Statistics of utility-scale power generation in South Africa in 2021

CSIR Energy Centre

v1.0

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Summary of 2021 statistics:
Coal still dominates and provides about 80% of electricity generated, record high diesel usage, and renewables (excluding hydro) accounted for 6.7%

By 2021 South Africa had 53.7 GW of wholesale/public nominal capacity

- Coal is 39.3 GW (increased)
- Nuclear is 1.9 GW (unchanged)
- Diesel (OCGT) is 3.4 GW (unchanged)
- Hydro is 0.6 GW hydro and pumped storage is 2.7 GW (unchanged)
- Wind is 3.0 GW (increased)
- Solar PV is 2.2 GW (increased)
- CSP is 0.5 GW (unchanged)
- 1 361 MW of coal, 528 MW of wind and 180 MW of utility-scale solar PV became operational in 2021

The electricity mix is still dominated by coal-fired power generation which contributed over 80% to system demand in 2021

- Coal energy contributed 81.4% (184.7 TWh)
- Nuclear energy contributed 5.4% (12.2 TWh)
- Renewable energy contributed 11.9% (27.0 TWh)
- Renewable energy contributed 6.7% (15.2 TWh) - excluding hydro
- The remaining 1.4% came from diesel (3.2 TWh)

NOTES: Nominal capacities reported as on 31 Dec 2021; Electricity mix given for 1 Jan 2021 – 31 Dec 2021; RSA = Republic of South Africa; OCGT – Open-Cycle Gas Turbine; CSP – Concentrating Solar Power; Excludes Embedded Generation (EG) and Distributed Generation (DG); Sources: CSIR Analysis; Eskom

Summary of 2021 statistics:
System demand recovered notably in 2021 but not yet to 2019 levels

In 2021, system demand increased by 6.5 TWh (3.0%) relative to 2020 but was still 5.3 TWh (-2.3%) less than that experienced in 2019

- Peak system demand was 35.0 GW (vs 34.1 GW the year before)
- All technologies (coal, nuclear, diesel and renewables) generated more electricity than the year before. The most notable relative increase was local hydro with more than double the output

In 2021, the VRE fleet of 5.7 GW (wind, solar PV, CSP) reduced peak demand slightly but more importantly high demand hours by ~70.5%

- VRE fleet reduced peak demand by ~0.96 GW
- VRE fleet also reduced high-demand hours (hours with >30 GW system demand) from 699 hours to 206 hours (~493 hours less, -70.5%)

Flexibility needs are not yet significantly increased with the existing VRE fleet in 2021

- Minimum system demand was 18.4 GW whilst residual demand minimum was 17.1 GW (relative to a minimum system demand of 14.9 GW and residual demand of 13.8 GW the year before due to reduced economic activity during extreme lockdown conditions)
- System demand & residual demand was above 20.5 GW and 19.5 GW, respectively for 90% of the year

NOTES :Residual demand = System demand less variable renewable energy (solar PV, CSP and wind); VRE – Variable Renewable Energy; Excludes Embedded Generation (EG) and Distributed Generation (DG); H2 stats for 1 Jan 2021 – 31 December 2021; H1 stats for 1 Jan 2021 – 30 Jun 2021
Sources: CSIR Analysis; Eskom

Summary of 2021 statistics:
2021 saw 1 169 hours of loadshedding (upper limit was 2 521 GWh) whilst actually achieved was 1 775 GWh

In 2021, loadshedding occurred for 1 169 hours (~13% of the time) with an upper limit of 2 521 GWh relative to actual energy shed of 1 775 GWh

- Intensive loadshedding has been experienced in 2021 (40% increase compared to 2020 loadshedding upper limit)
- Loadshedding dominated by Stage 2 type loadshedding
- Loadshedding occurred for 13% of the hours in 2021

Eskom fleet EAF declining trend continues and drove loadshedding events in 2021 with specific concerns surrounding UCLF (unplanned) trends

- **Eskom fleet average EAF of 61.8%** for 2021 (relative to 2020 of 65%, 2019 of 66.9% and 2018 of 71.9%)
- EAF planned maintenance at 10.8% (PCLF), unplanned outages at 24.6% (UCLF) & other outages at 2.9% (OCLF)
- The best hourly EAF was 74.2% and worst was 51.0%, respectively achieved on 5 Aug 2021 and 28 Dec 2021

NOTES: EAF - Energy Availability Factor; PCLF - Planned capability Loss Factor;
Excludes Embedded Generation (EG) and Distributed Generation (DG); Statistics calculated for 1 Jan 2021 – 31 Dec 2021
UCLF – Unplanned Capability Loss Factor; OCLF – Other Capability Loss Factor; EAF = 100%-PCLF-UCLF-OCLF

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6 Actual load shedding (2021)

7 Other power system statistics

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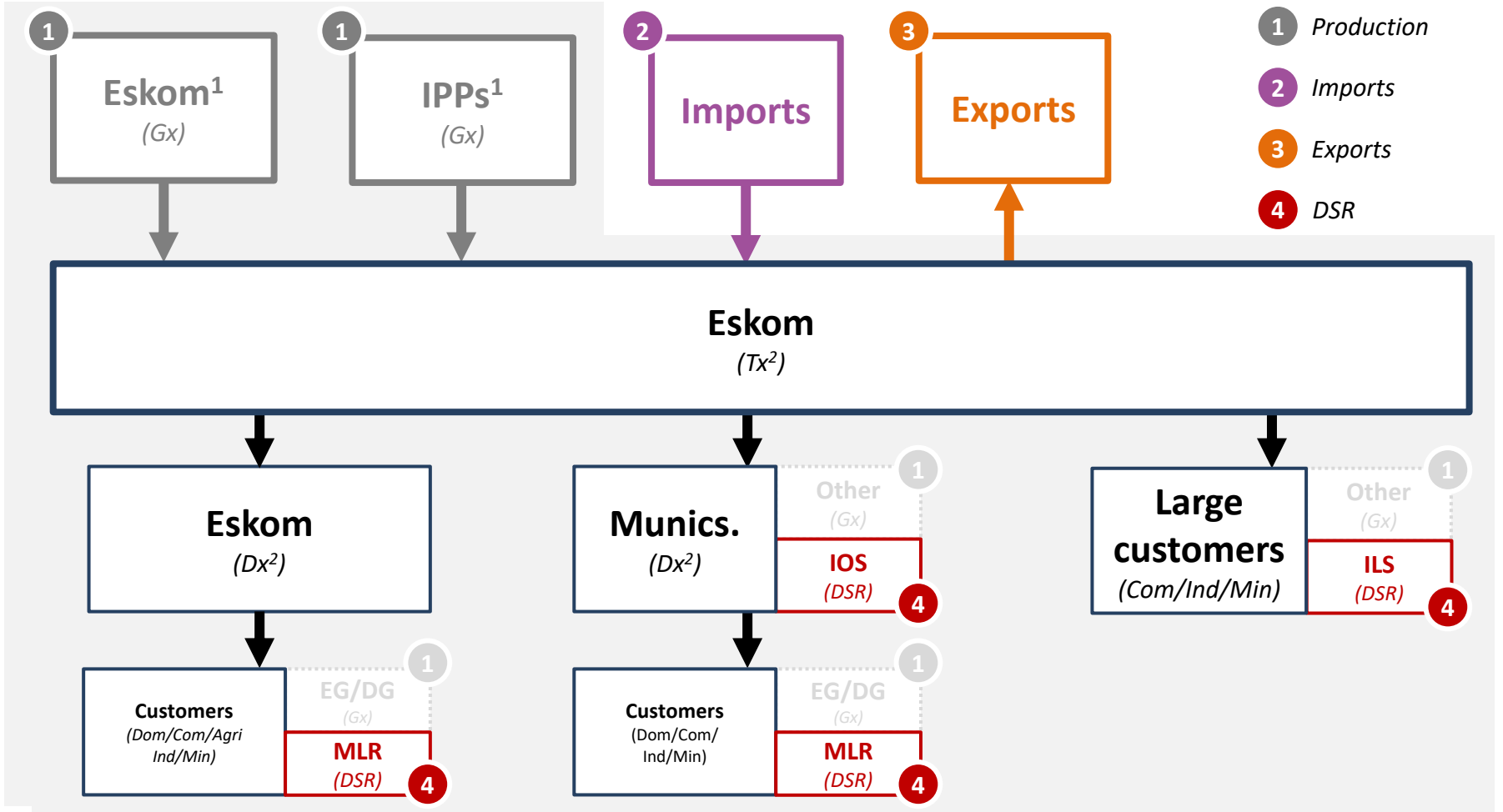
Equivalent wholesale South African electricity production and demand as measured & published by Eskom



EG = Embedded Generation; DG = Distributed Generation; Gx = Generation; Tx = Transmission; Dx = Distribution;
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS);
NOTES: Items in light faded gray are NOT included in statistics presented in this publication.
[1] Power generated less power station load (auxillaries); Minus pumping load (Eskom owned pumped storage); [2] Transmission/distribution networks incur losses before delivery to customers

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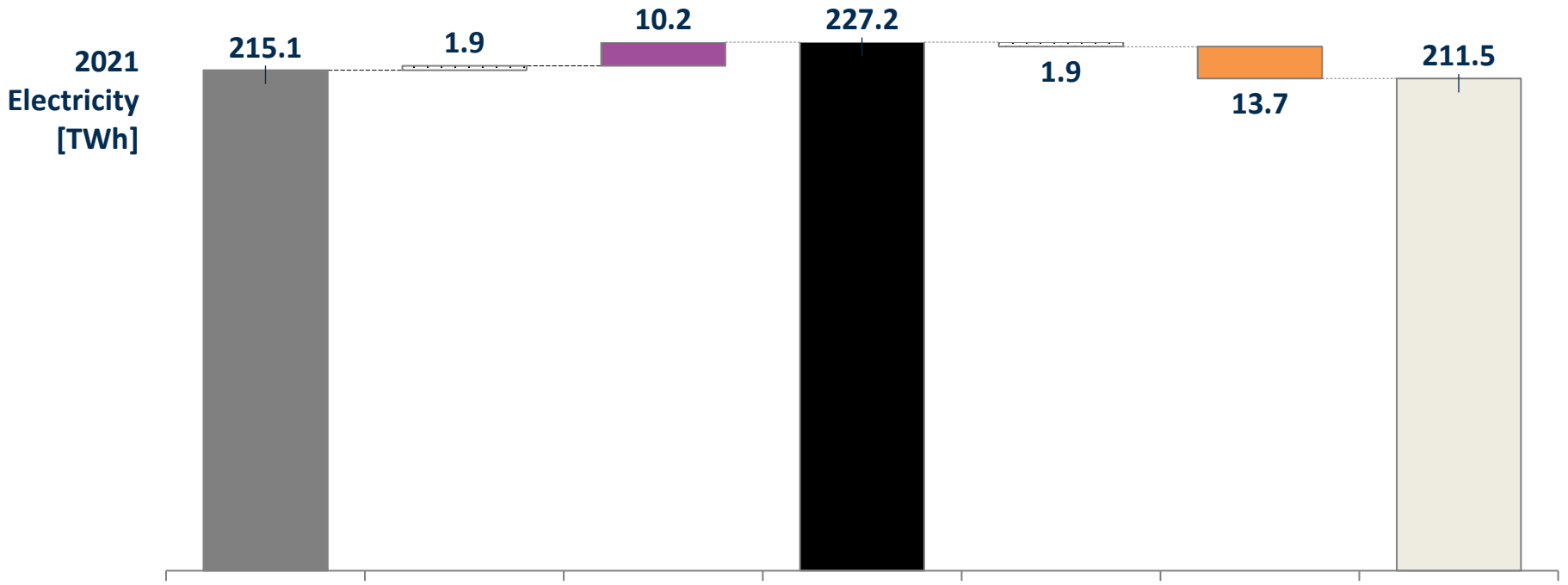
From Jan-Dec 2021, 227 TWh of net electricity was produced in SA

Actuals captured in wholesale market for the period Jan-Dec 2021 (i.e. without self-consumption of embedded plants)

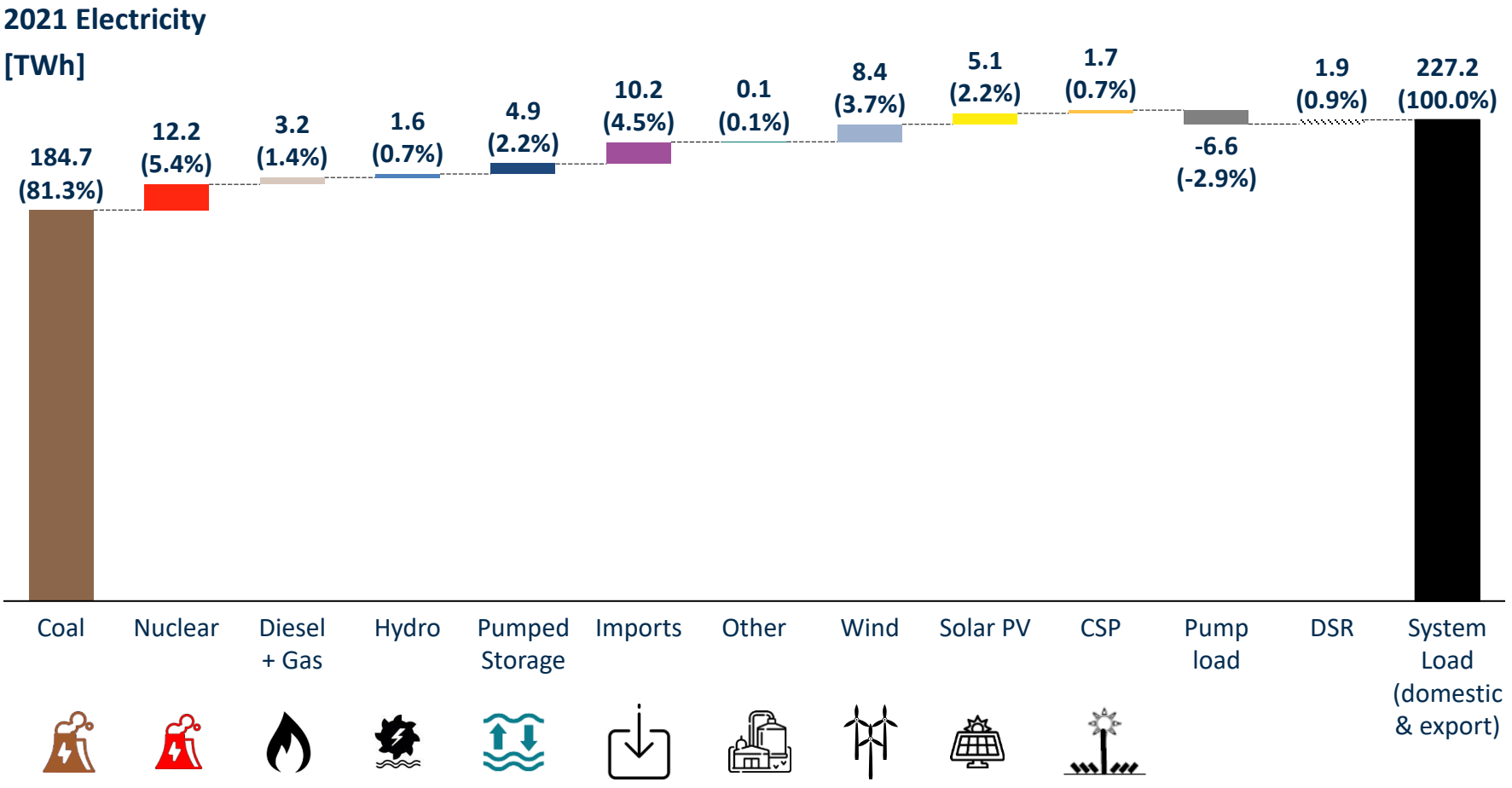


	Net Sent Out	DSR	Imports	System Load (domestic and export load)	DSR	Exports	Available for distribution in RSA
2020 (full-year, TWh)**	209.3	1.4	10.0	220.7	1.4	13.7	205.6

Notes: "Net Sent Out" = Total domestic generation (Sent Out) minus pumping load (not shown); Demand not served is exlcuded = Interruptible load supply (ILS) + manual load reduction (MLR);
**Note slight changes in comparison to the 2020 values published in previous version.
Sources: Eskom; Statistics South Africa for imports and exports

In 2021, coal dominated the energy mix at 81.3% of the 227 TWh of total system load met whilst PV, wind and CSP contributed 6.6%

Actuals captured in wholesale market for Jan-Dec 2021 (i.e. without self-consumption of embedded plants)

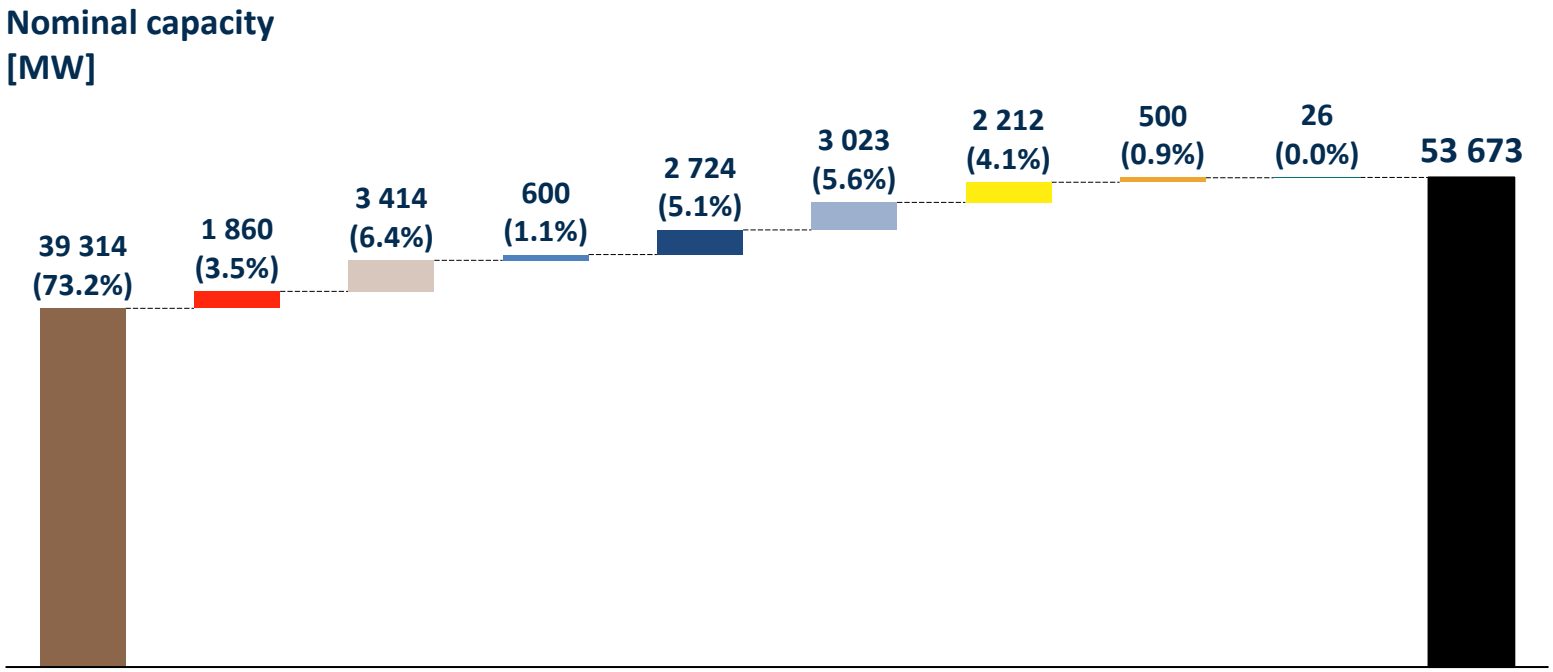


	Coal	Nuclear	Diesel + Gas	Hydro	Pumped Storage	Imports	Other	Wind	Solar PV	CSP	Pump load	DSR	System Load (domestic & export)
2020 (full-year)	184.4	11.5	1.9	0.8	5.1	9.9	0.1	6.6	4.1	1.6	-6.8	1.4	220.6

