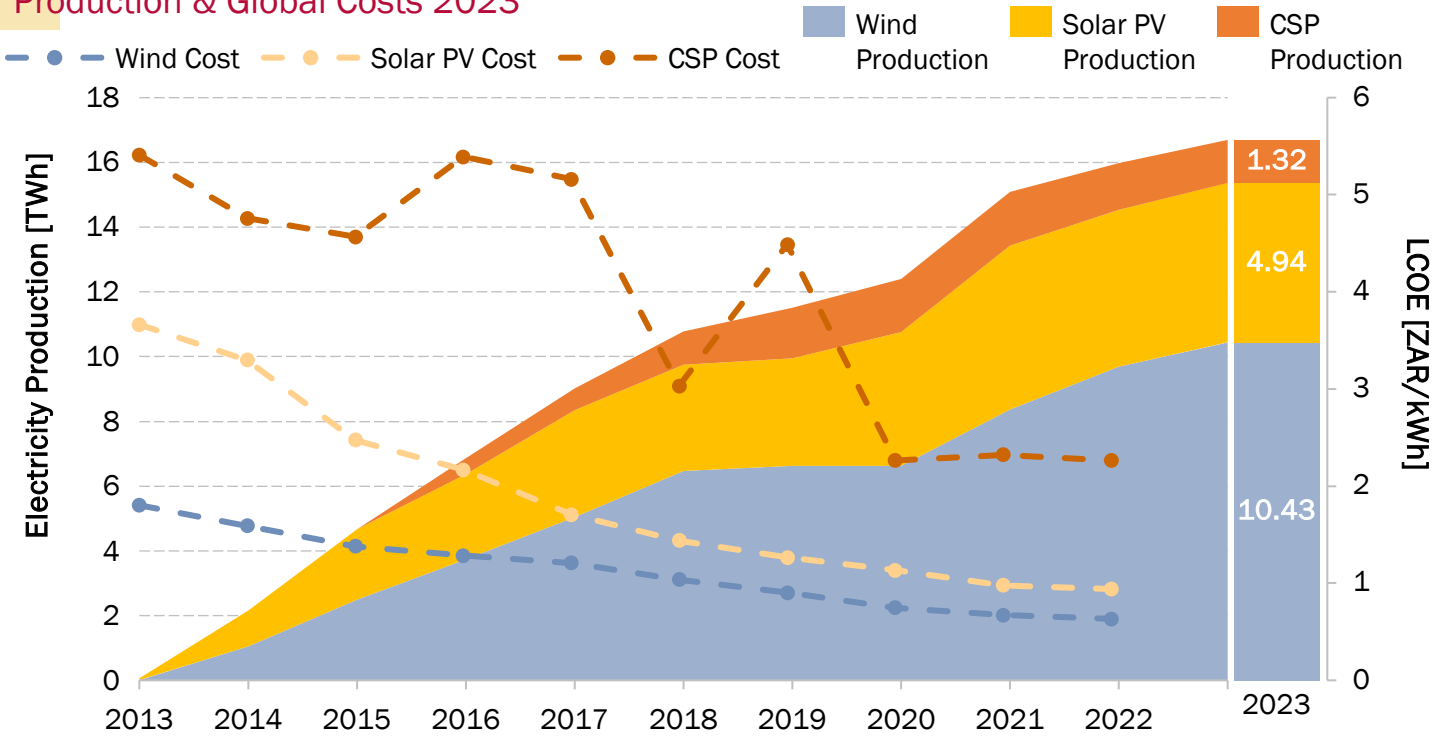
Production & Global Costs 2023



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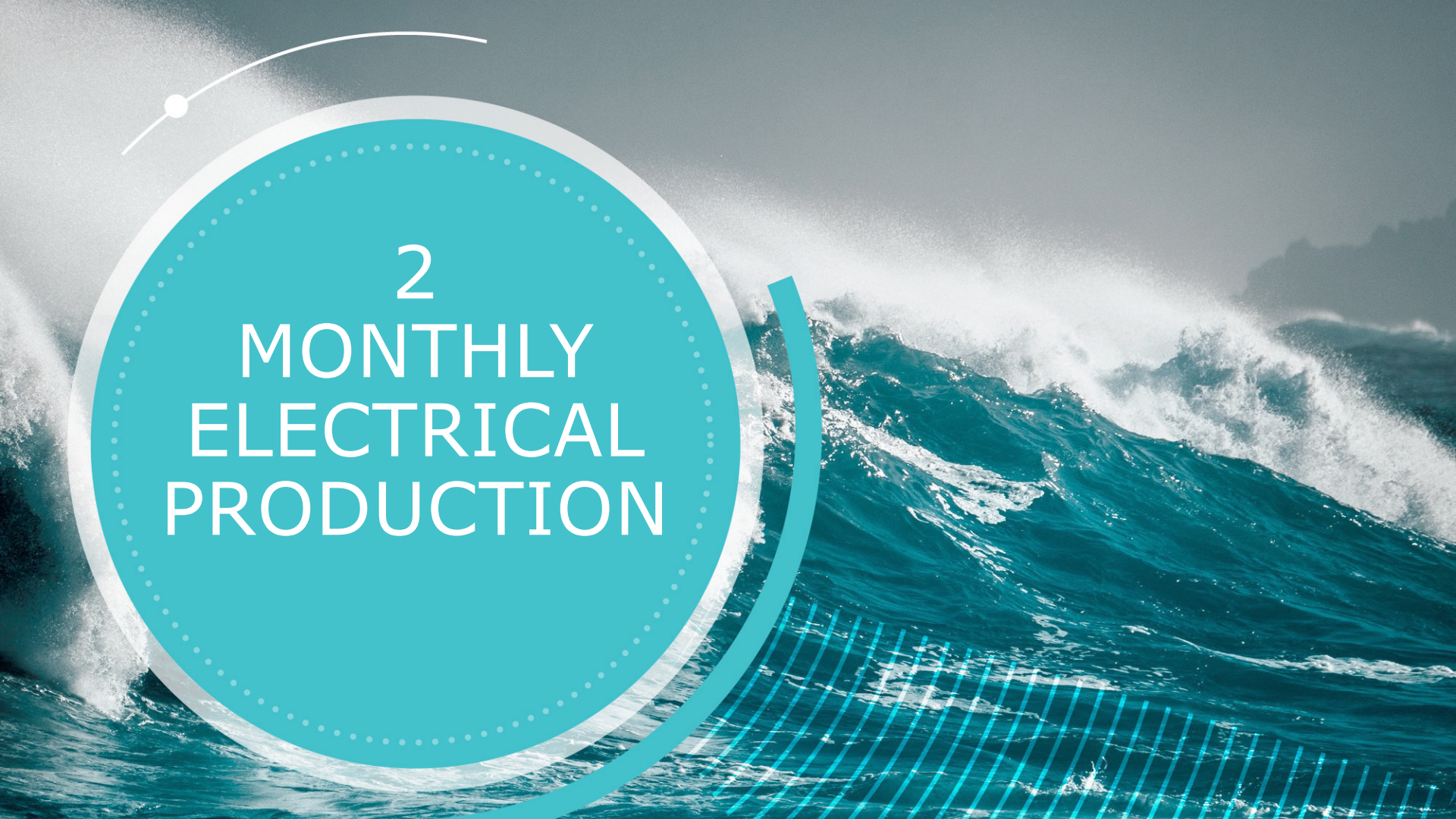
Source: Eskom 2024 | IRENA 2023. **Notes:** Costs are in 2023 value. Solar PV capacity is at the point of common coupling.


2
MONTHLY
ELECTRICAL
PRODUCTION

Energy production categorized by source for the latest year up to **2024 Q1**. Coal has been compressed on this graph to zoom in (see y-axis).