Notes: Wind includes Eskom's Sere wind farm (100 MW). Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation. PS = pumped storage
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom

Nominal capacity by end of 2021

Actual nominal installed capacity at 31 Dec 2021 (excluding embedded generation capacity and private capacity)



	Coal	Nuclear	Diesel + Gas	Hydro	Pumped Storage	Wind	Solar PV	CSP	Other	Total
2020 (31 Dec 2020, MW)	37 945	1 860	3 414	600	2 724	2 495	2 032	500	22	51 592

Notes: RE = Renewable Energy; Total nominal installed capacity = Eskom capacity + IPPs; Embedded generation and municipal-owned capacity excluded

Sources: Eskom

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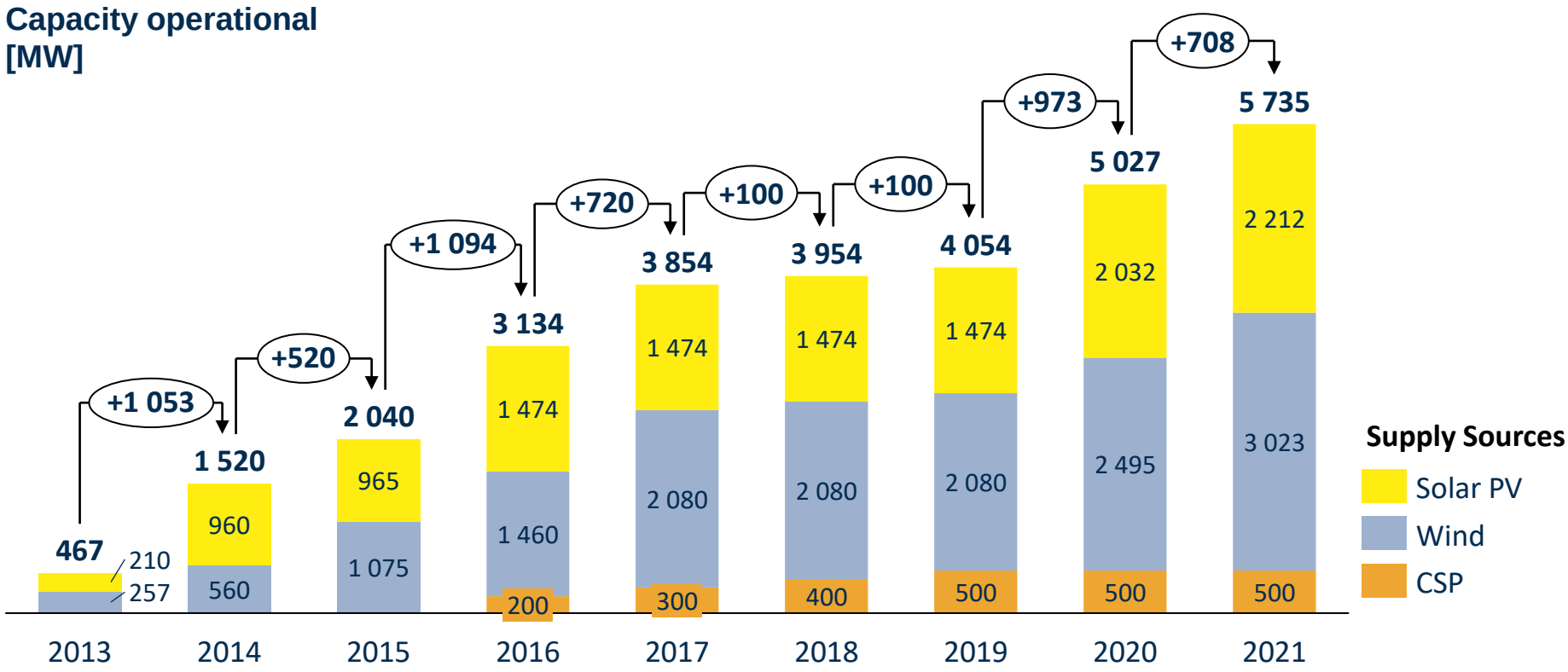
From 1 Nov 2013 to 31 Dec 2021, 3 023 MW of wind, 2 212 MW of large-scale solar PV and 500 MW of CSP became operational in RSA



Notes: RSA = Republic of South Africa. Solar PV capacity = capacity at point of common coupling. Wind includes Eskom's Sere wind farm.
Sources: Eskom; DoE IPP Office

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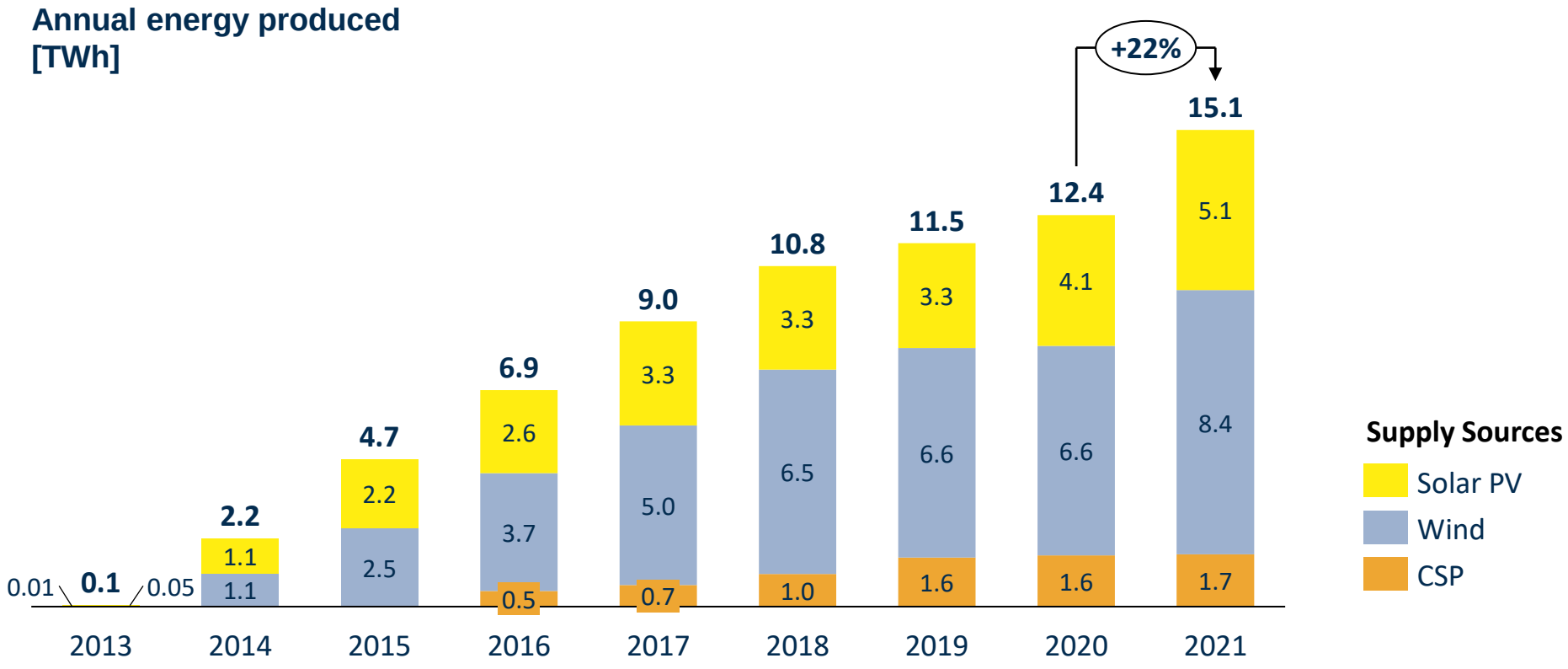
In 2021 ~15.1 TWh of wind, solar PV & CSP energy was produced in South Africa



Notes: Wind includes Eskom's Sere wind farm (100 MW). CSP energy measured from date when more than two CSP plant were commissioned.
Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation
Sources: Eskom; DoE IPP Office

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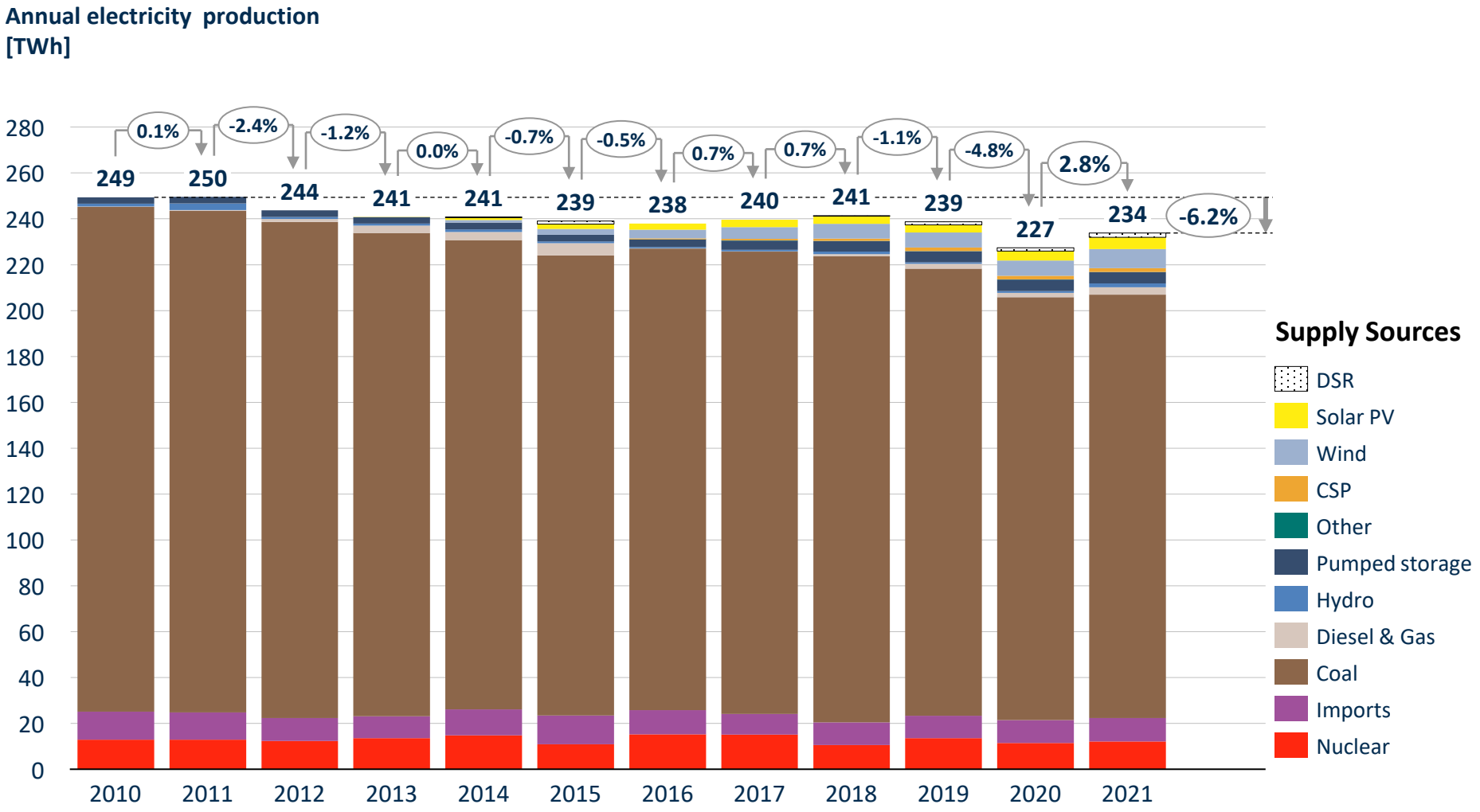
Production in 2010-2021 dropped by 6.2% which is an average annual reduction of 0.6% – this is an improvement compared to the 8.8% drop between 2010-2020

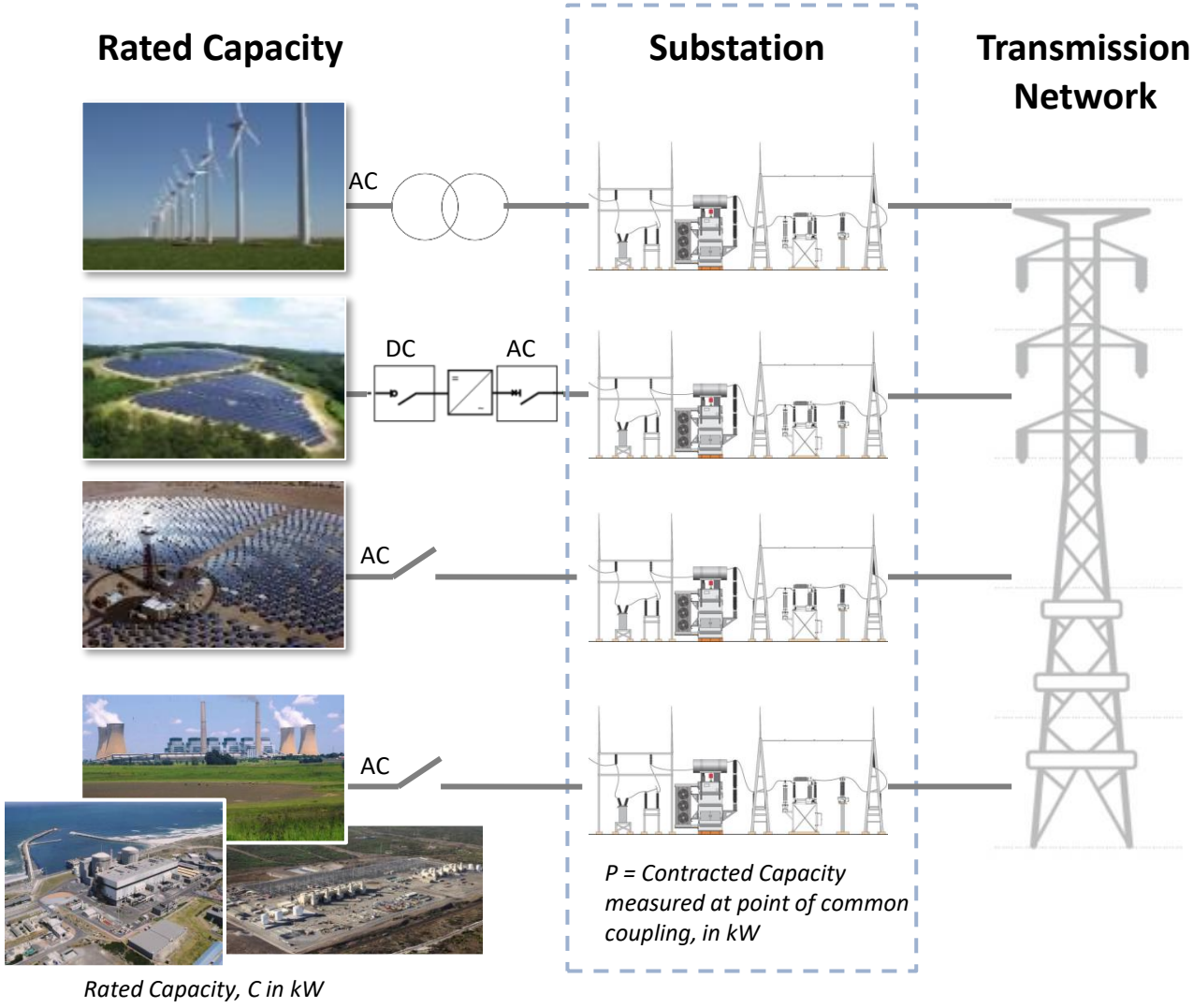
Historical annual electricity production per supply source in TWh; production values exclude pumping load



NOTES: Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS). DSR prior to 2020 has been estimated by the CSIR

Sources: Eskom; CSIR Energy Centre analysis

Illustration: Calculation of the average capacity factor of operational power plant categories in RSA



Average Capacity Factor (CF)

$$CF = \frac{\sum_{t=1}^{n} E_t}{\frac{\sum_{t=1}^{n} P_t}{n}}$$

$$= \frac{Total\ Energy\ in\ time\ period\ (kWh)}{Average\ Capacity\ in\ time\ period\ (kW)}$$

Where:
P = Contracted Capacity, in kW
E = Energy production, in kWh
t = Time period
n = Number of time periods

Notes: RSA = Republic of South Africa. Simplified illustration of technology grid interconnections

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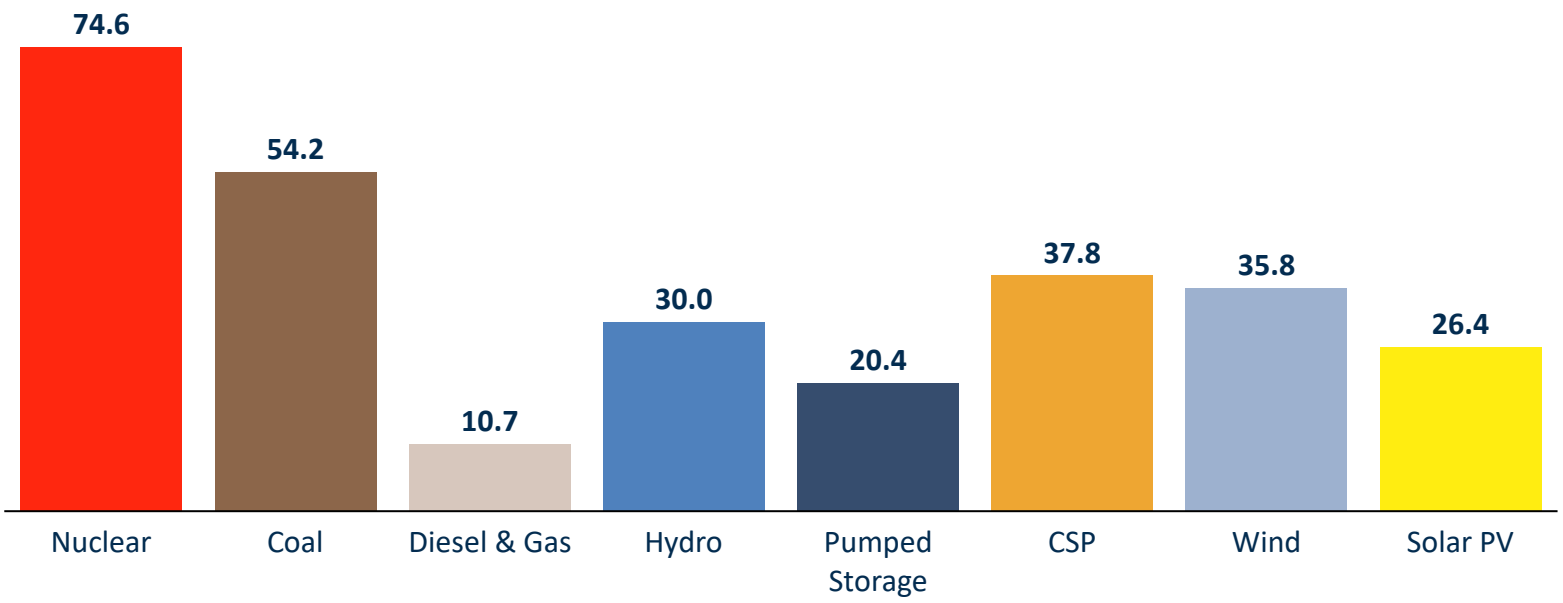
Annual capacity factors per supply source in South Africa in 2021

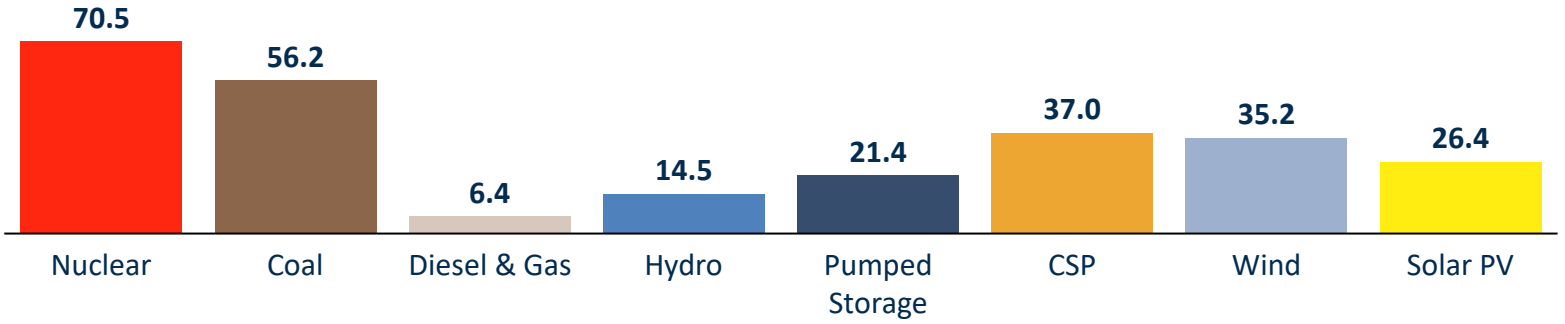
2021
Annual capacity factors [%]



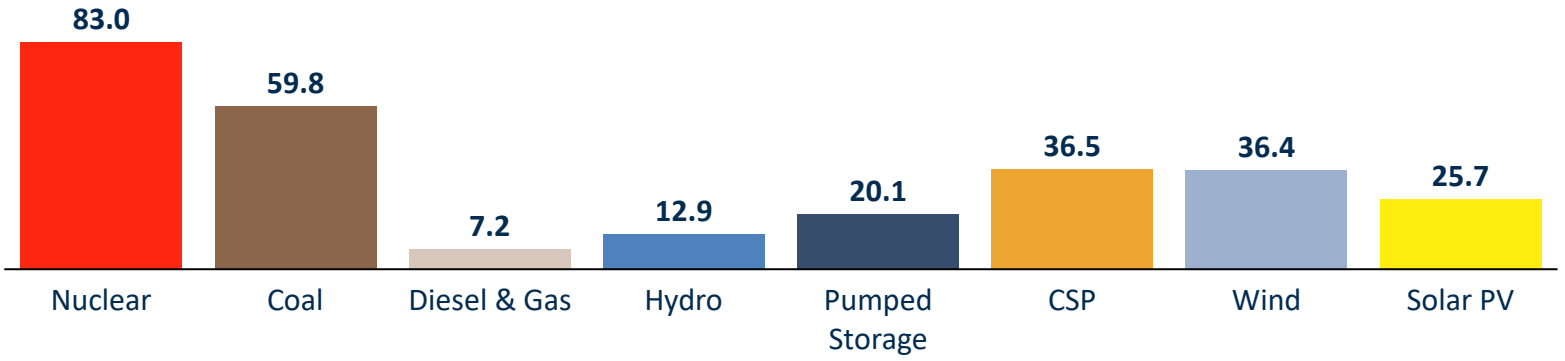
Wind includes Sere wind farm (100 MW). Previous Diesel & Gas did not include IPPs, from this version on IPP Peakers (Diesel) are included
Sources: Eskom

Annual capacity factors per supply source in South Africa in 2020 and 2019

2020
Annual capacity factors [%]



2019
Annual capacity factors [%]



Wind includes Sere wind farm (100 MW).
Sources: Eskom

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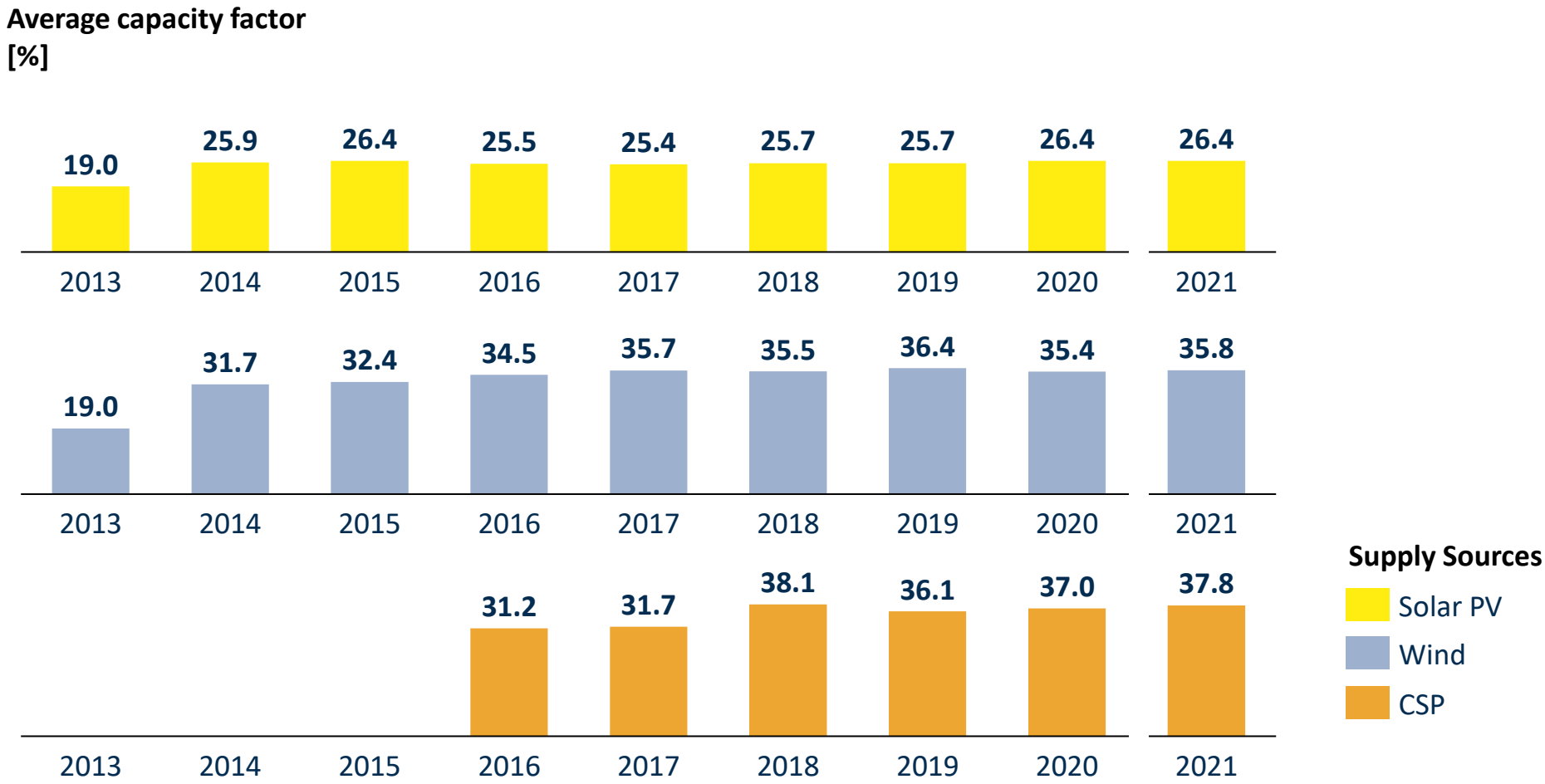
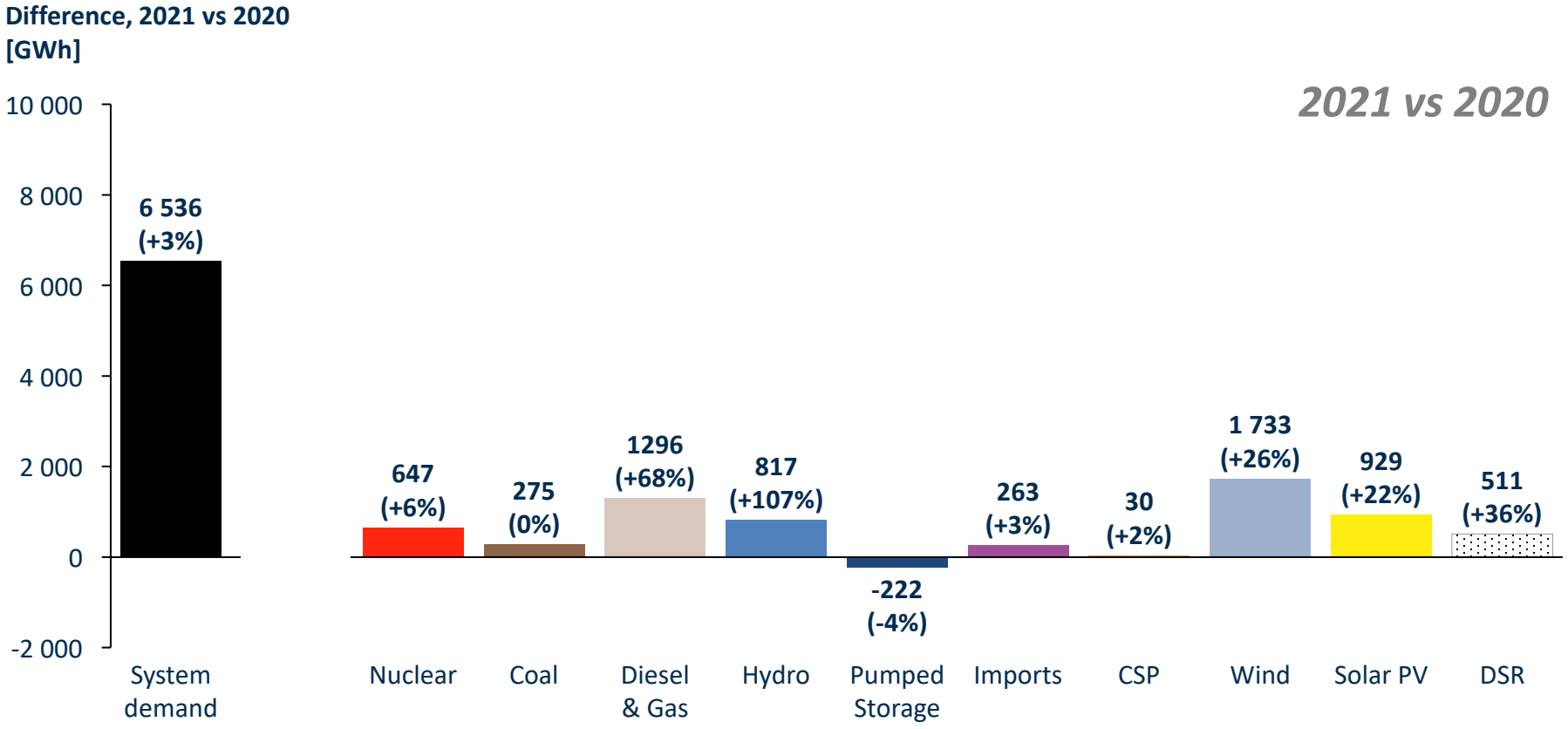
In 2021, the average annual capacity factor of the solar PV, wind & CSP fleet was 26%, 36% and 38% respectively



NOTES: Historical capacity factors for other technologies were not available at the time of publication; Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants were commissioned. Wind includes Sere wind farm (100 MW). Wind and solar PV energy excludes curtailment and thus capacity factor is lower than actual wind and solar PV available.
Sources: Eskom; DoE IPP Office

System demand increased in 2021 relative to 2020 by 6.54 TWh (3%)

Difference in annual electricity production 2021 vs 2020



Wind includes Sere wind farm (100 MW); Percentages shown are changes within the category between years.
Sources: Eskom

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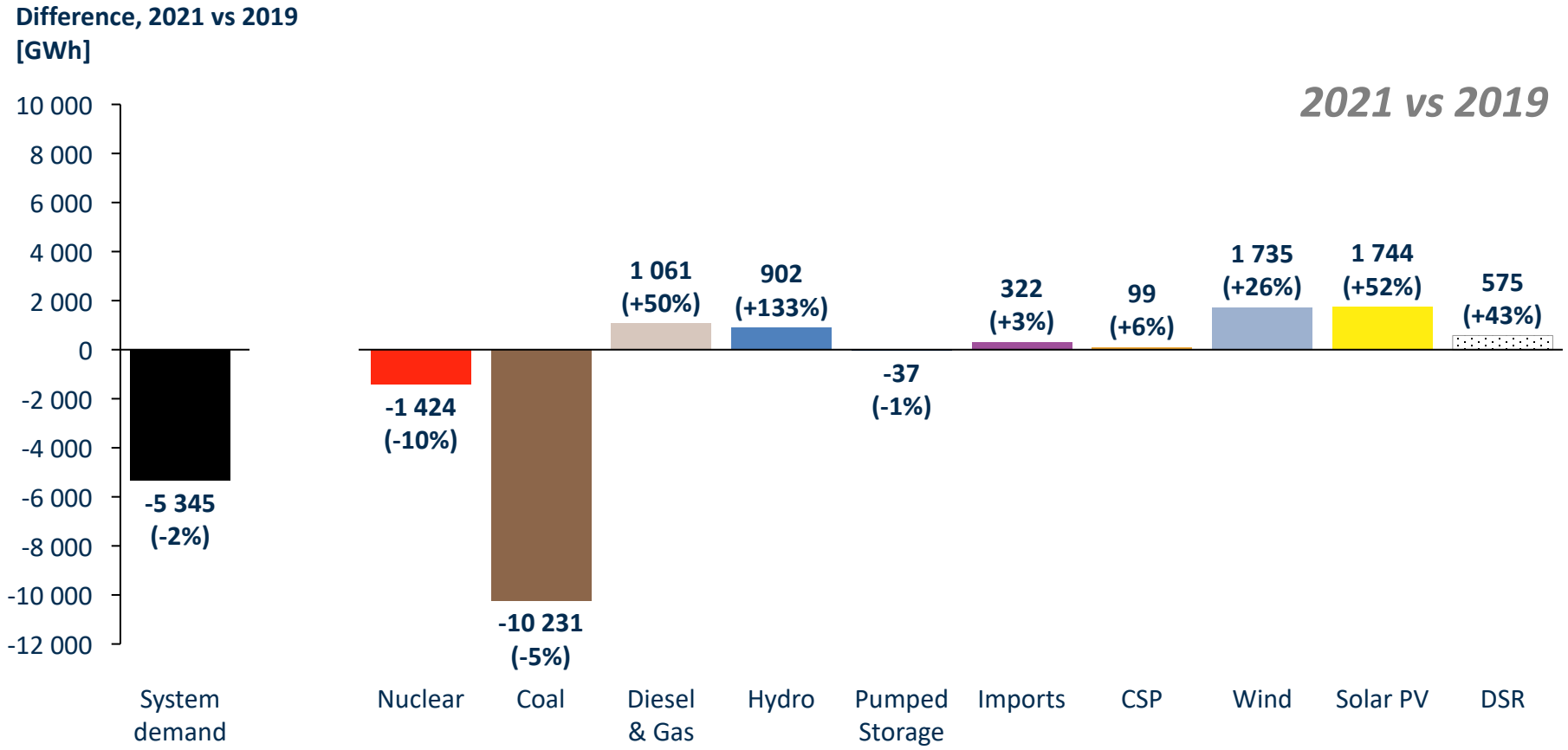
Comparing 2021 and 2019, the coal energy supplied decreased by 10.2 TWh (-5%) while RE (wind, solar PV and CSP) increased significantly (6 to 52%)

Difference in annual electricity production 2021 vs 2019



Wind includes Sere wind farm (100 MW); Percentages shown are changes within the category between years.
Sources: Eskom

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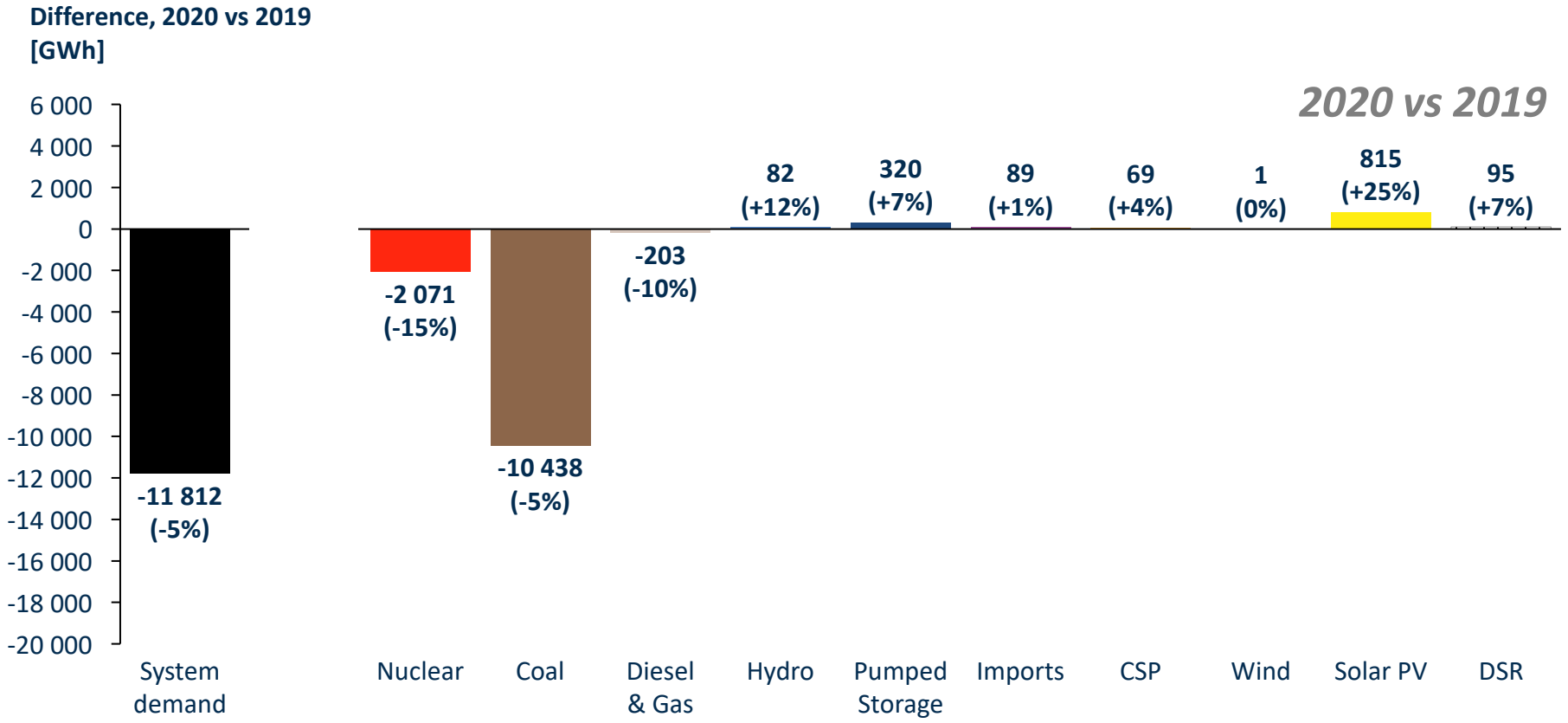
In comparison, 2020 had lower coal production relative to 2019 by 10.4 TWh (-5%) – Covid-19 lockdown (reduced demand)