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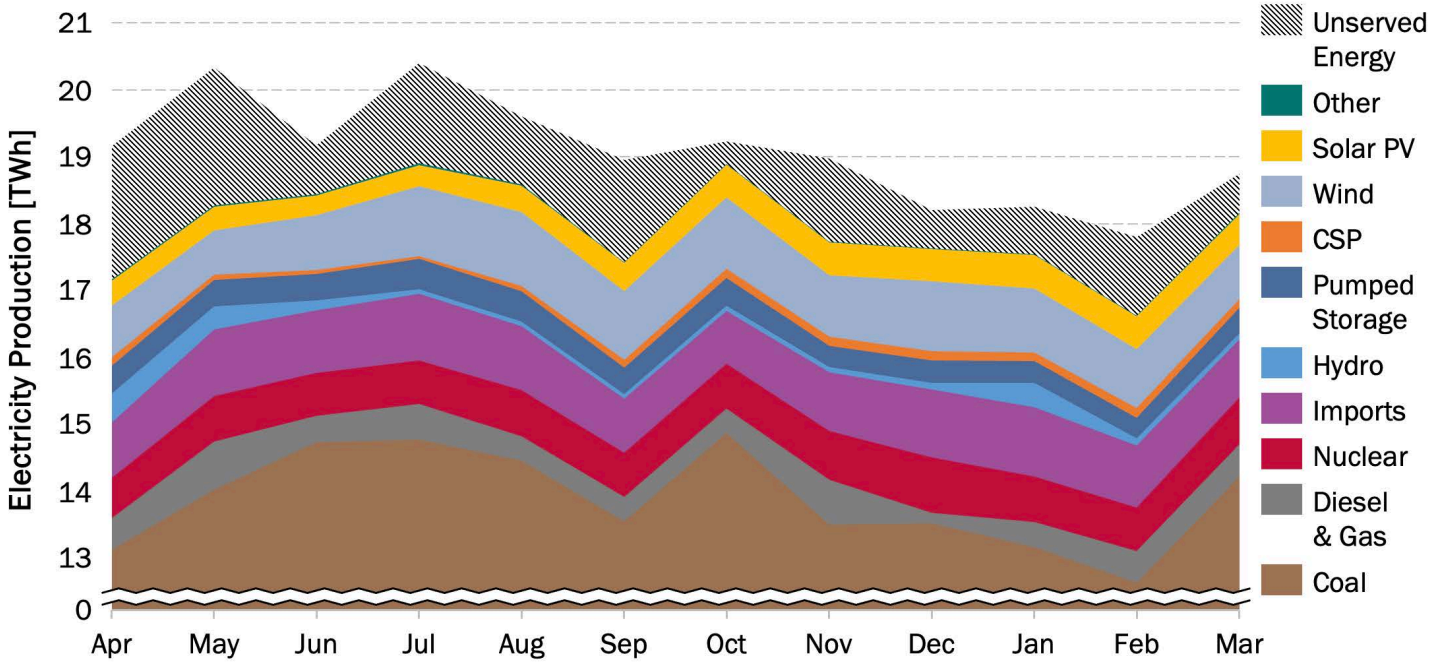
Monthly Electricity Production 2024 Q1



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Source: Eskom 2024. **Notes:** Pumping load excluded. 2024 Q1 (quarter 1) is up to April 2024.
Unserved Energy = Manual Load Reduction (MLR) (load shedding) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).

The **Energy Availability Factor** (EAF) is the amount of energy a generator was able to produce compared to its capacity over a period. From the figure below it is clear that the **EAF** has **decreased** from 2018 to 2023.

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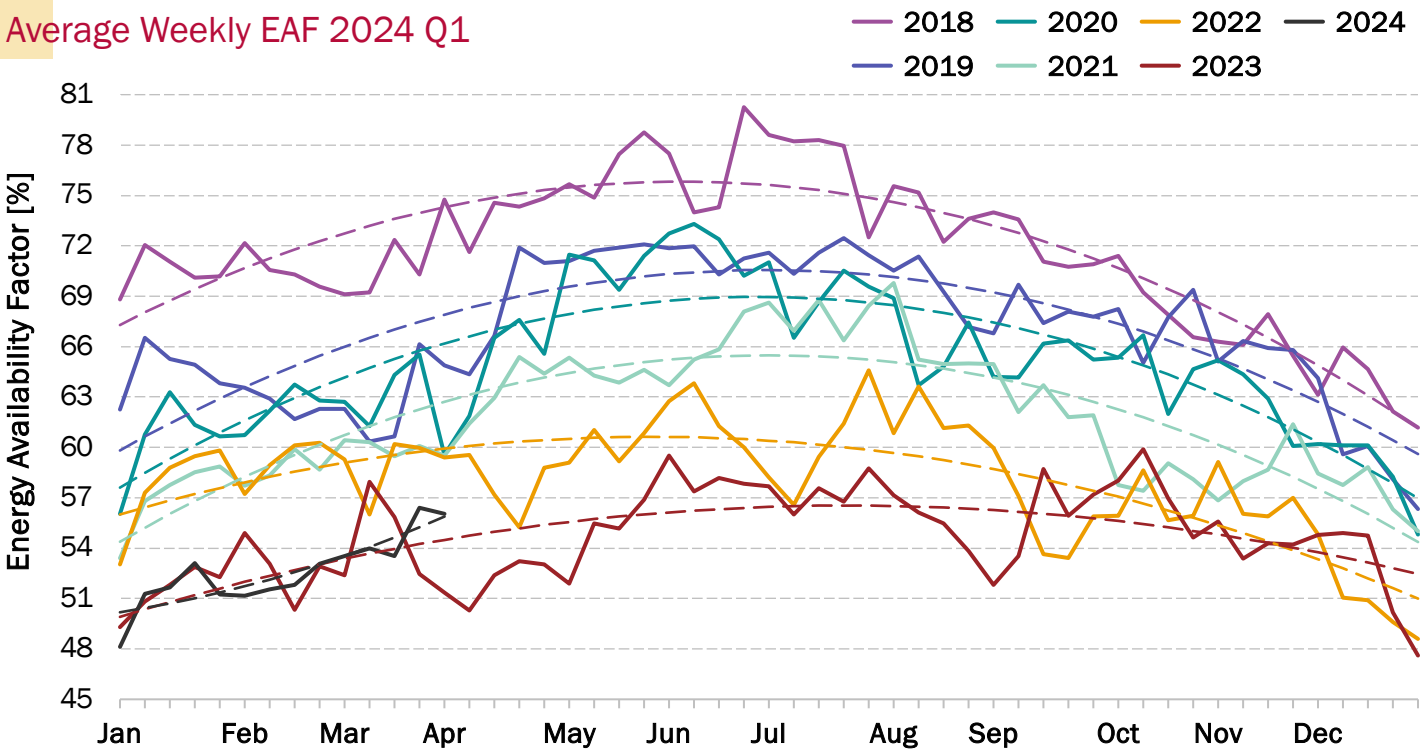
Average Weekly EAF 2024 Q1



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Source: Eskom 2024. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

Monthly **capacity factor** for **6** of the primary **energy sources** for the latest year up to **2024 Q1**.