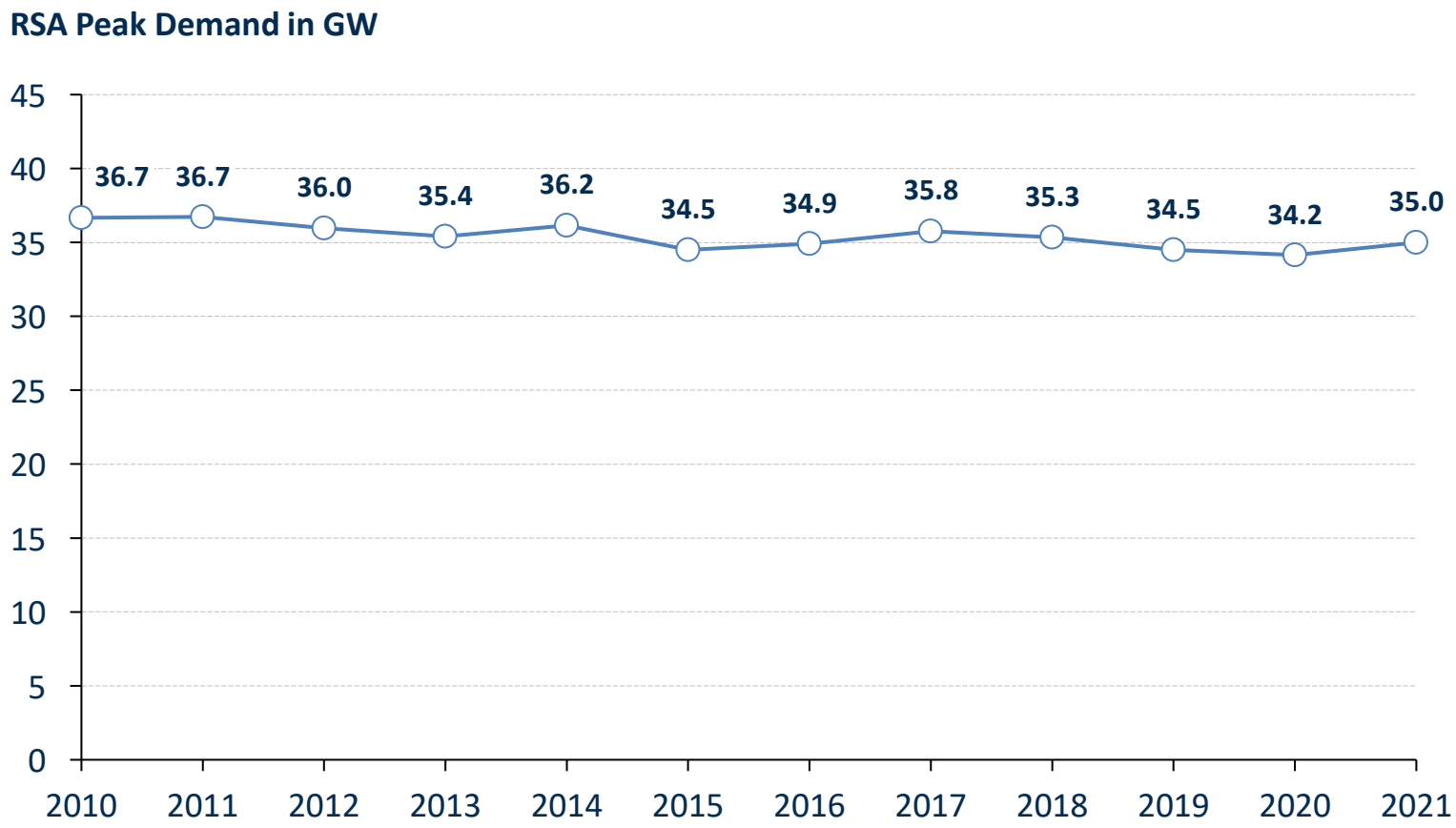
Difference in annual electricity production 2020 vs 2019



Wind includes Sere wind farm (100 MW); Percentages shown are changes within the category between years.
Sources: Eskom

Annual peak demand in 2021 increased slightly in comparison to 2020

Historical annual peak demand in GW; annual peak demand has been declining over the last 10 years



Notes: Peak demand includes Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).
Sources: Eskom

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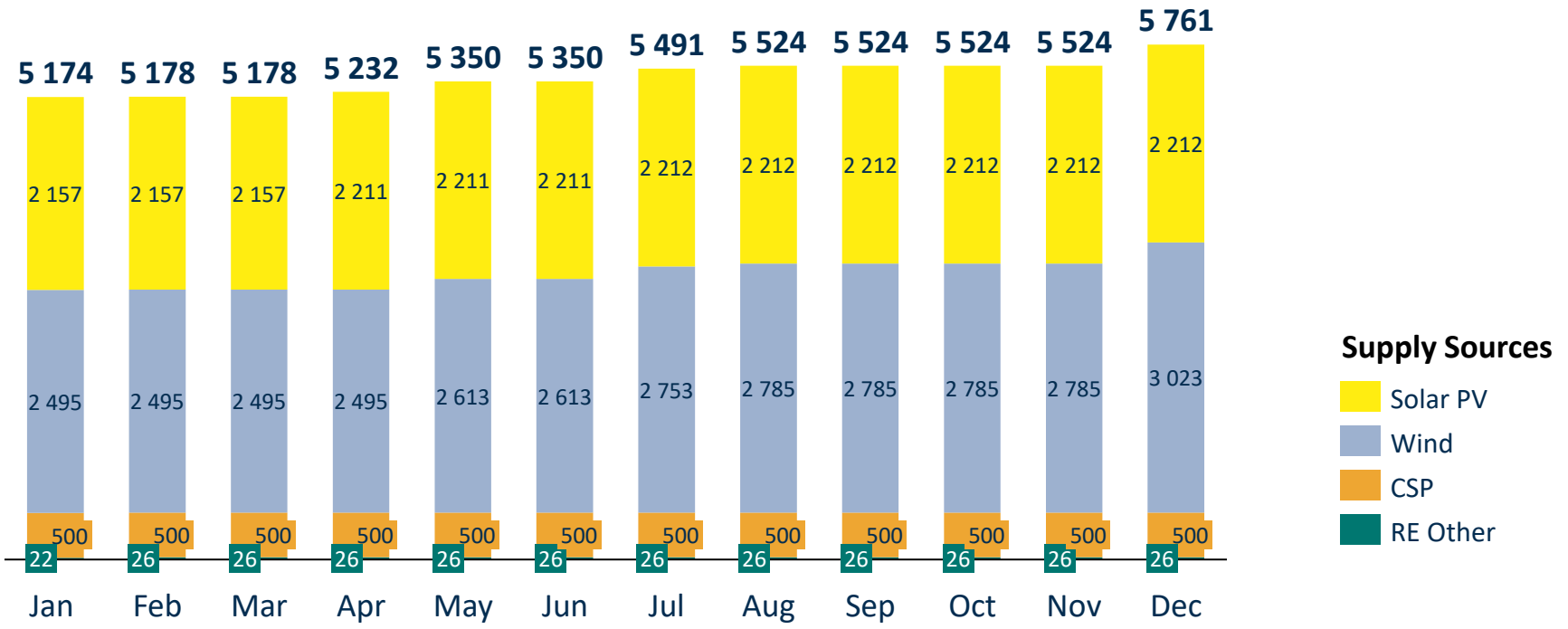
In 2021: 528 MW of wind & 180 MW of solar PV was added to the grid

Total monthly installed capacity of utility-scale solar PV, wind and CSP in RSA from Jan-Dec 2021

Capacity operational in 2021 [MW]
(month end)



Notes: Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants commissioned. Wind includes Sere wind farm (100 MW). RE = renewable energy
Sources: Eskom

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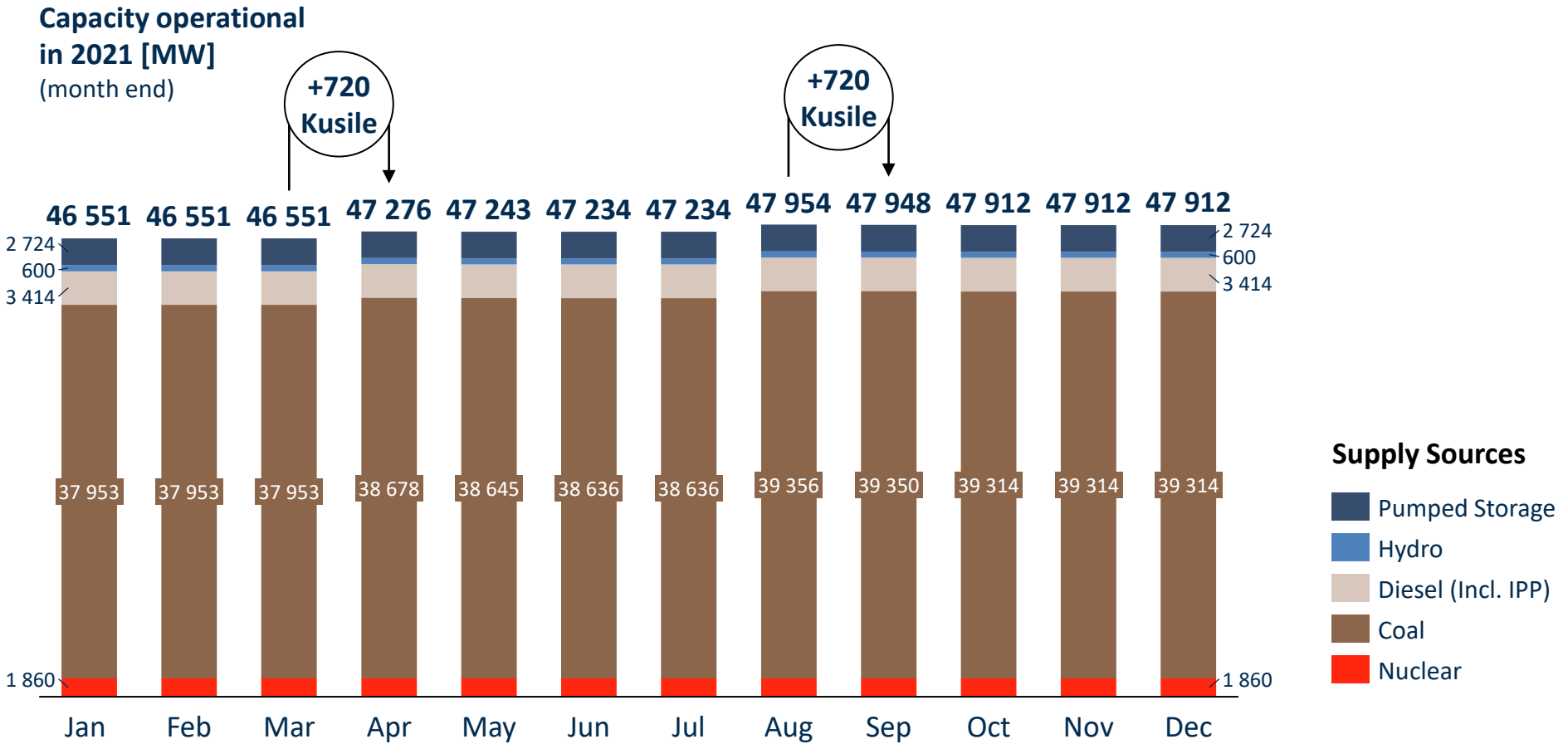
Between Jan and Dec 2021, an additional 1 440 MW (two units) of coal was added at Kusile

Total monthly installed capacity of utility-scale generation capacity in RSA from Jan-Dec 2021



Notes: RE = Renewable Energy;
Sources: Eskom; CSIR analysis

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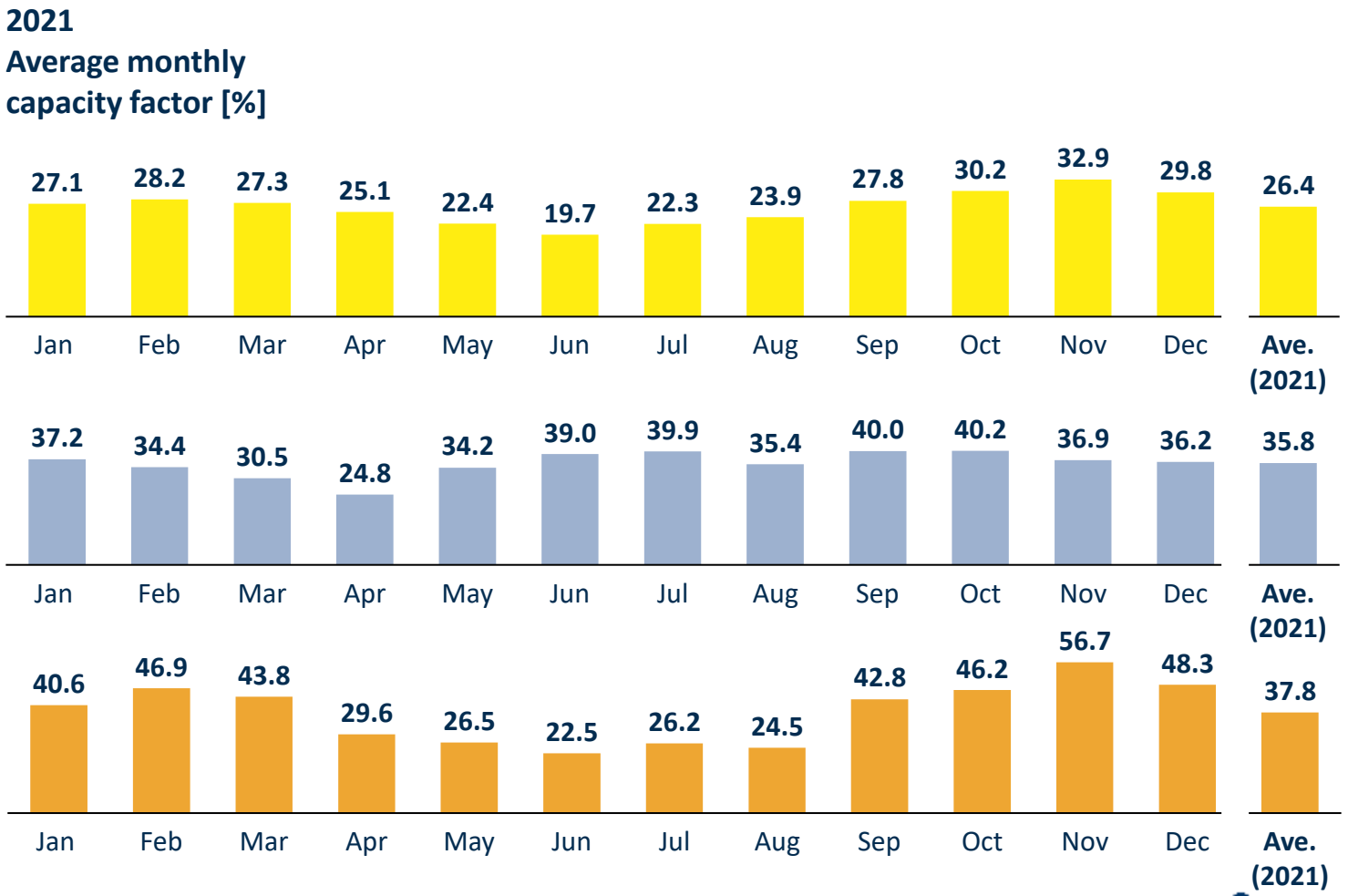
Average monthly capacity factors for solar PV, wind and CSP

Average monthly capacity factors of solar PV, wind and CSP in RSA from Jan-Dec 2021



Notes: Capacity operational as per the actual start of operation (can differ from REIPPP contracted date). Wind includes Sere wind farm.
Sources: Eskom

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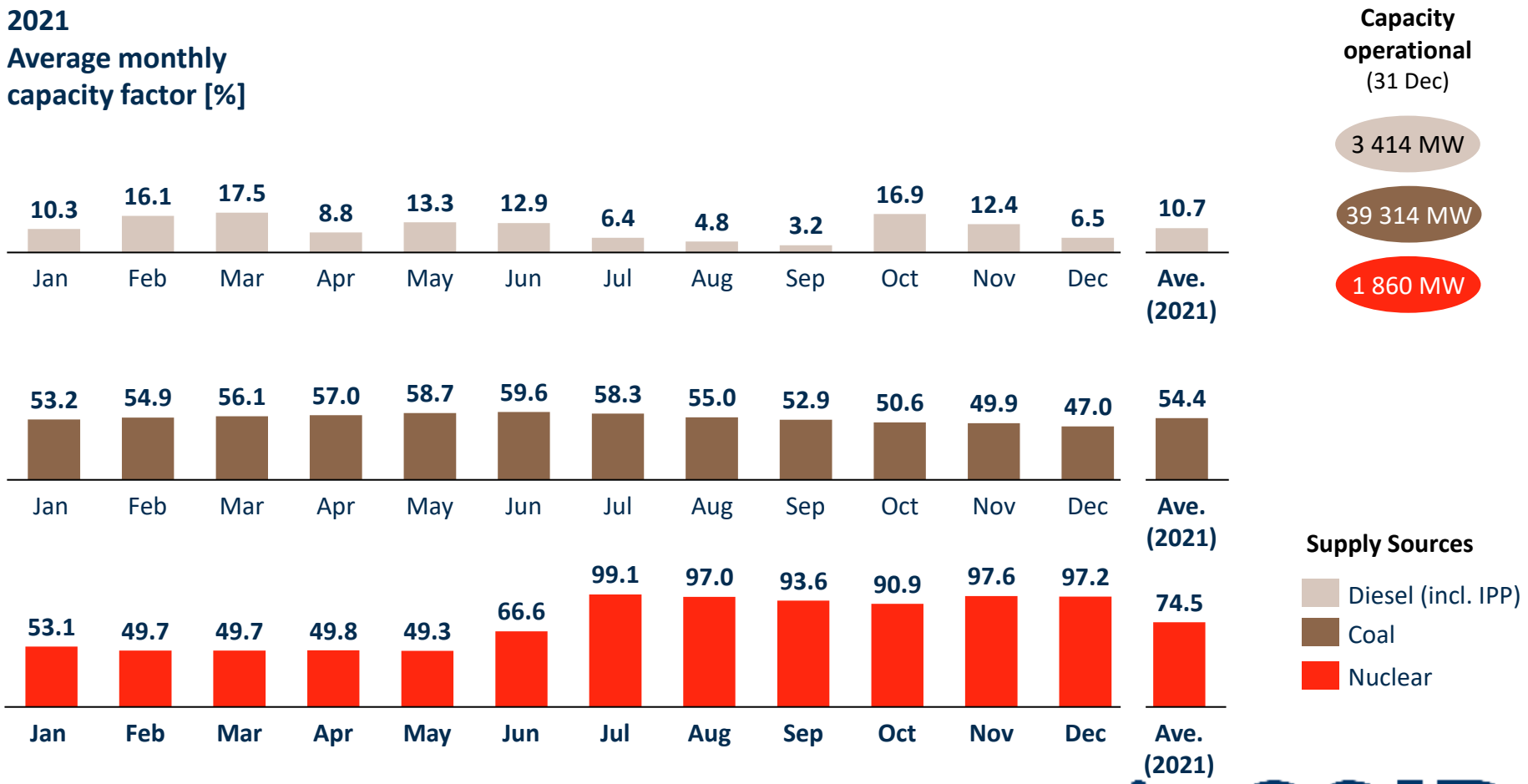
Average monthly capacity factors for thermal plants

Average monthly capacity factors of thermal capacity in RSA from Jan-Dec 2021



Sources: Eskom

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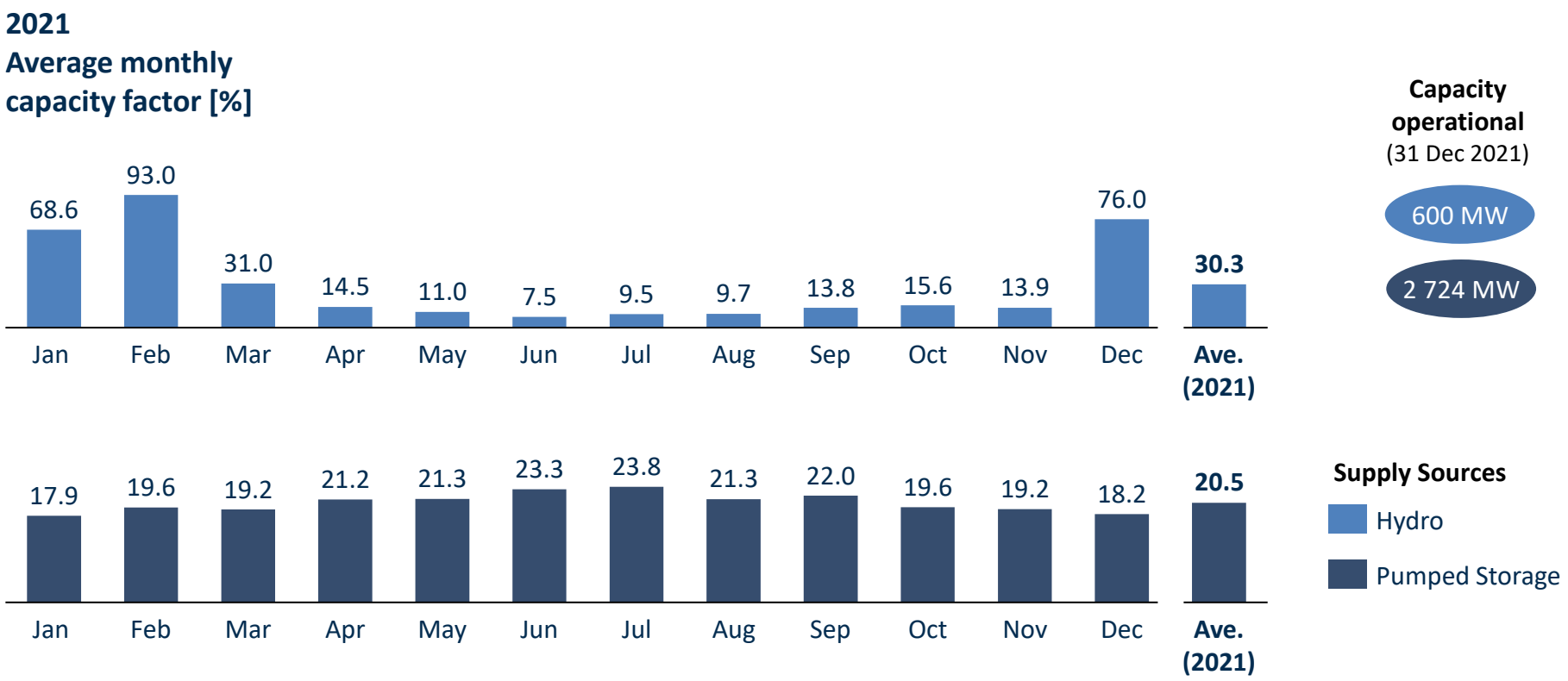
Average monthly capacity factors for hydro and pumped storage plants

Average monthly capacity factors of hydro & pumped storage in RSA from Jan-Dec 2021



Sources: Eskom

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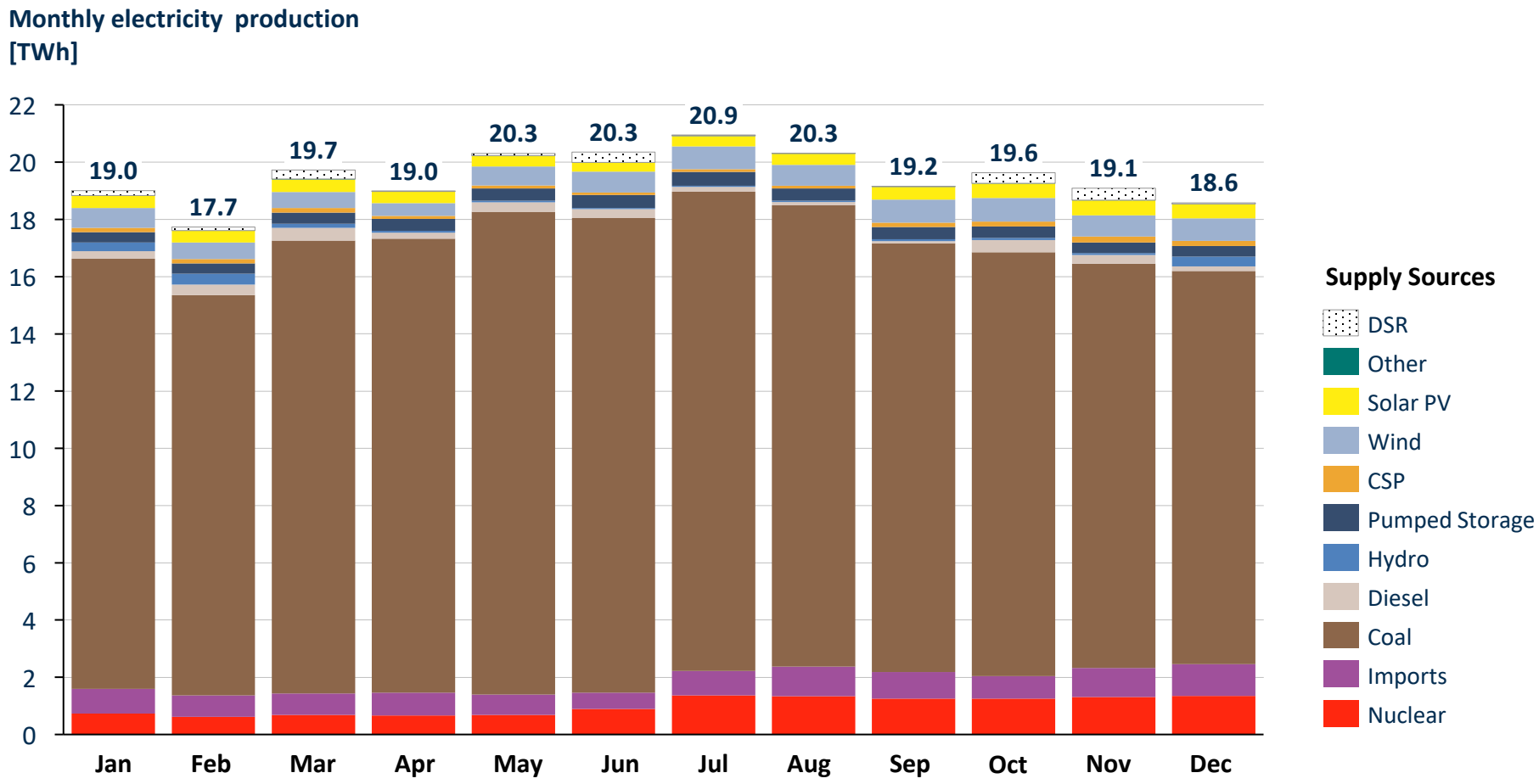
Monthly electricity production from all power supply sources (absolute)

Actual monthly electricity production for the period Jan-Dec 2021 from the different supply sources in RSA



Notes: Pumping load excluded. Wind generation includes Eskom's 100 MW Sere wind farm.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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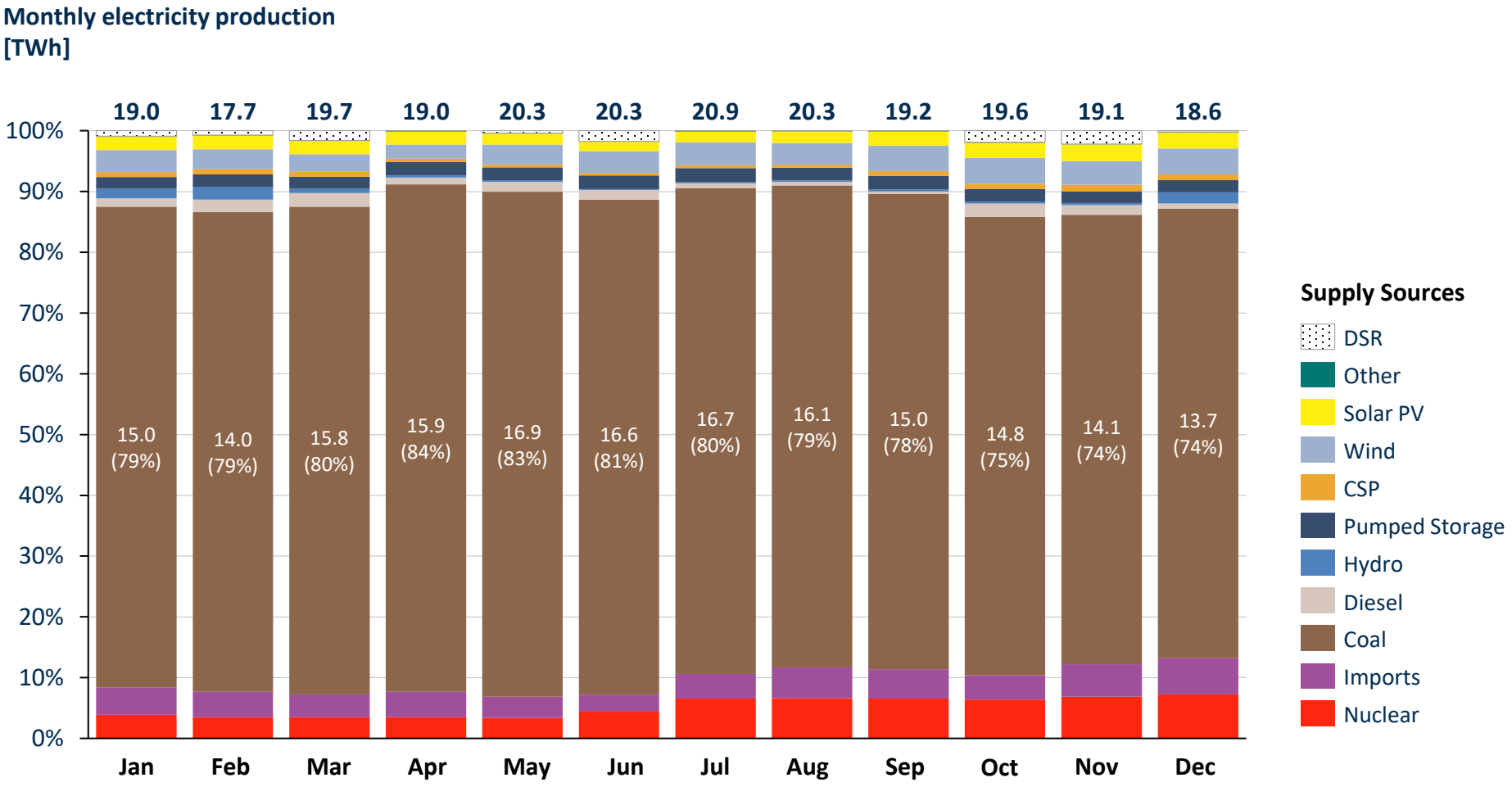
Monthly electricity production from all power supply sources (share)

Actual monthly electricity production for the period Jan-Dec 2021 from the different supply sources in RSA



Notes: Pumping load excluded. Wind generation includes Eskom's 100 MW Sere wind farm.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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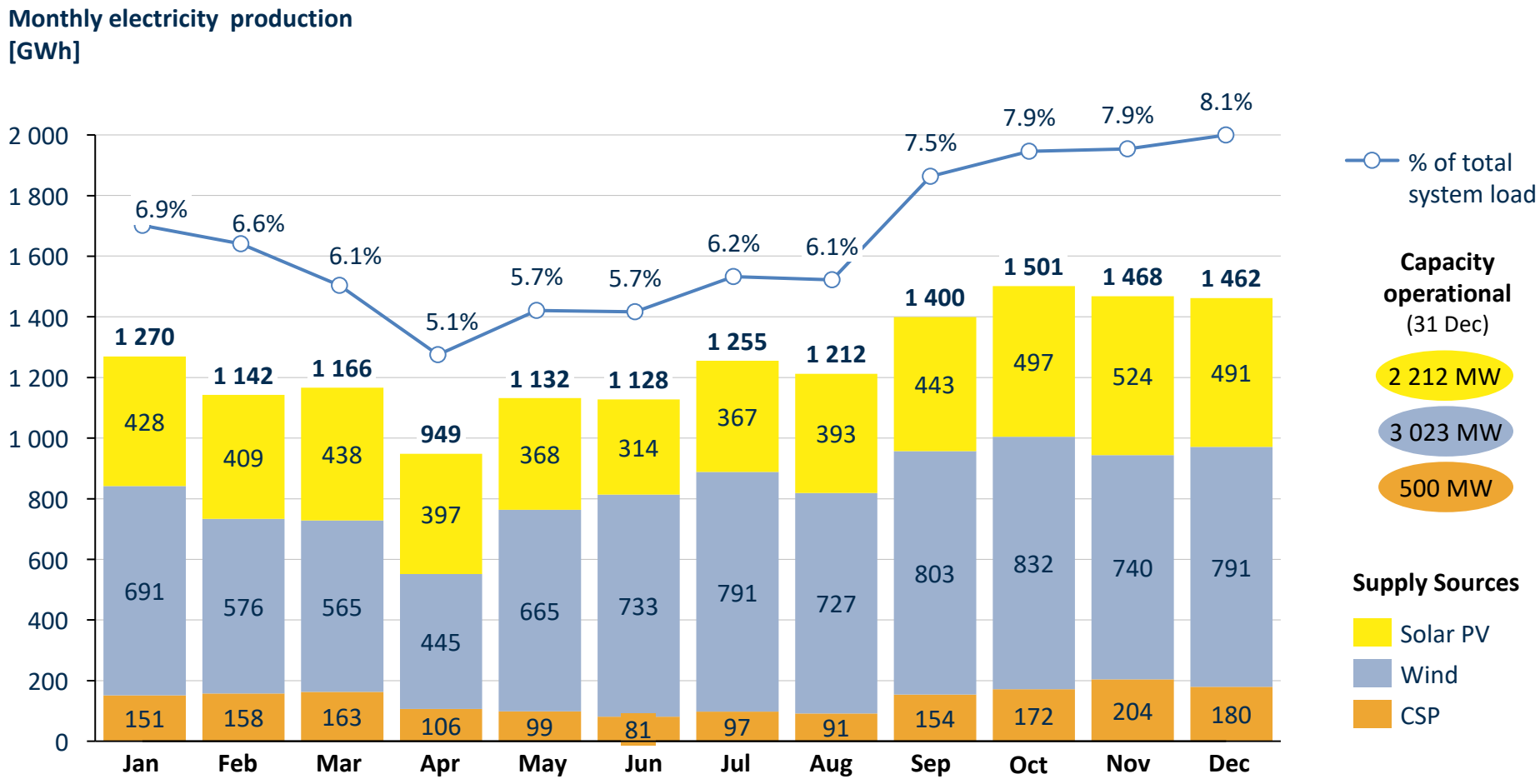
Monthly electricity production of SA's wind, solar PV & CSP fleet

Actual monthly production from wind, solar PV and CSP plants in South Africa from Jan-Dec 2021



Notes: Wind generation includes Eskom's 100 MW Sere wind farm. CSP energy only measured from date when more than two CSP plant were commissioned. Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation.
Sources: Eskom; CSIR Energy Centre analysis

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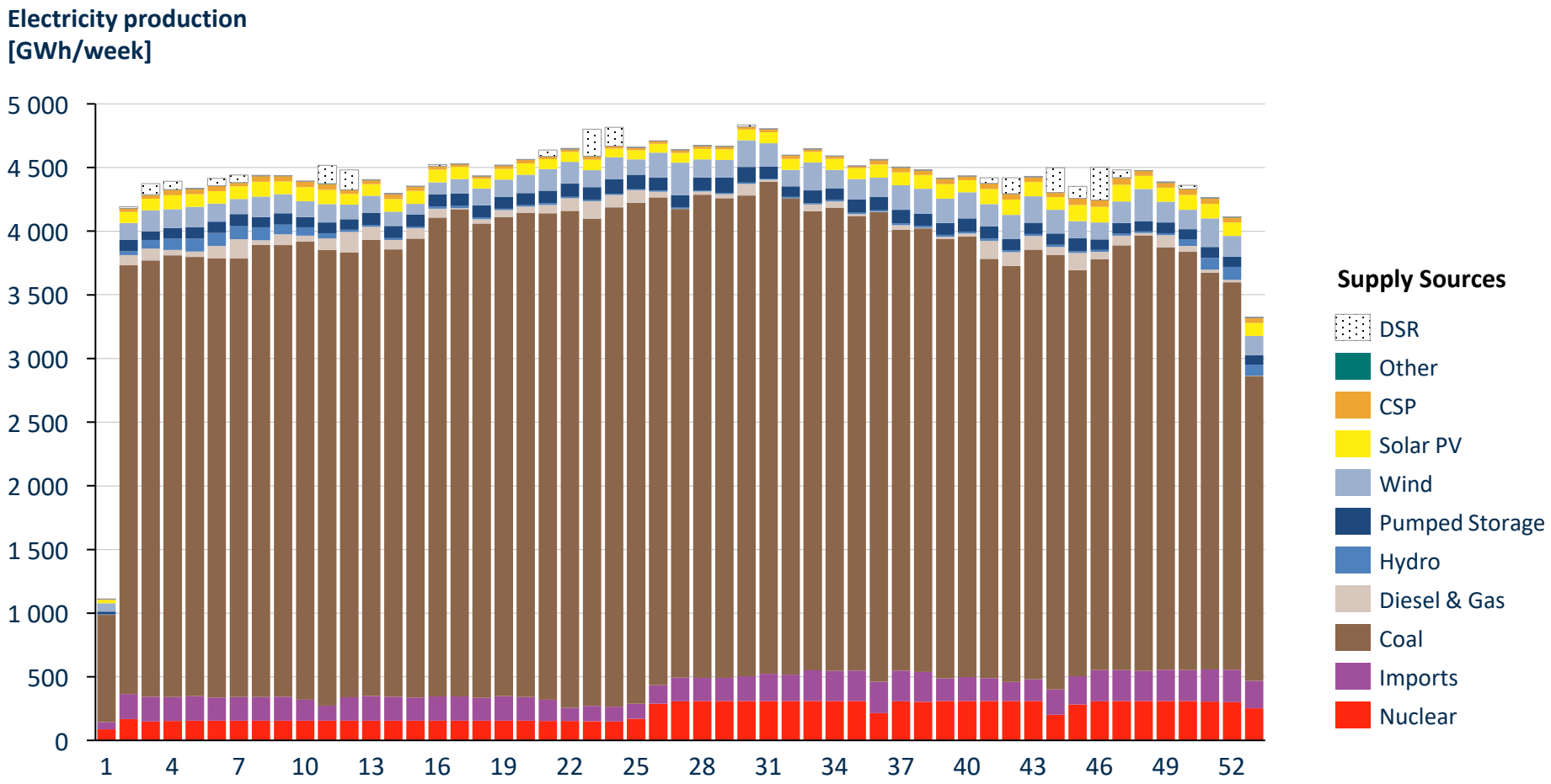
Weekly electricity production for all power supply sources

Actual weekly production: conventional fleet, wind, solar PV & CSP (Jan-Dec 2021)



Note: Pumping load excluded. First week and last week included not full weeks.
Sources: Eskom; CSIR Energy Centre analysis