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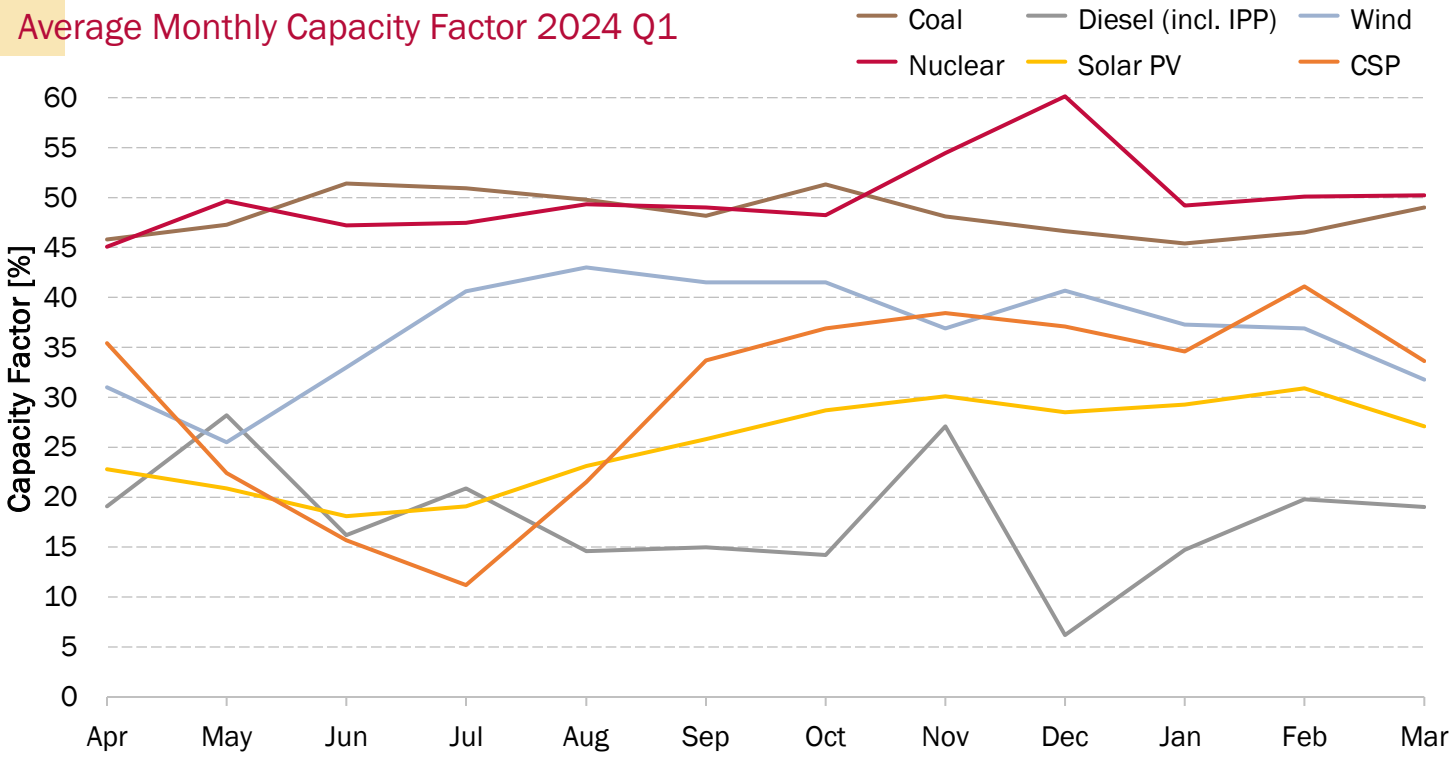
Average Monthly Capacity Factor 2024 Q1



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Source: Eskom 2024. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

The contribution of renewable energy **varies** both **daily** and **seasonally**. **Solar PV** is not well aligned to the typical system **electricity demand**, as seen in the figures below.

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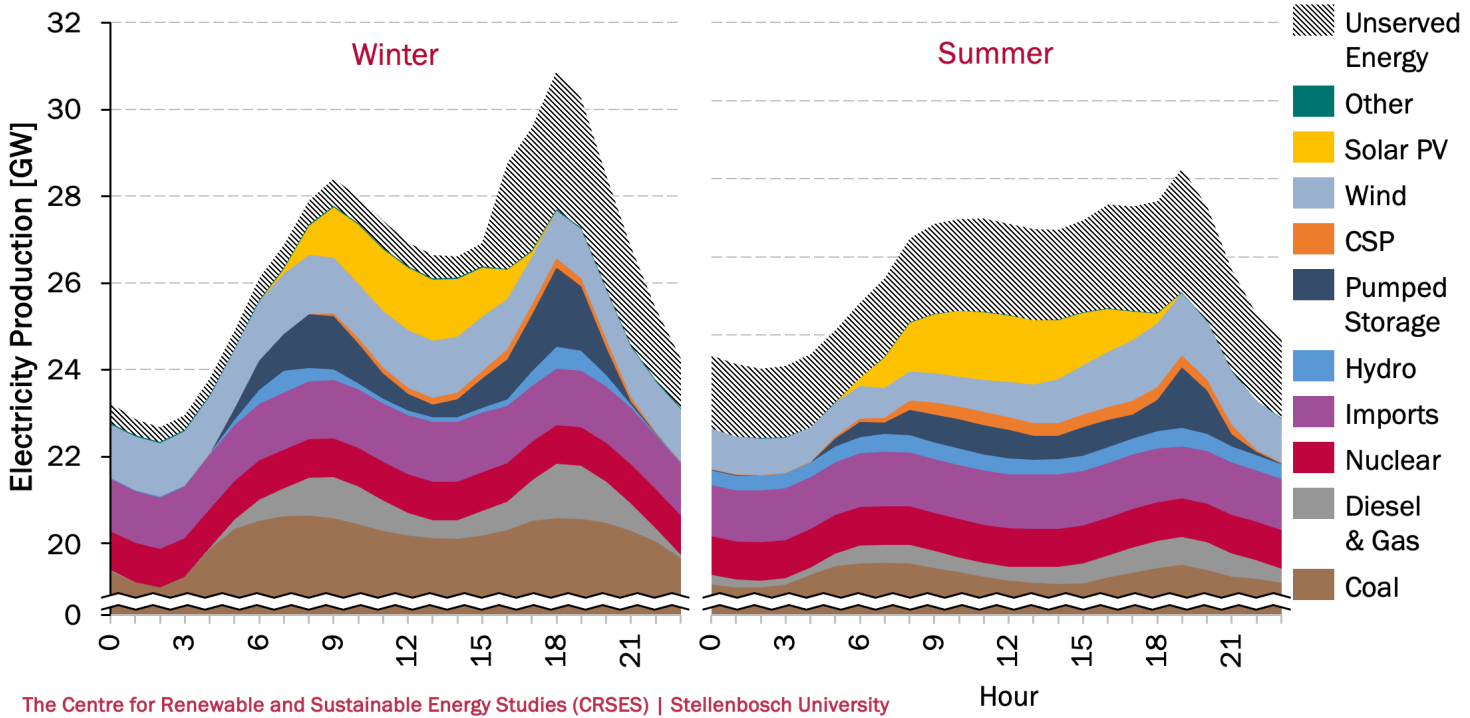
Typical-Day Energy Production 2023



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Source: Eskom 2024. **Notes:** Winter daily average uses data from June, July, and August; while summer uses data from December, January, and February.

Wind production is also **variable** throughout the **year**, but in general aligns better with the **total system demand**. The **location** of the wind farm can impact the **daily** and **seasonal production** profiles significantly.