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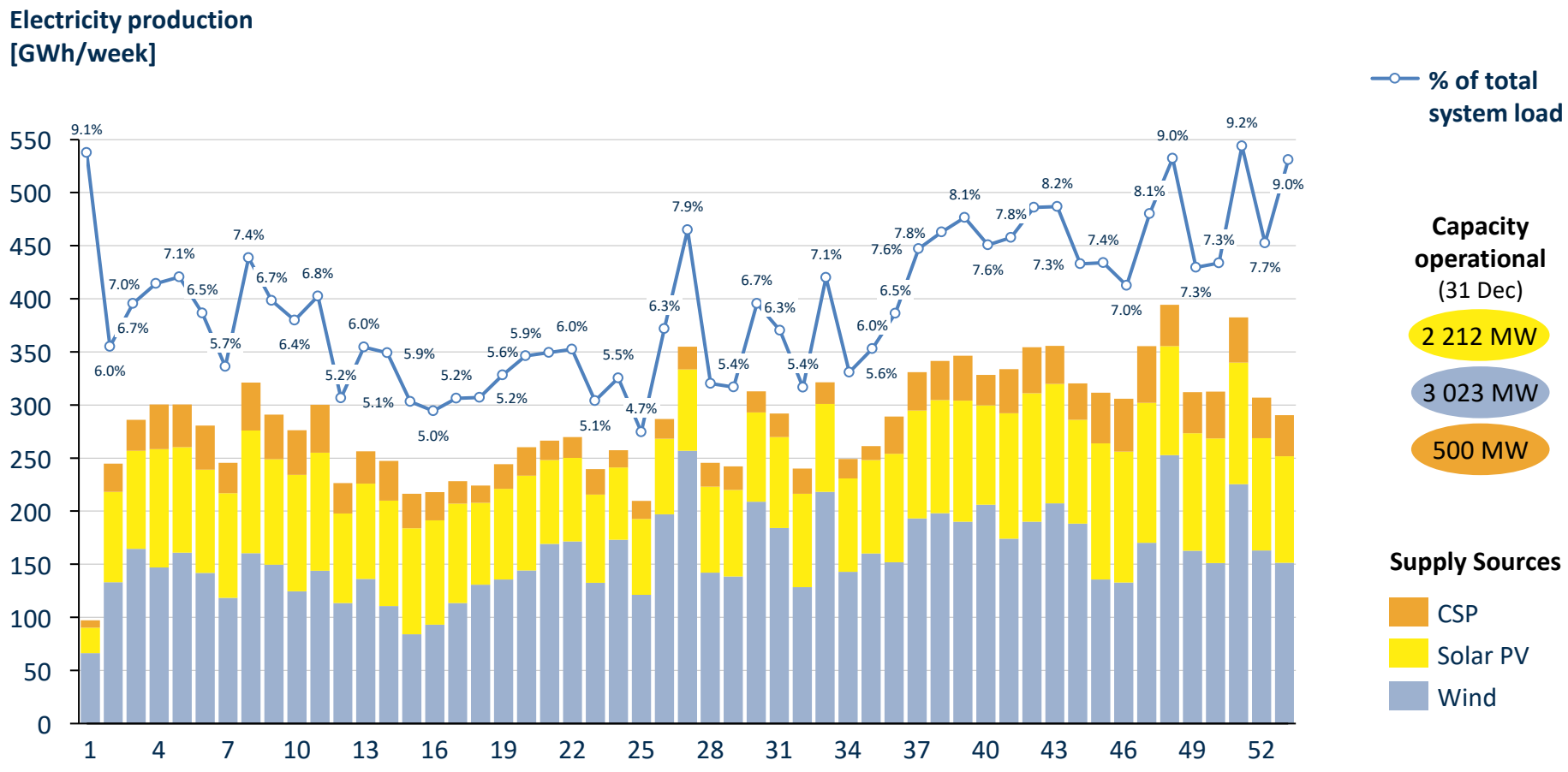
Weekly electricity production of SA's wind, solar PV and CSP fleet

Actual weekly production from large-scale solar PV, wind & CSP plants under the REIPPPP from Jan-Dec 2021



- Maximum wind + solar PV + CSP weekly production of 394 GWh in week 48 (21 Nov – 27 Nov)
- Minimum wind + solar PV + CSP weekly production of 210 GWh in week 25 (13 Jun – 19 Jun)

Note: First and last week, not full weeks, included and are thus excluded from min/max statistics.
Sources: Eskom; CSIR Energy Centre analysis

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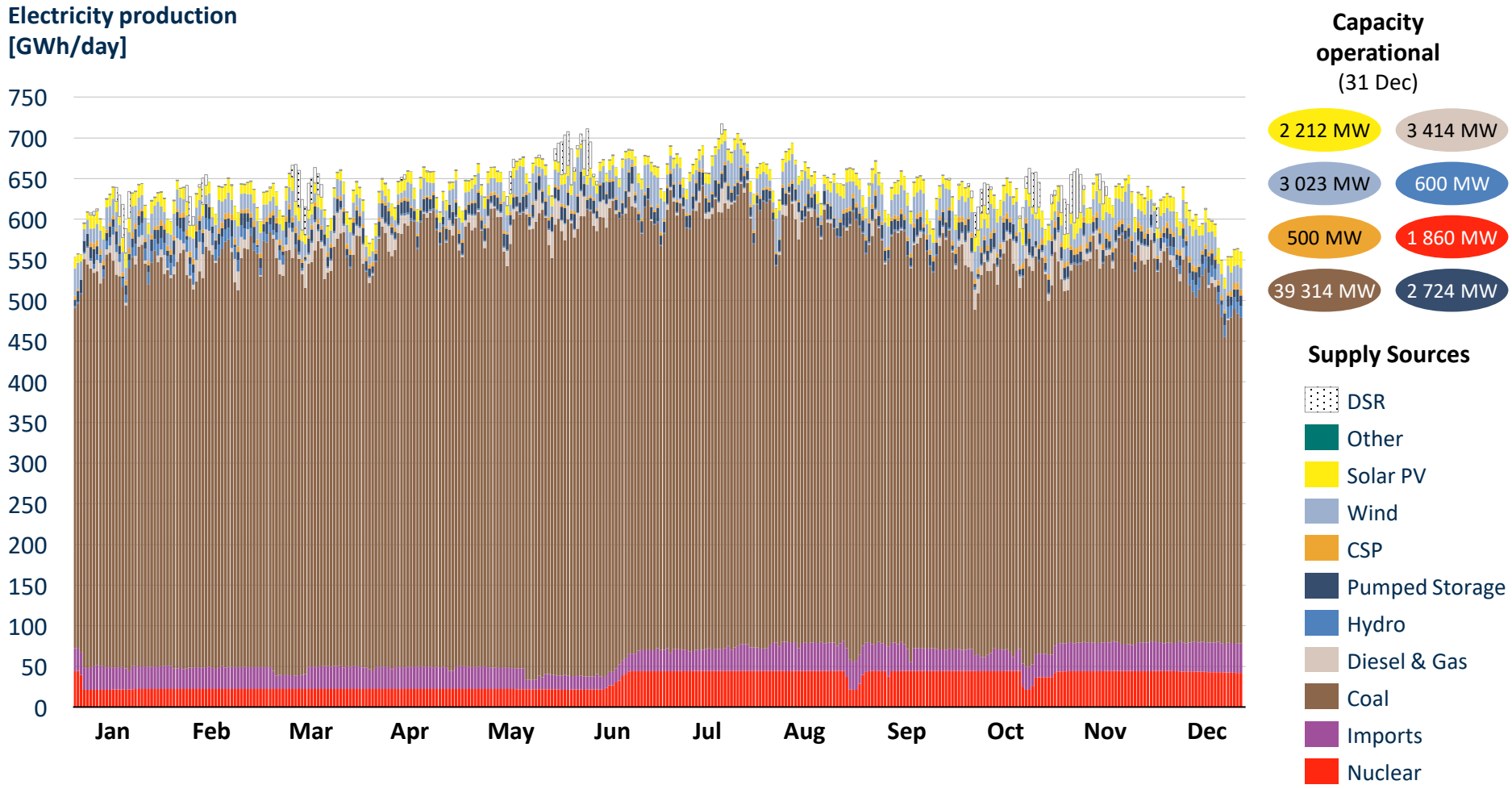
Daily electricity production for all power supply sources

Actual daily production: conventional fleet, wind, solar PV & CSP (Jan-Dec 2021)



Note: Wind includes Eskom's Sere wind plant.
Sources: Eskom; CSIR Energy Centre analysis

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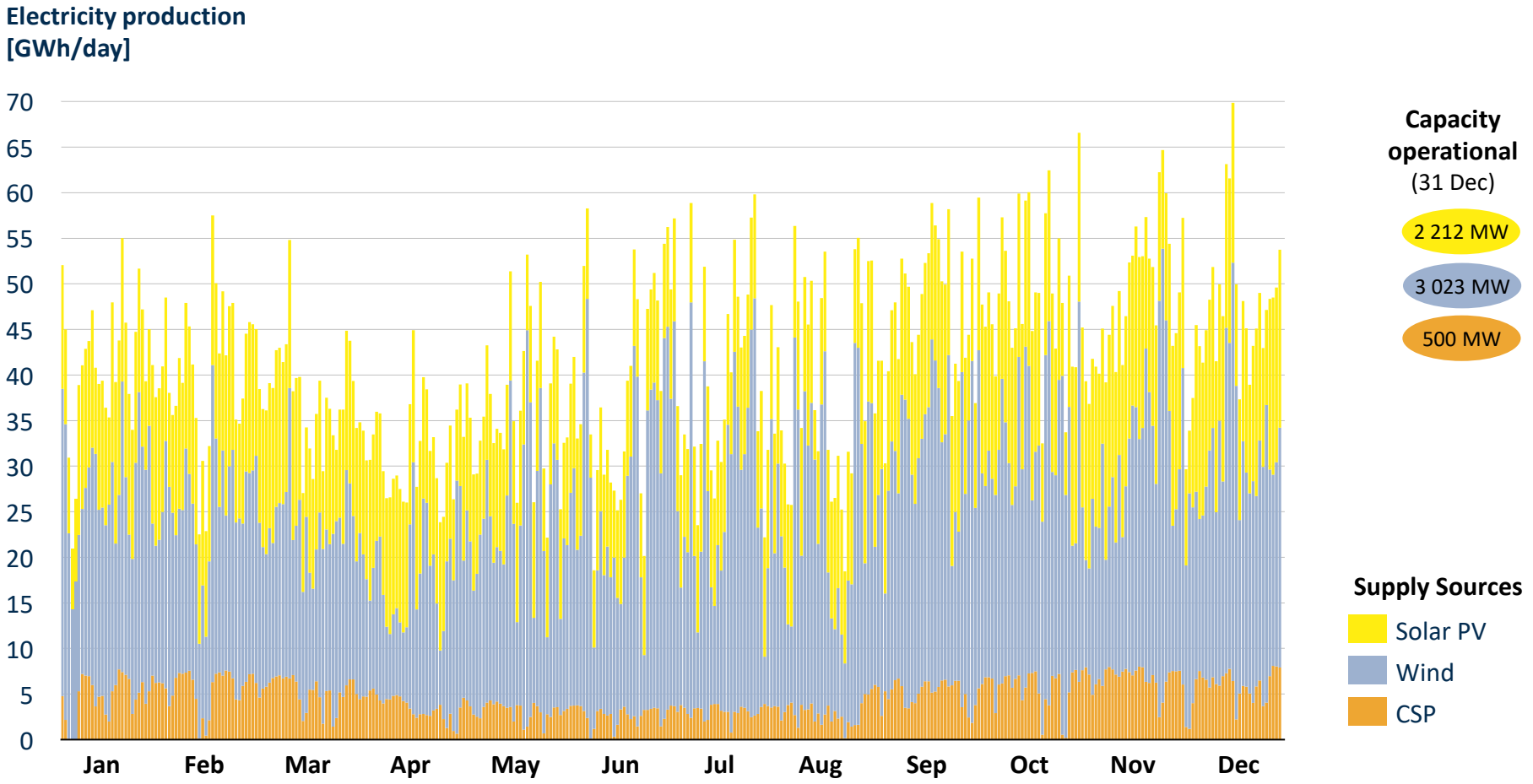
Daily electricity production of wind, solar PV & CSP fleet

Actual daily production from large-scale solar PV, wind and CSP plants under the REIPPPP from Jan-Dec 2021



- Maximum daily production of 70 GWh on 17 Dec 2021 (Friday)
- Minimum daily production of 18 GWh on 23 Aug 2021 (Monday)

Note: Design as per Fraunhofer ISE.Wind includes Eskom's Sere wind plant.
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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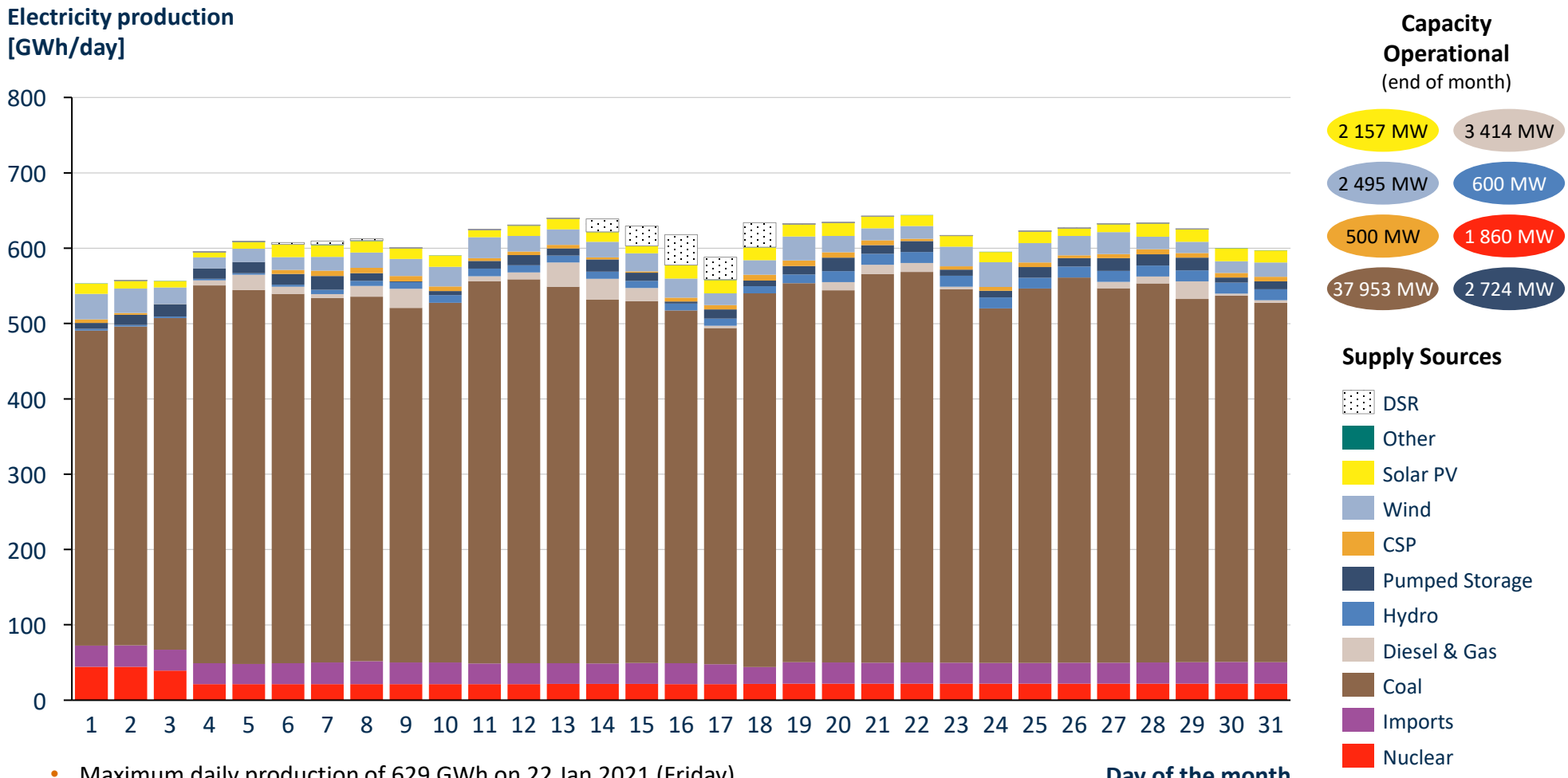
Daily electricity production between 531-629 GWh in Jan 2021

Actual daily production from all power supply sources in South Africa for January 2021



- Maximum daily production of 629 GWh on 22 Jan 2021 (Friday)
- Minimum daily production of 531 GWh on 1 Jan 2021 (Friday - National Holiday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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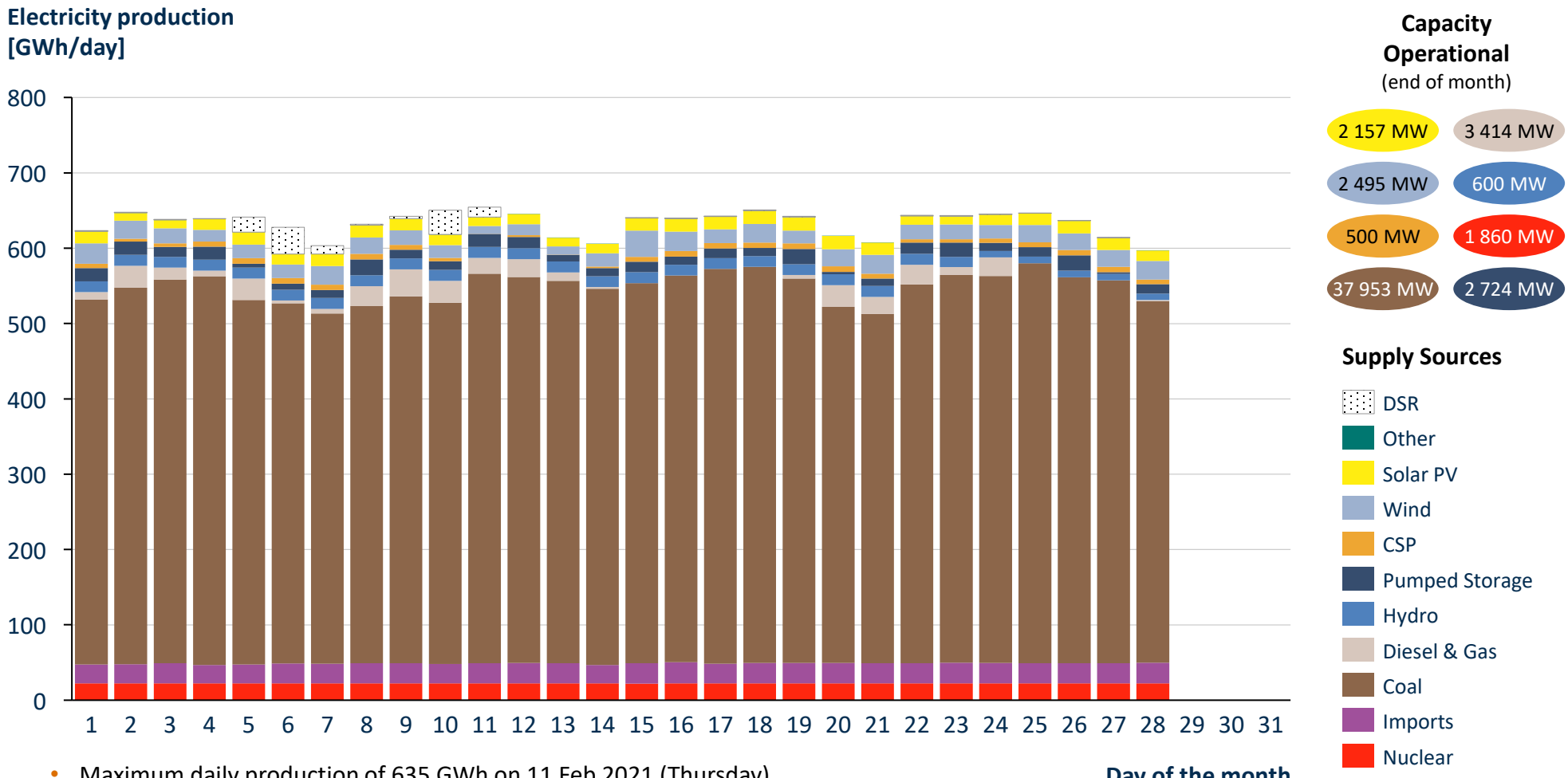
Daily electricity production between 580-635 GWh in Feb 2021

Actual daily production from all power supply sources in South Africa for February 2021



- Maximum daily production of 635 GWh on 11 Feb 2021 (Thursday)
- Minimum daily production of 580 GWh on 28 Feb 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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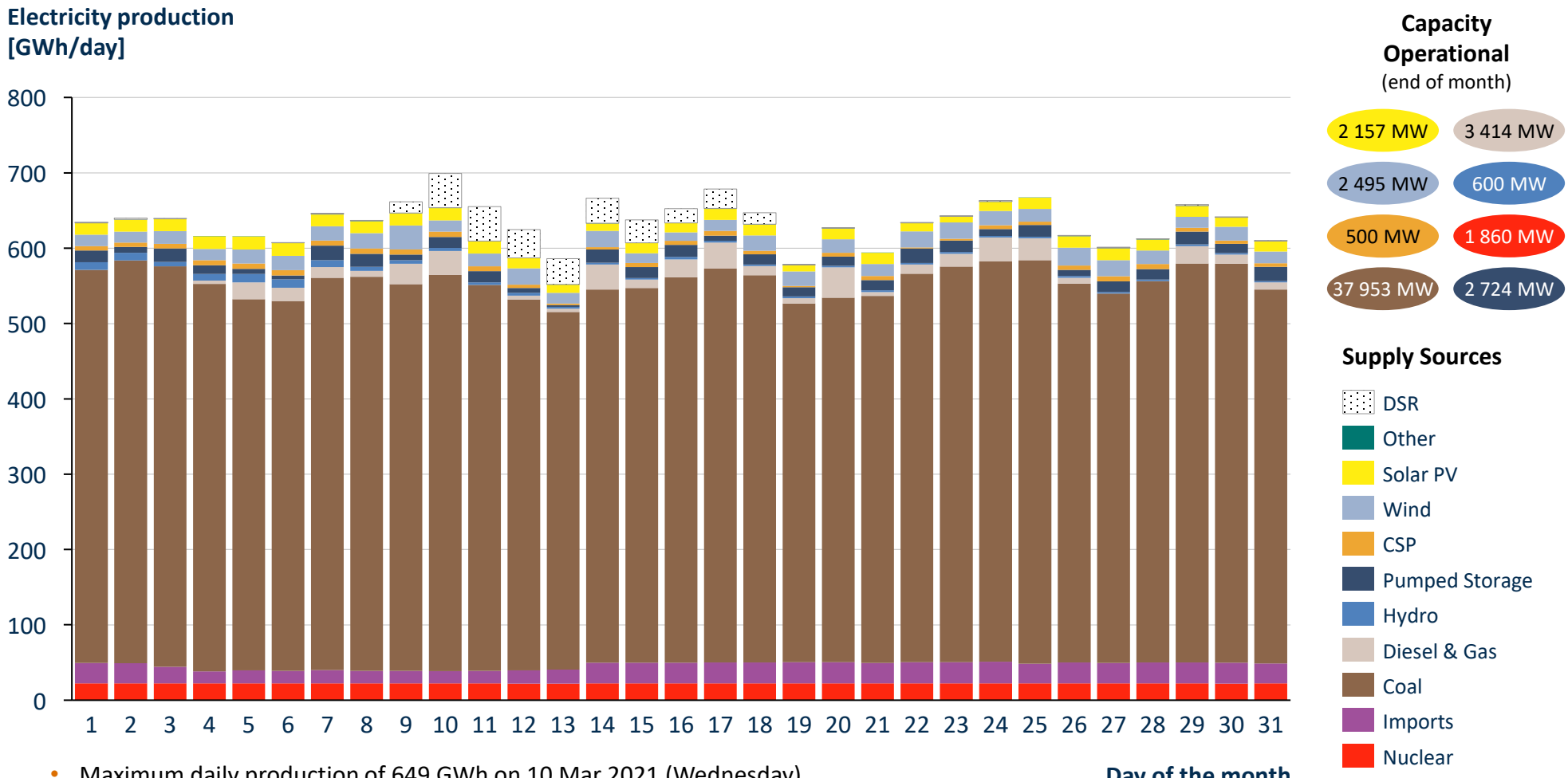
Daily electricity production between 472-649 GWh in Mar 2021

Actual daily production from all power supply sources in South Africa for March 2021



- Maximum daily production of 649 GWh on 10 Mar 2021 (Wednesday)
- Minimum daily production of 570 GWh on 21 Mar 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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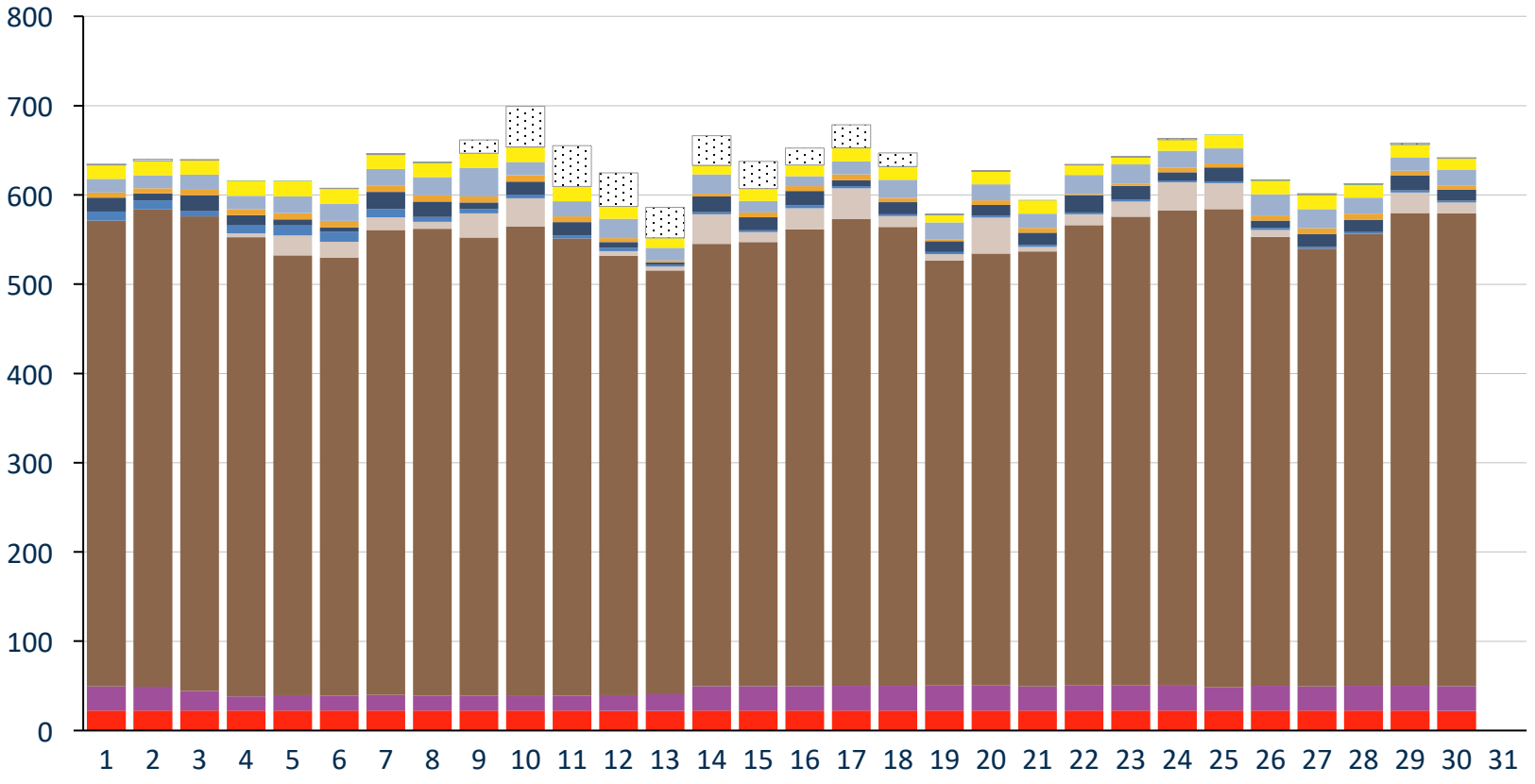
Daily electricity production between 554-646 GWh in Apr 2021

Actual daily production from all power supply sources in South Africa for April 2021

Electricity production [GWh/day]



Capacity Operational (end of month)

2 211 MW	3 414 MW
2 495 MW	600 MW
500 MW	1 860 MW
38 678 MW	2 724 MW

Supply Sources

- DSR
- Other
- Solar PV
- Wind
- CSP
- Pumped Storage
- Hydro
- Diesel & Gas
- Coal
- Imports
- Nuclear

- Maximum daily production of 646 GWh on 20 Apr 2021 (Tuesday)
- Minimum daily production of 554 GWh on 3 Apr 2021 (Saturday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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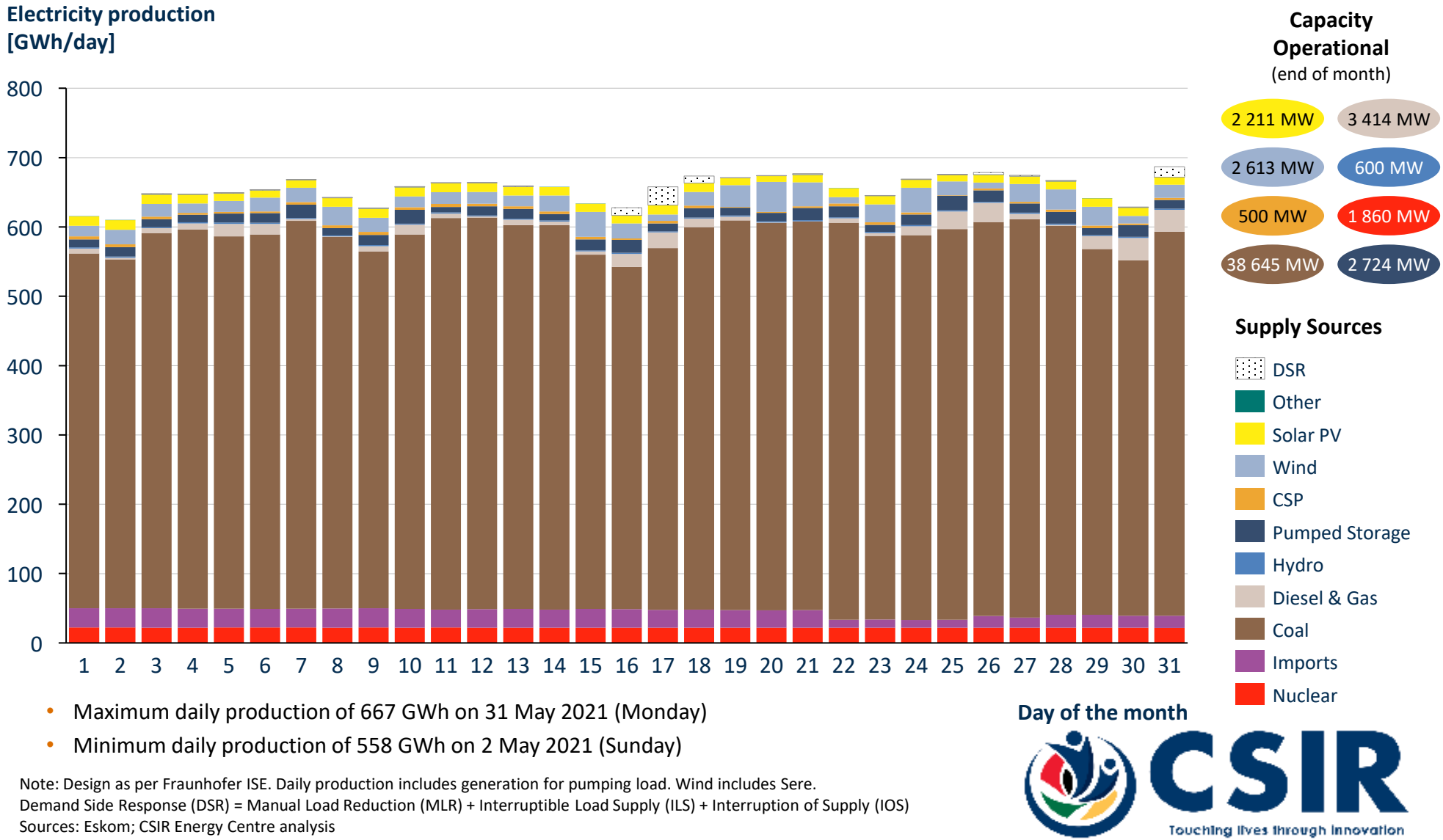
Daily electricity production between 588-667 GWh in May 2021

Actual daily production from all power supply sources in South Africa for May 2021



- Maximum daily production of 667 GWh on 31 May 2021 (Monday)
- Minimum daily production of 558 GWh on 2 May 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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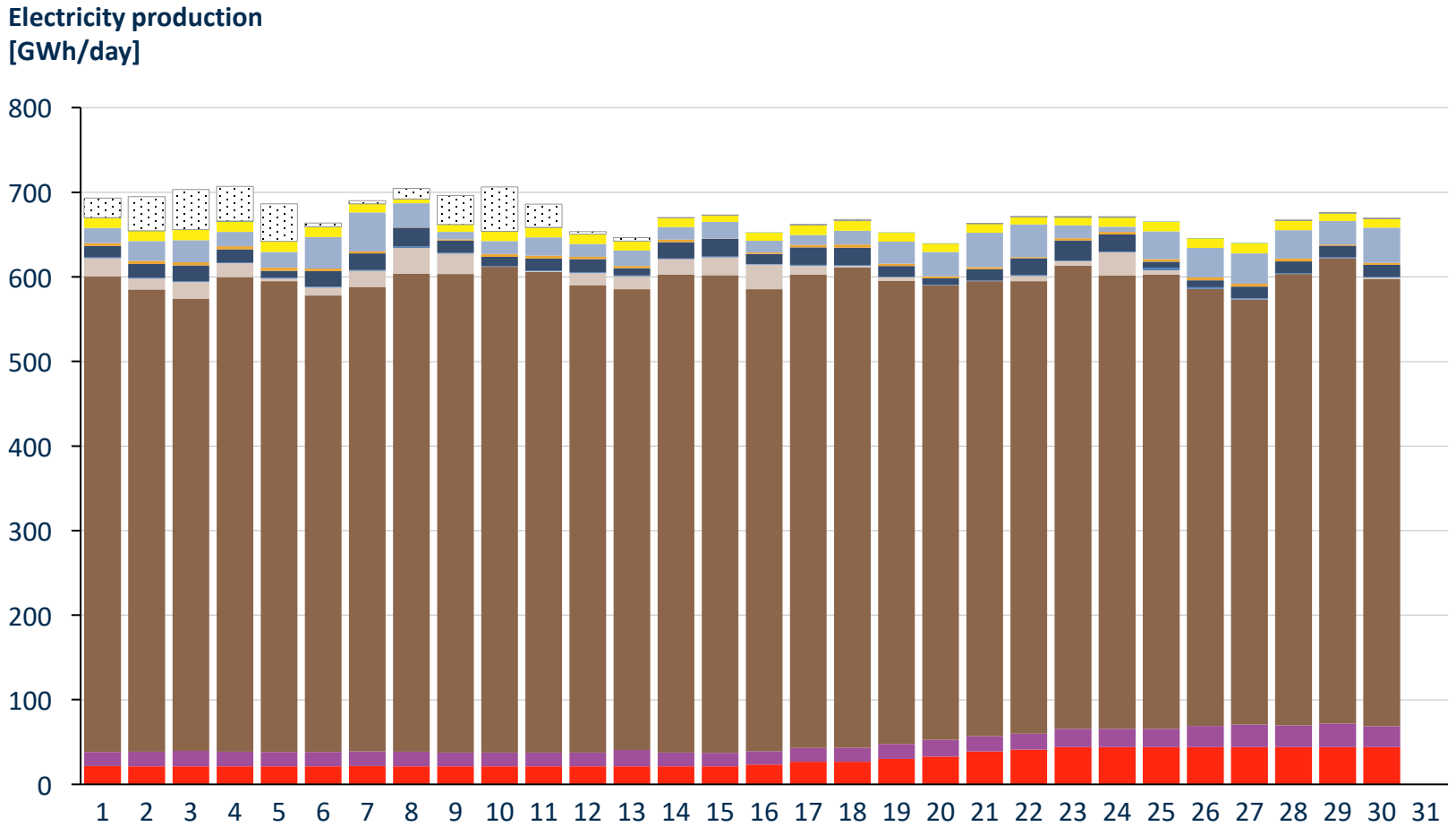
Daily electricity production between 611-685 GWh in Jun 2021

Actual daily production from all power supply sources in South Africa for June 2021



Capacity Operational (end of month)

- 2 211 MW
- 3 414 MW
- 2 613 MW
- 600 MW
- 500 MW
- 1 860 MW
- 38 636 MW
- 2 724 MW

Supply Sources

- DSR
- Other
- Solar PV
- Wind
- CSP
- Pumped Storage
- Hydro
- Diesel & Gas
- Coal
- Imports
- Nuclear

- Maximum daily production of 687 GWh on 10 Jun 2021 (Friday)
- Minimum daily production of 621 GWh on 20 Jun 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