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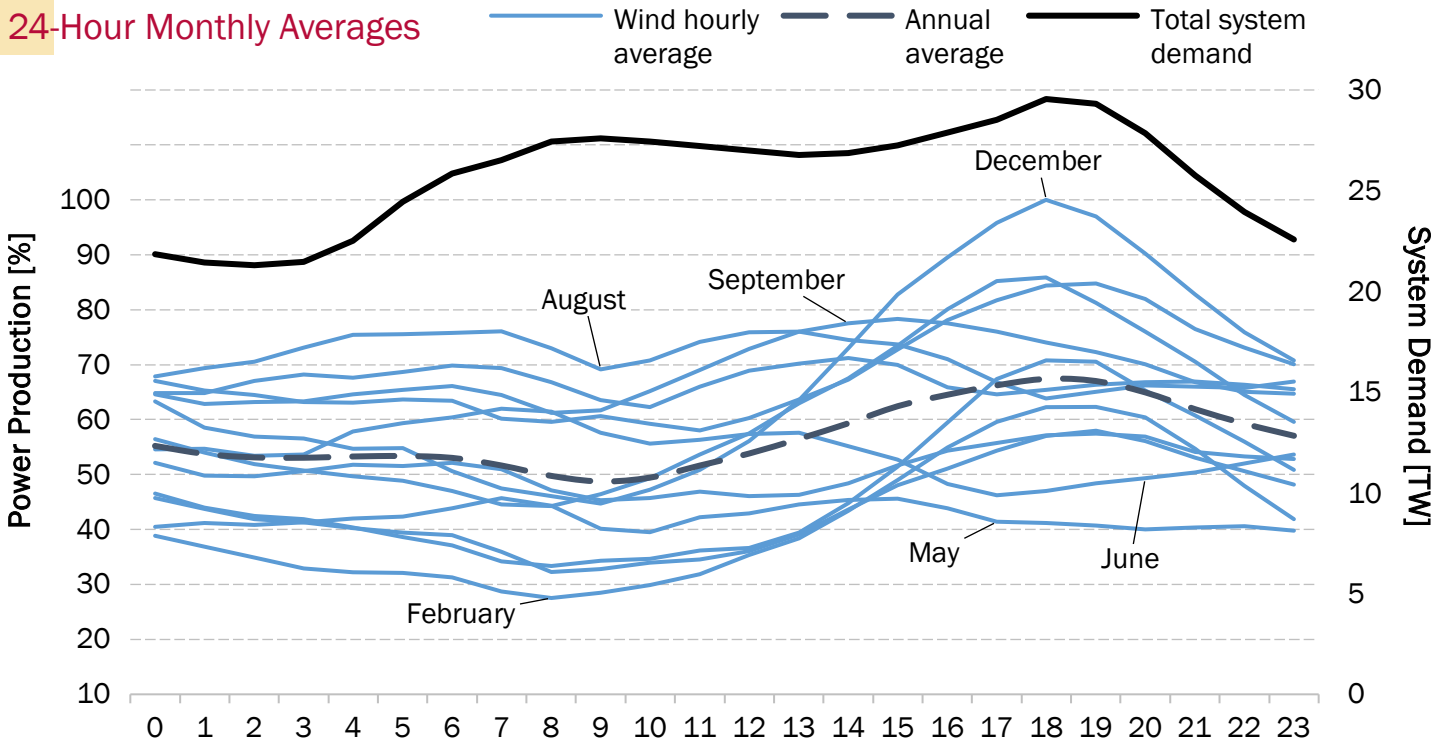
24-Hour Monthly Averages



Source: Eskom 2024.

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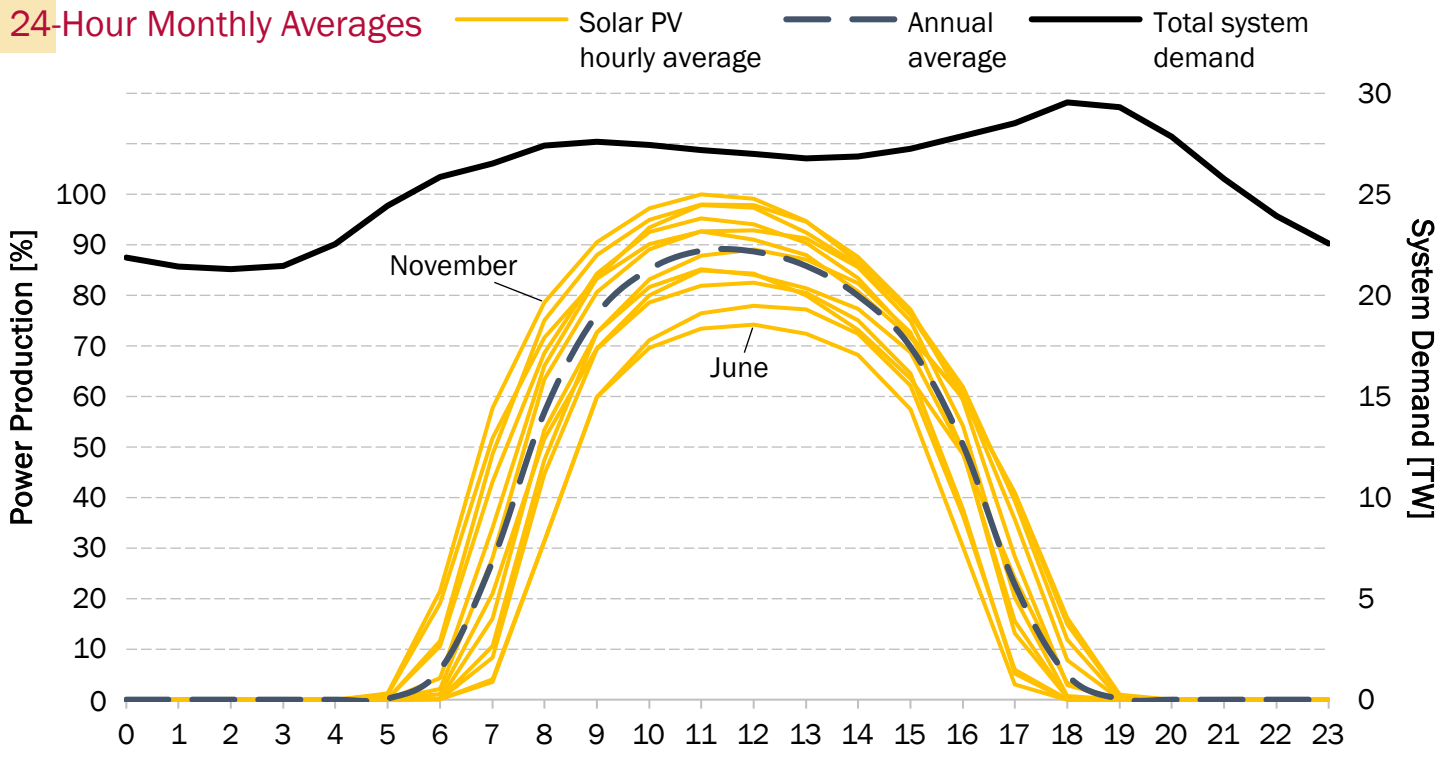

Source: Eskom 2024.

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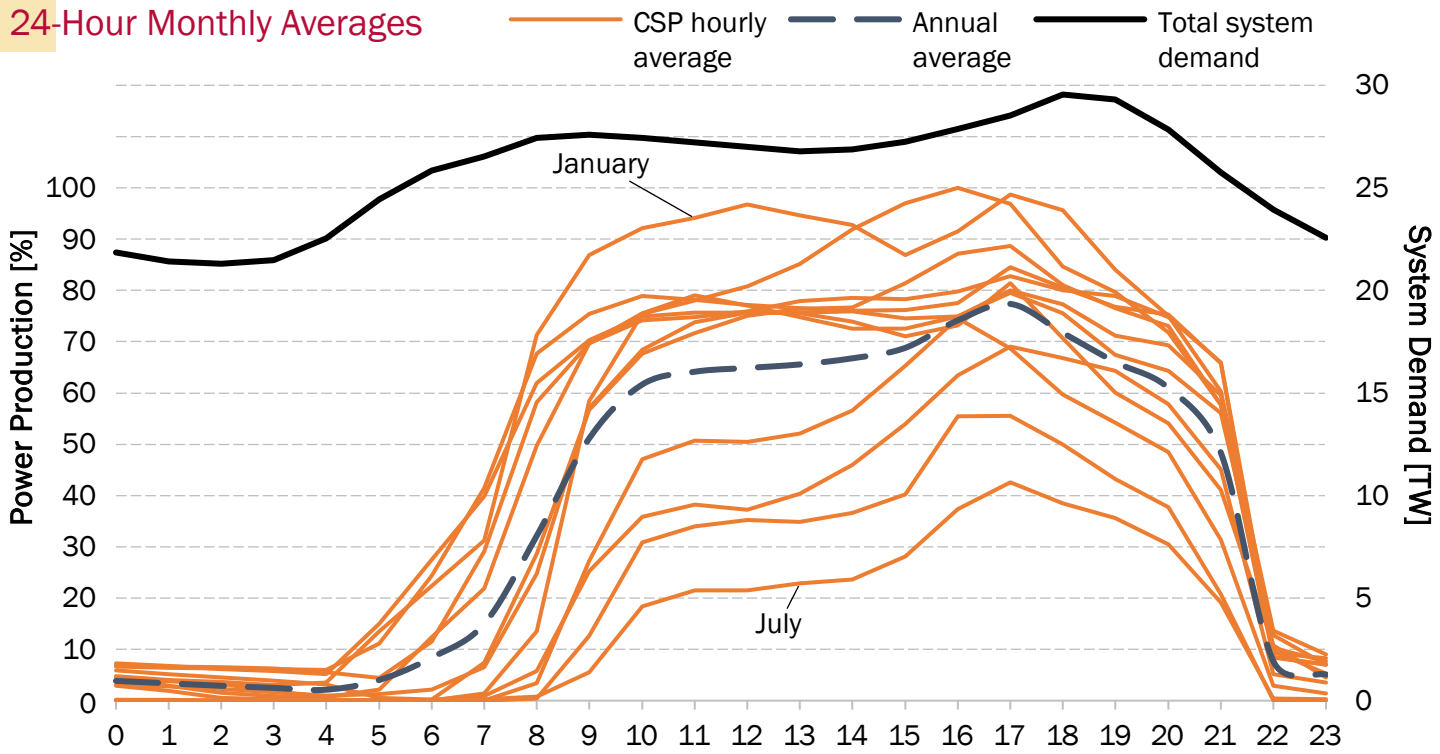
24-Hour Monthly Averages



Source: Eskom 2024.

3 EMBEDDED SOLAR PV CAPACITY

The installation of **privately owned** solar photovoltaics (**PV**), also known as **embedded generation**, has **increased** dramatically in recent years, driven by increasing **electricity prices**, decreasing PV **technology costs** and increased **loadshedding**.

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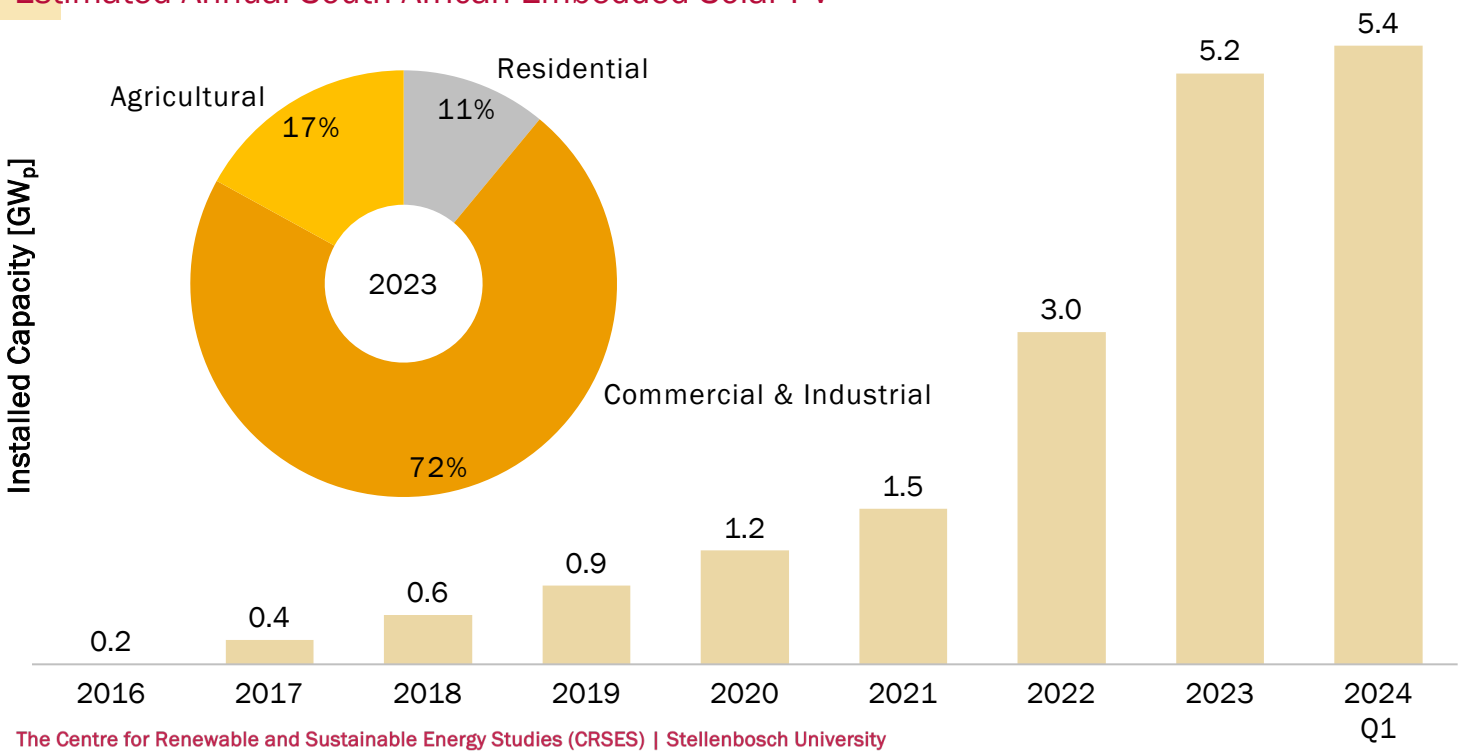
Estimated Annual South African Embedded Solar PV



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Source: Eskom 2024 | SALGA 2023 | GreenCape 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

By April 2024, the **capacity** of embedded PV was almost **double** that of **utility-scale** PV. This contributes to South Africa's **generation capacity**, assisting with the mitigation of generation adequacy problems resulting in **loadshedding**.

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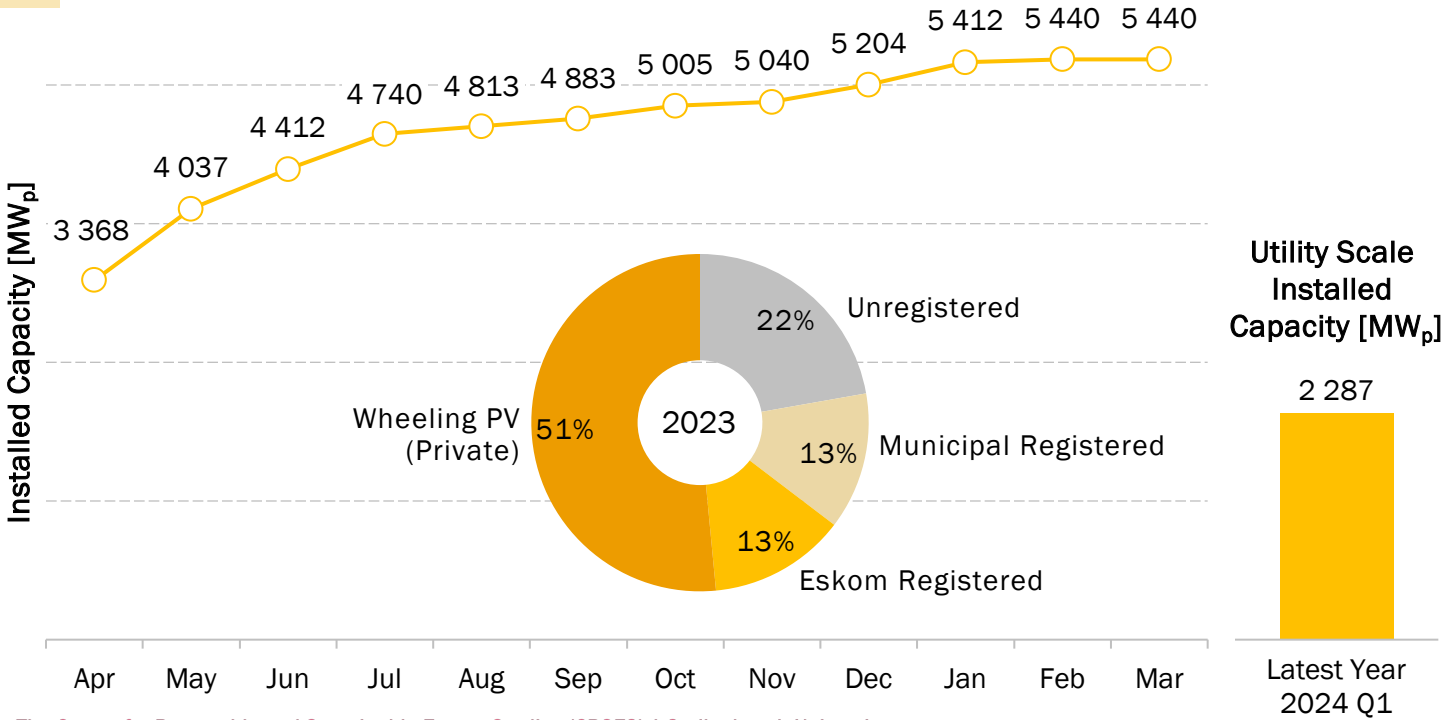
Estimated Embedded Solar PV 2024 Q1



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Source: Eskom 2024 | SALGA 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

A high penetration of embedded generation does, however, give rise to new challenges. Embedded generation systems, especially **unregistered ones**, are **invisible** to the **utility** during operation, and cannot be **controlled** easily. Power system operations (i.e. making sure that the system is stable) becomes more challenging.

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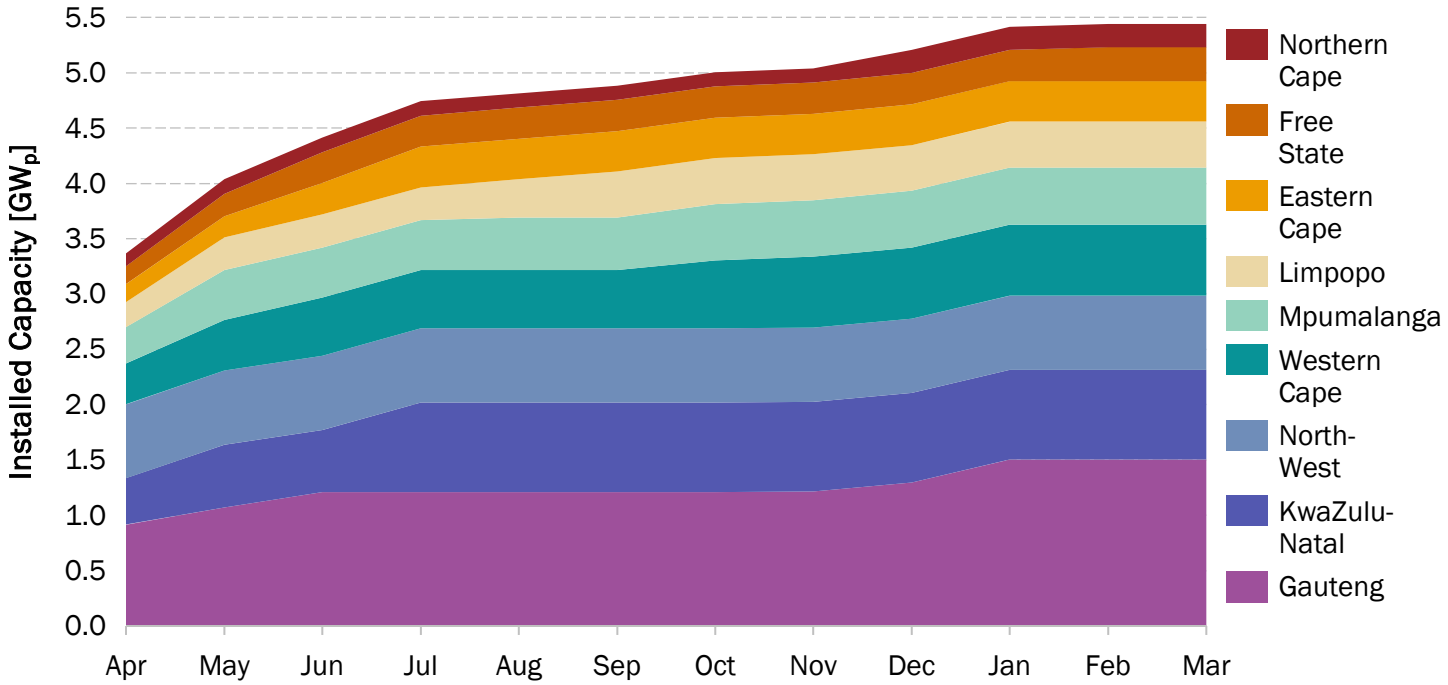
Estimated Embedded Solar PV 2024 Q1



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Source: Eskom 2024 | Department of Statistics South Africa. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

Renewable Energy Integration Impact

International Experience

The integration of wind and PV into existing power systems impacts a variety of technical aspects on a local, regional, and system-wide (national) level. Some of these impacts are relevant from the first wind and PV installations on a network, while other impacts only start occurring as the share of renewables on the network grows. In South Africa we need to investigate constrained flexibility, while stability will only become a challenge in the 2030s (based on our existing electricity policy).

This illustrates the **constraints** experienced by the **system** as there is increased **integration** of **renewable energy**.

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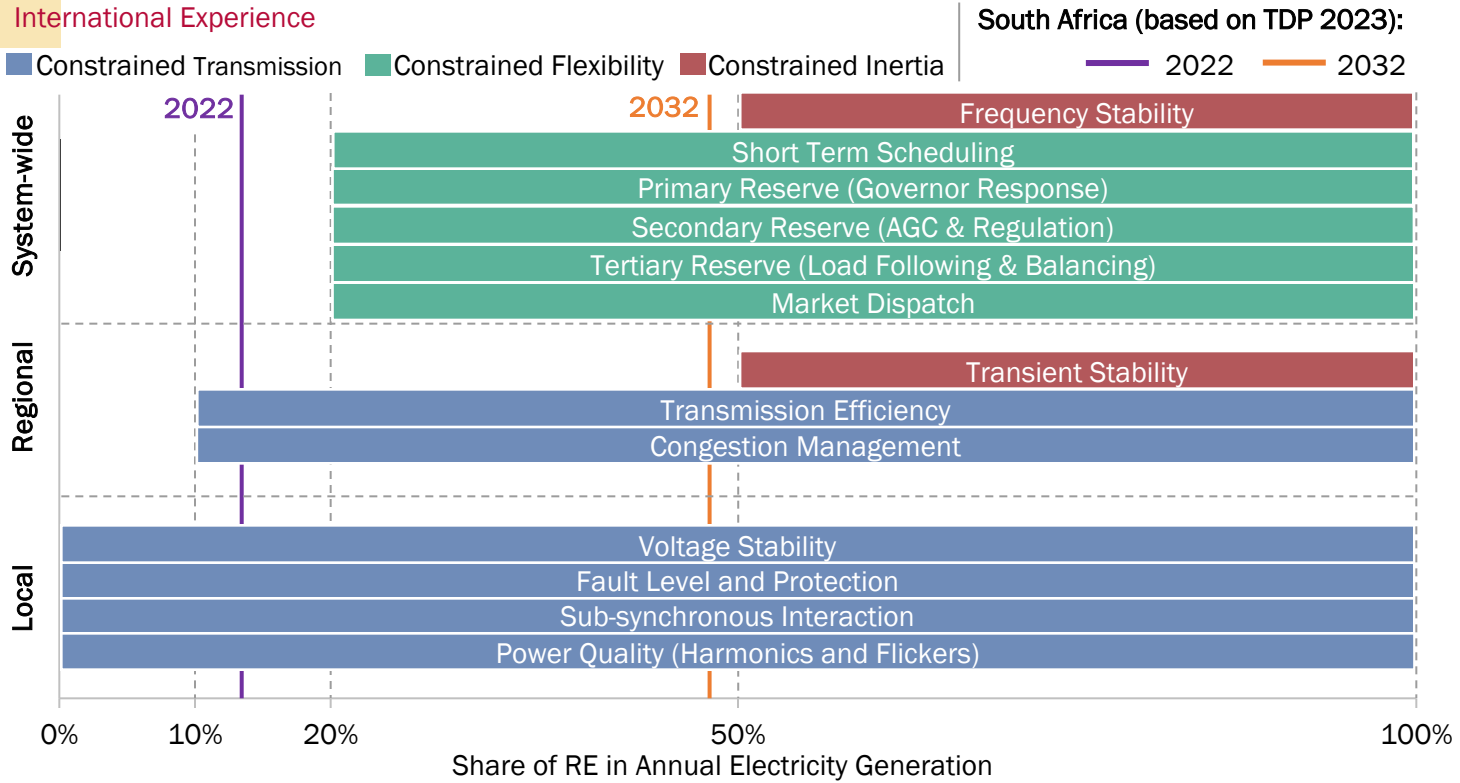
Renewable Energy Integration Impact

International Experience



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Source: Mararakanye & Bekker 2019 | Eskom 2022 (TDP 2023 – 32).

4 LOAD SHEDDING STATISTICS

Load shedding is **increasing exponentially** in recent years. In **2023** we experienced 6 838 hours (**78%**) of load shedding out of the 8 760 hours in the year.

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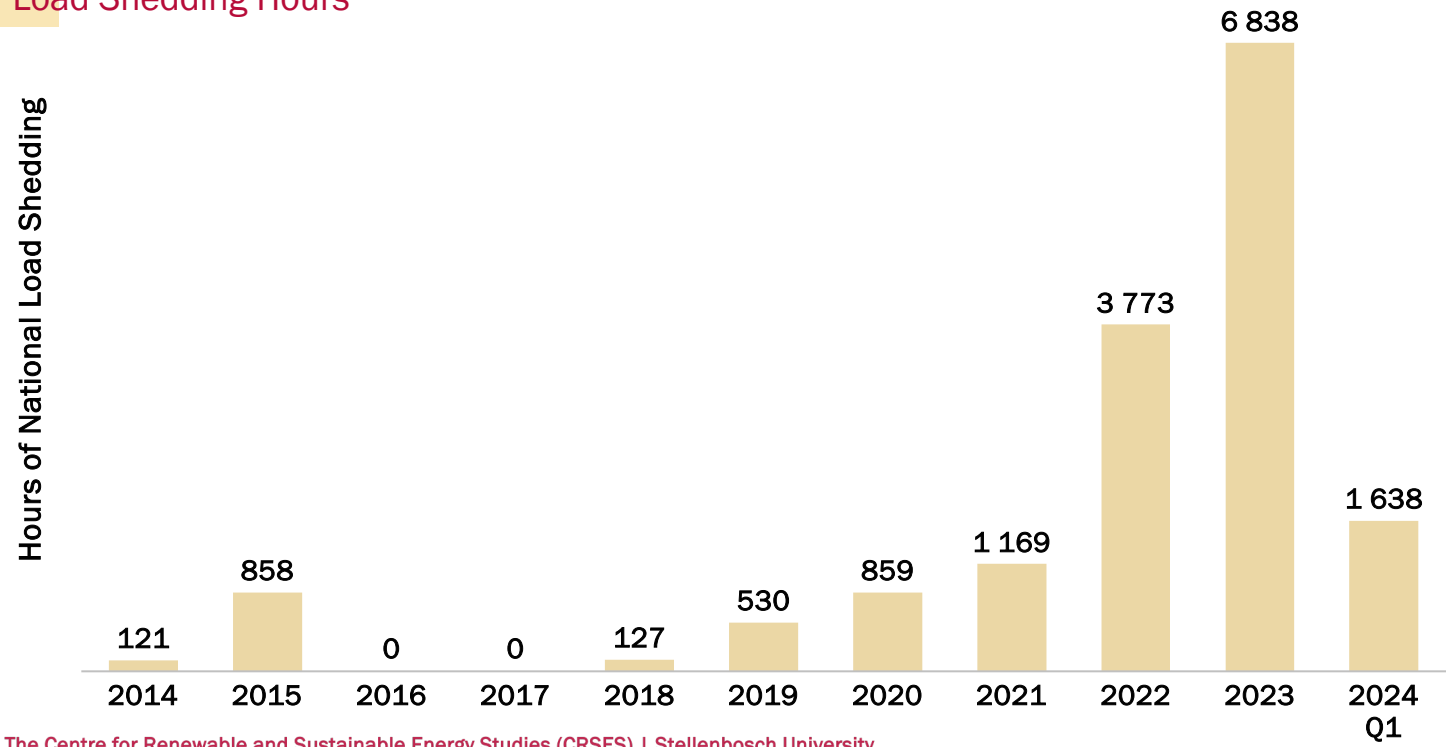
Load Shedding Hours



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Source: Eskom 2024 | Eskom se Push 2024 | NERSA 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

We can now **zoom in** on the last few **years** and **categorize** the load shedding by **stage**. There was an **81% increase** from 2022 to 2023 in the total number of hours. **Stage 6** increased significantly from 2022 to 2023, by **505%**.

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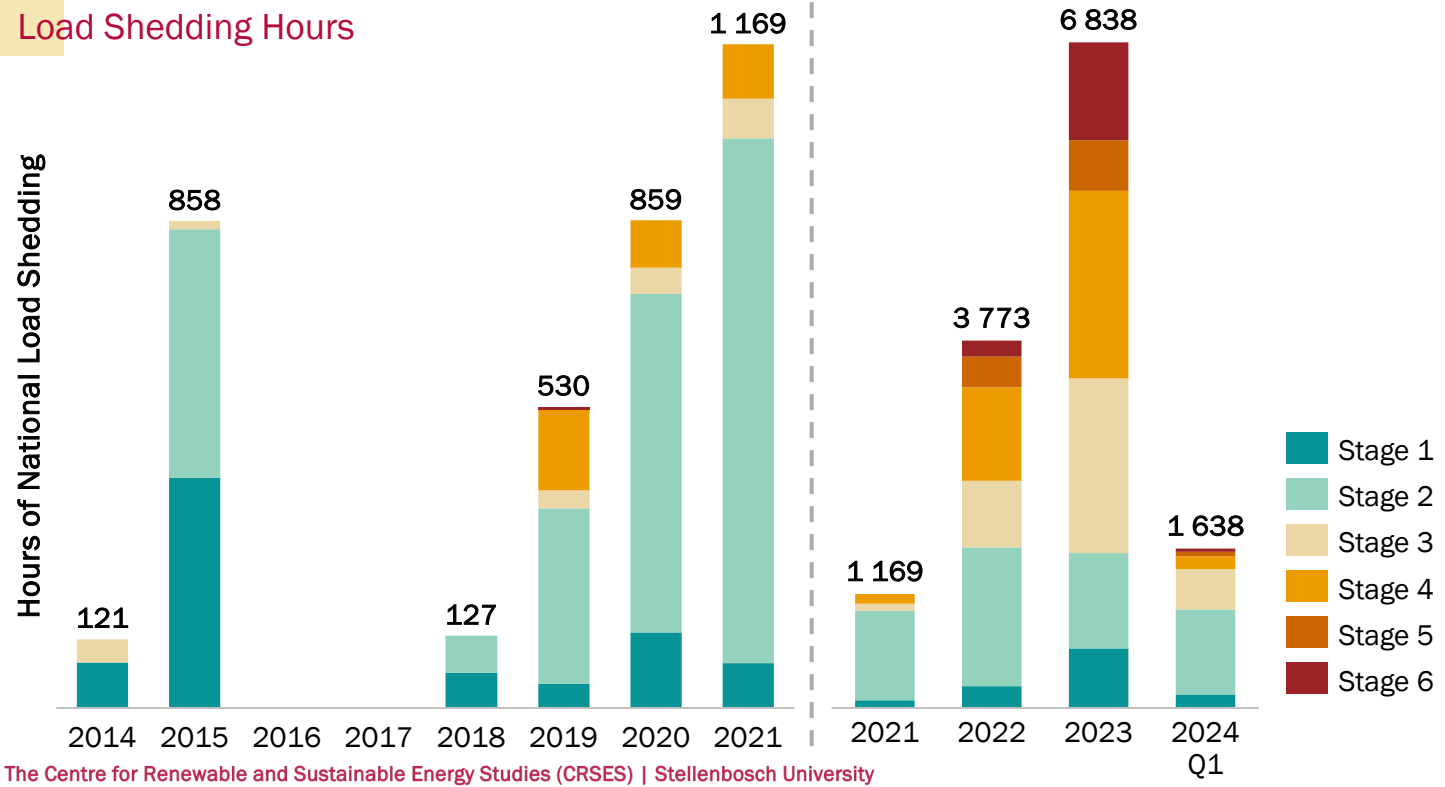
Load Shedding Hours



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Source: Eskom 2024 | Eskom se Push 2024 | NERSA 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

Load shedding saw **low months** in 2023, including **June**, **October**, and **December**.

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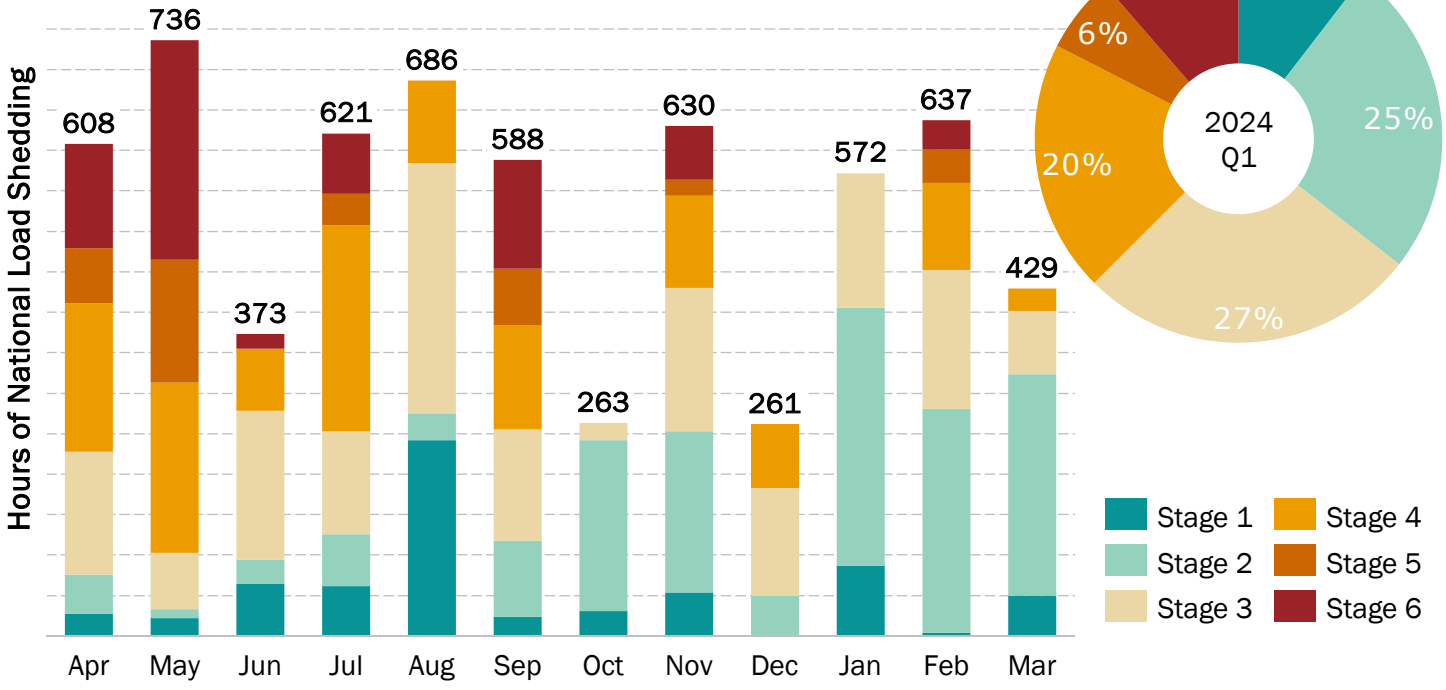
Load Shedding Stage Hours 2024 Q1



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Source: Eskom 2024 | Eskom se Push 2024 | NERSA 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

The **upper limit** of load shedding refers to the **maximum load** that **could** be shed during a **specific stage**. Stage 1 has a load shedding upper limit of 1000MW, stage 2: 2000MW, stage 3: 3000 MW and so on. Therefore, the **unserved energy** (what was actually shed) is **lower** than the **upper limit of that stage**. Now we can compare the **unserved energy** with this **upper limit** for each month. These are also correlated to the **load shedding hours**.

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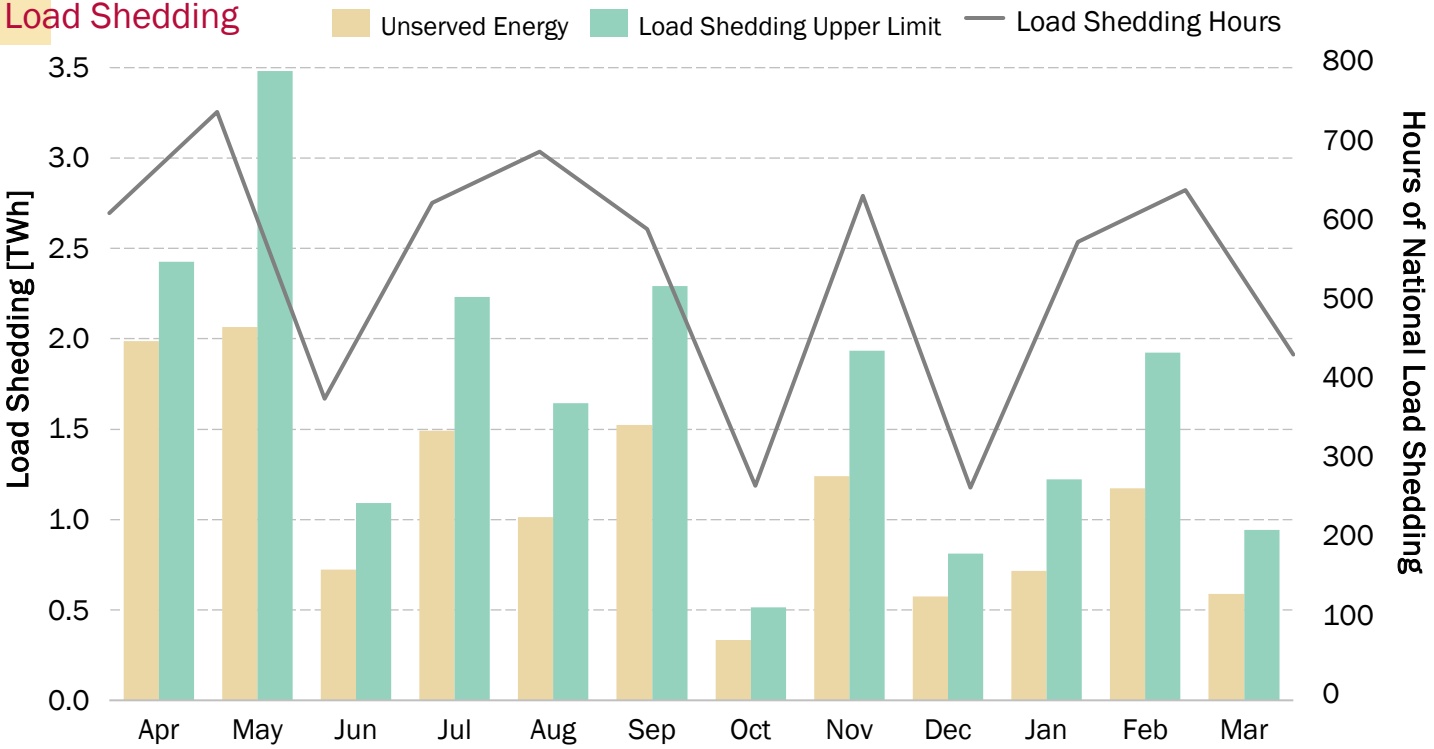
Load Shedding



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Source: Eskom 2024 | Eskom se Push 2024 | NERSA 2023. **Notes:** 2024 Q1 (quarter 1) is up to April 2024.

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