CSIR
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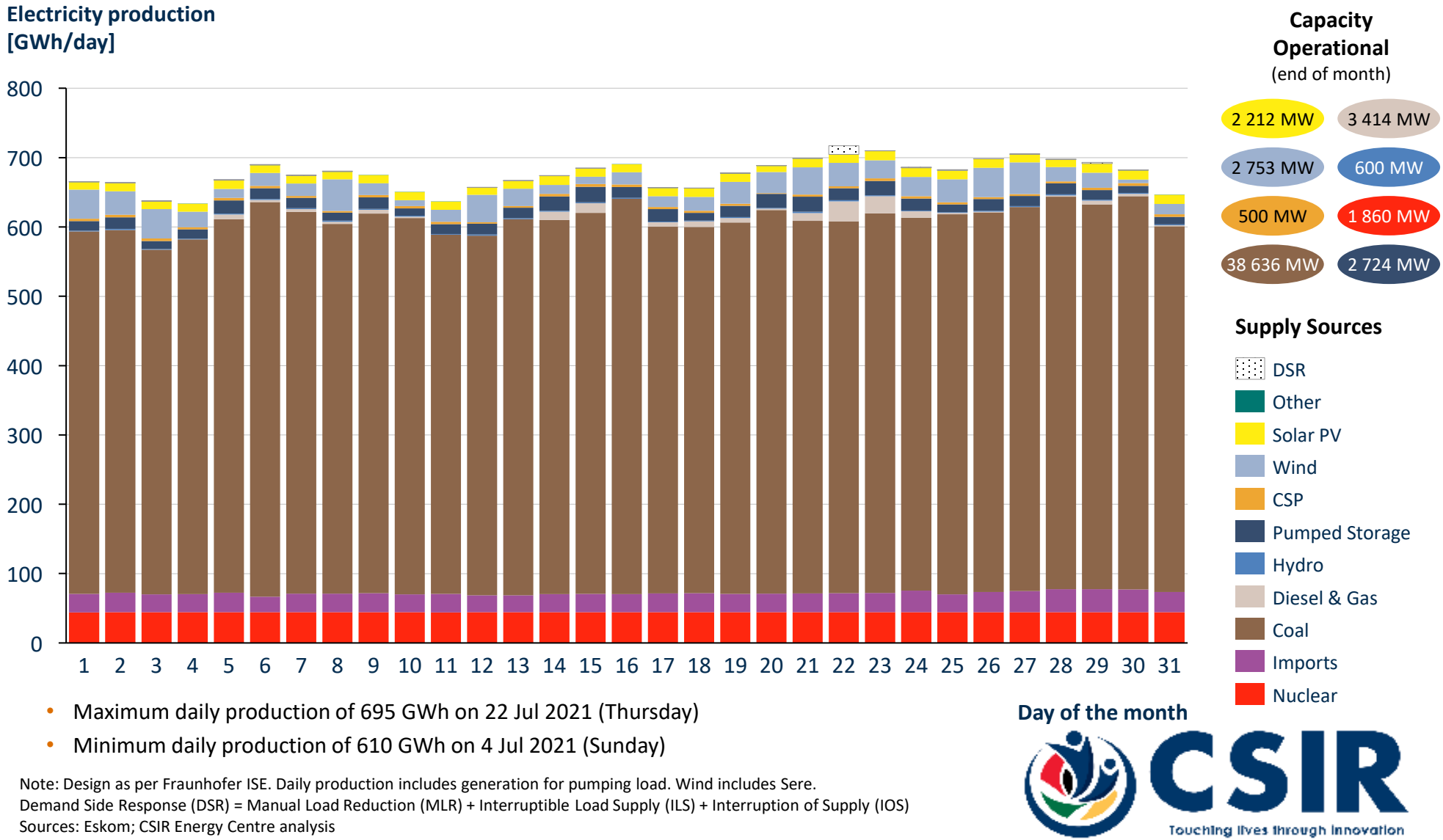
Daily electricity production between 634-710 GWh in Jul 2021

Actual daily production from all power supply sources in South Africa for July 2021



- Maximum daily production of 695 GWh on 22 Jul 2021 (Thursday)
- Minimum daily production of 610 GWh on 4 Jul 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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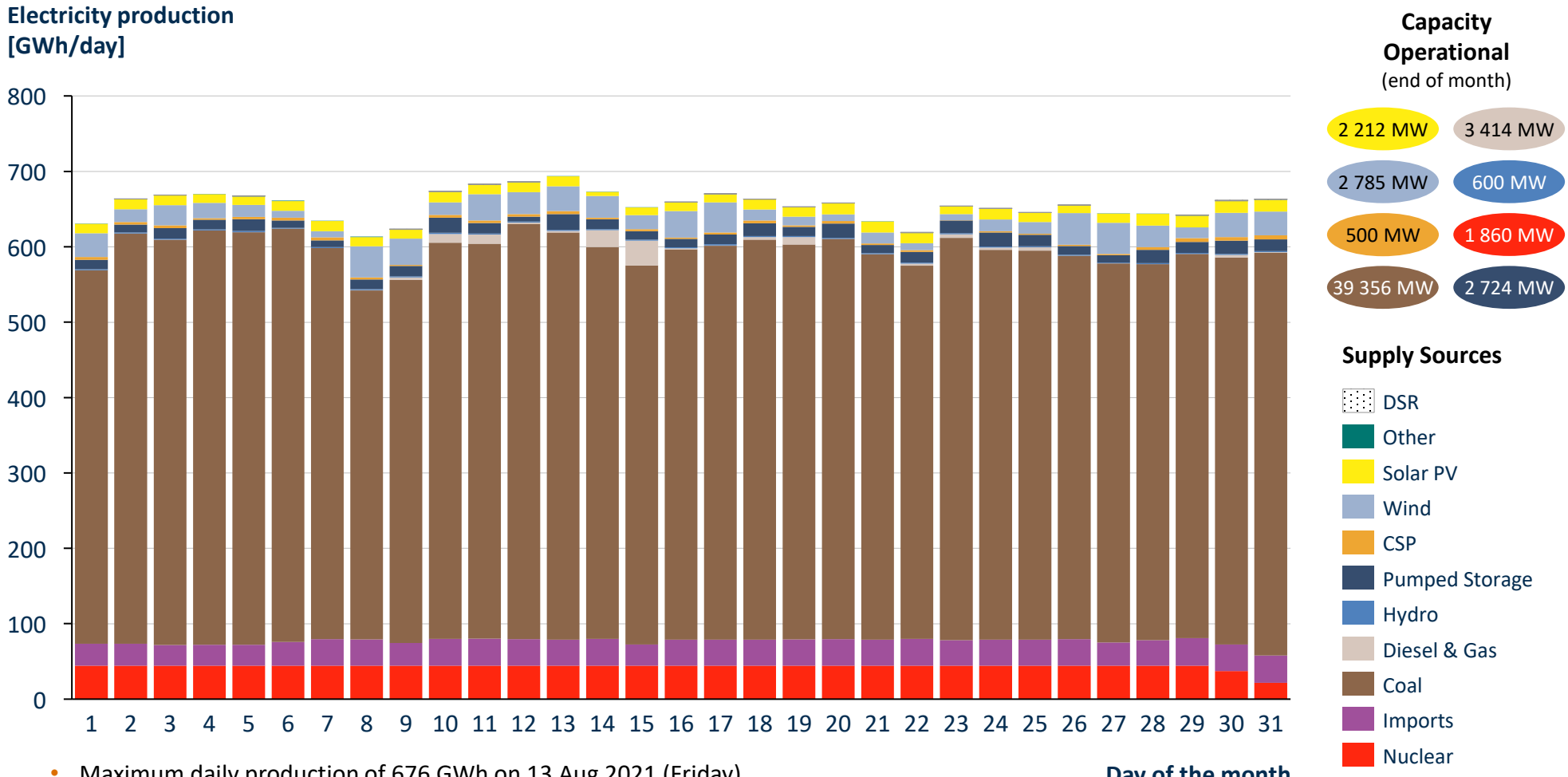
Daily electricity production between 613-694 GWh in Aug 2021

Actual daily production from all power supply sources in South Africa for August 2021



- Maximum daily production of 676 GWh on 13 Aug 2021 (Friday)
- Minimum daily production of 596 GWh on 22 Aug 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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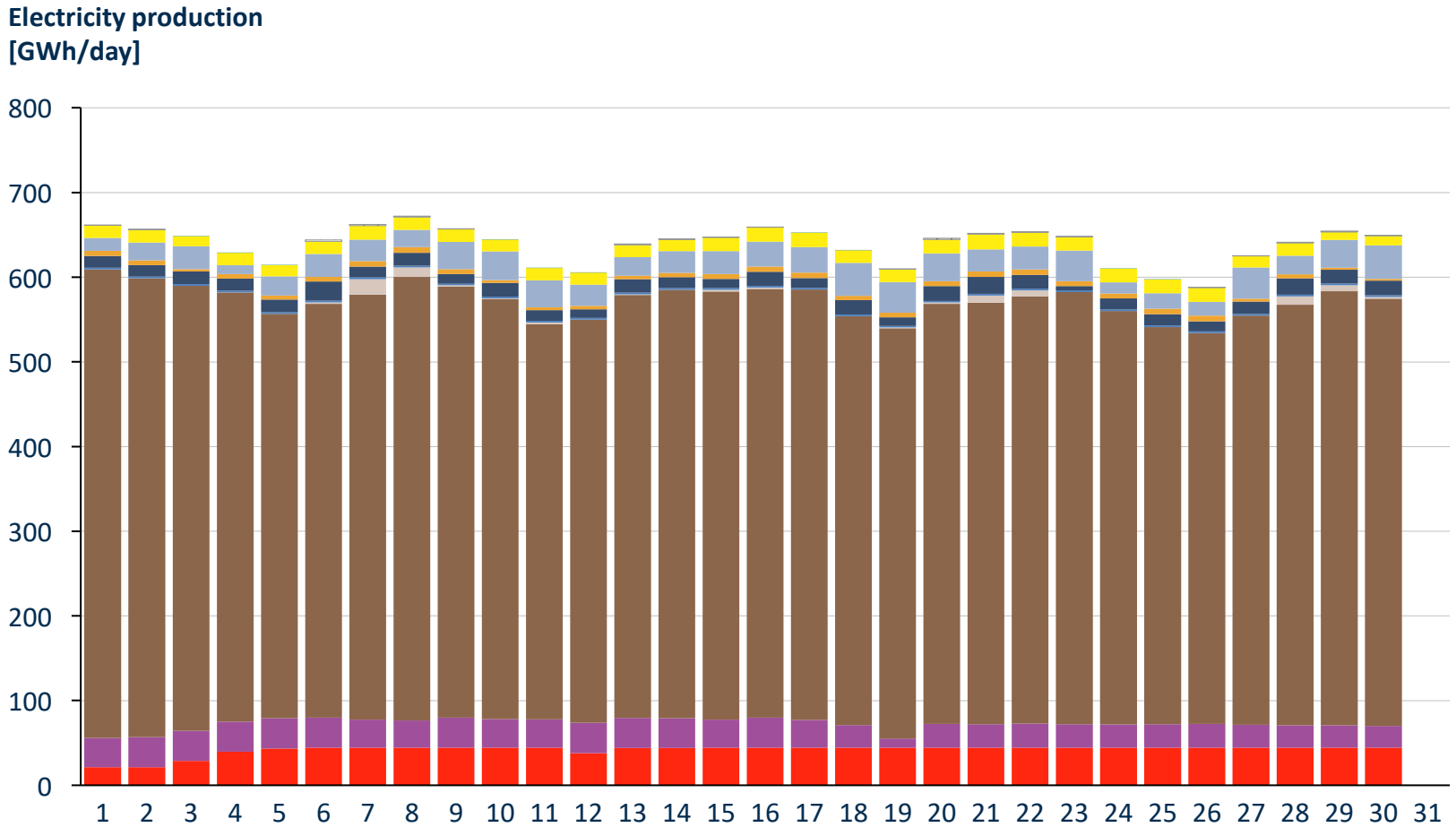
Daily electricity production between 588-671 GWh in Sep 2021

Actual daily production from all power supply sources in South Africa for September 2021



Capacity Operational (end of month)

- 2 212 MW
- 3 414 MW
- 2 785 MW
- 600 MW
- 500 MW
- 1 860 MW
- 39 350 MW
- 2 724 MW

Supply Sources

- DSR
- Other
- Solar PV
- Wind
- CSP
- Pumped Storage
- Hydro
- Diesel & Gas
- Coal
- Imports
- Nuclear

- Maximum daily production of 650 GWh on 8 Sep 2021 (Wednesday)
- Minimum daily production of 568 GWh on 26 Sep 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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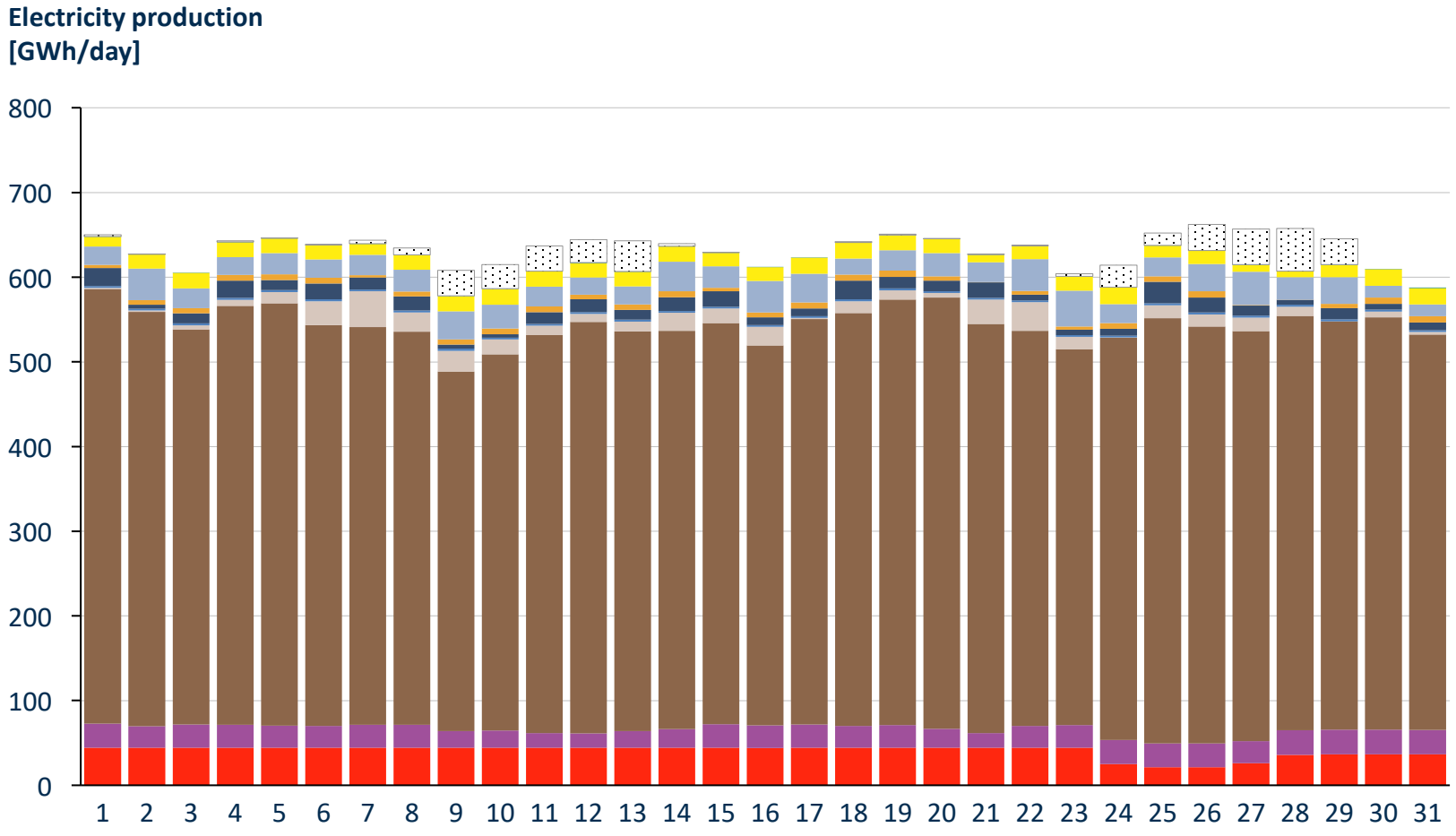
Daily electricity production between 578-650 GWh in Oct 2021

Actual daily production from all power supply sources in South Africa for October 2021



Capacity Operational (end of month)

2 212 MW	3 414 MW
2 785 MW	600 MW
500 MW	1 860 MW
39 314 MW	2 724 MW

Supply Sources

- DSR
- Other
- Solar PV
- Wind
- CSP
- Pumped Storage
- Hydro
- Diesel & Gas
- Coal
- Imports
- Nuclear

- Maximum daily production of 645 GWh on 26 Oct 2021 (Tuesday)
- Minimum daily production of 574 GWh on 31 Oct 2021 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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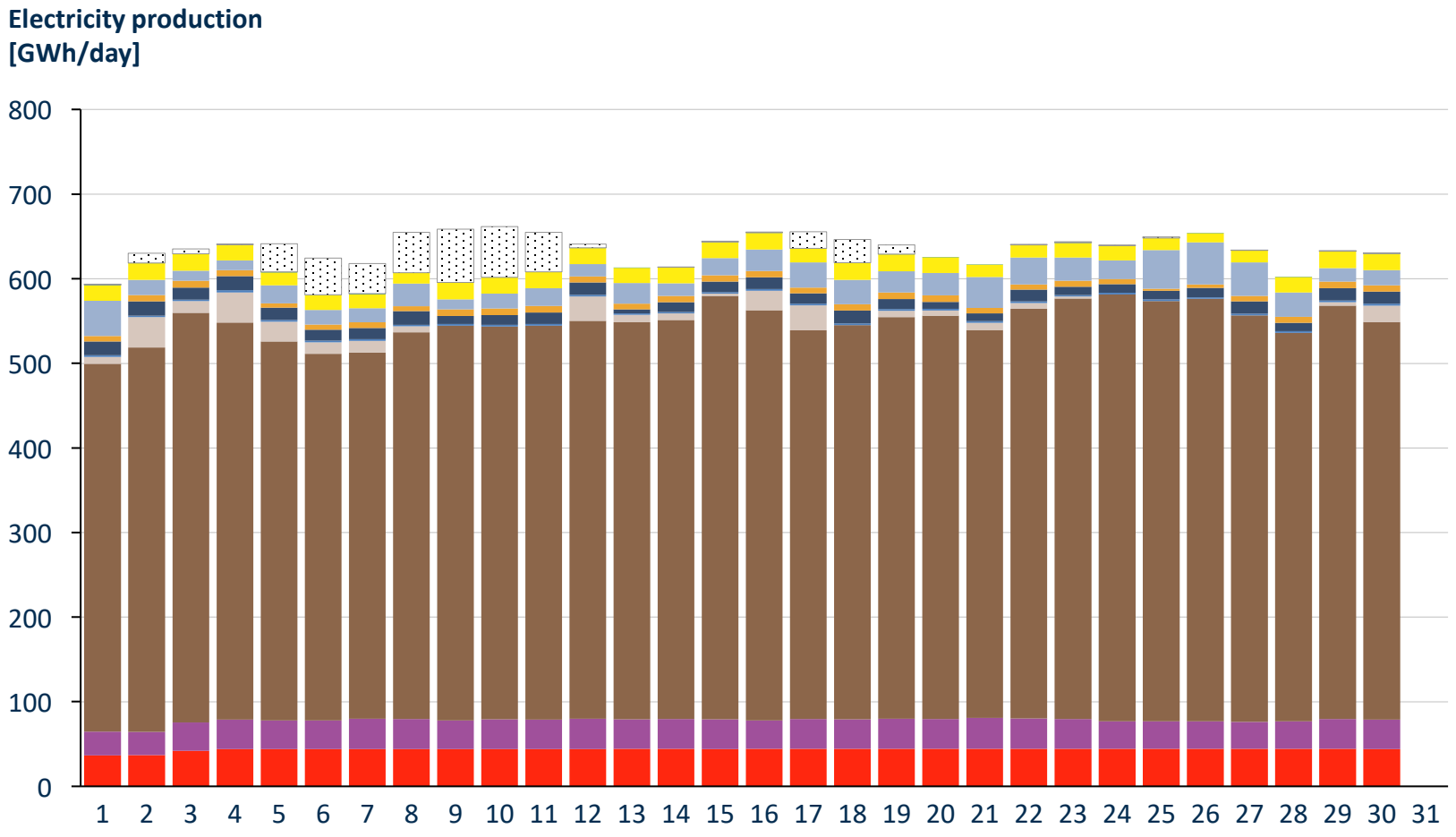
Daily electricity production between 581-654 GWh in Nov 2021

Actual daily production from all power supply sources in South Africa for November 2021



Capacity Operational (end of month)

2 212 MW	3 414 MW
2 785 MW	600 MW
500 MW	1 860 MW
39 314 MW	2 724 MW

Supply Sources

- DSR
- Other
- Solar PV
- Wind
- CSP
- Pumped Storage
- Hydro
- Diesel & Gas
- Coal
- Imports
- Nuclear

- Maximum daily production of 642 GWh on 10 Nov 2021 (Wednesday)
- Minimum daily production of 574 GWh on 1 Nov 2021 (Monday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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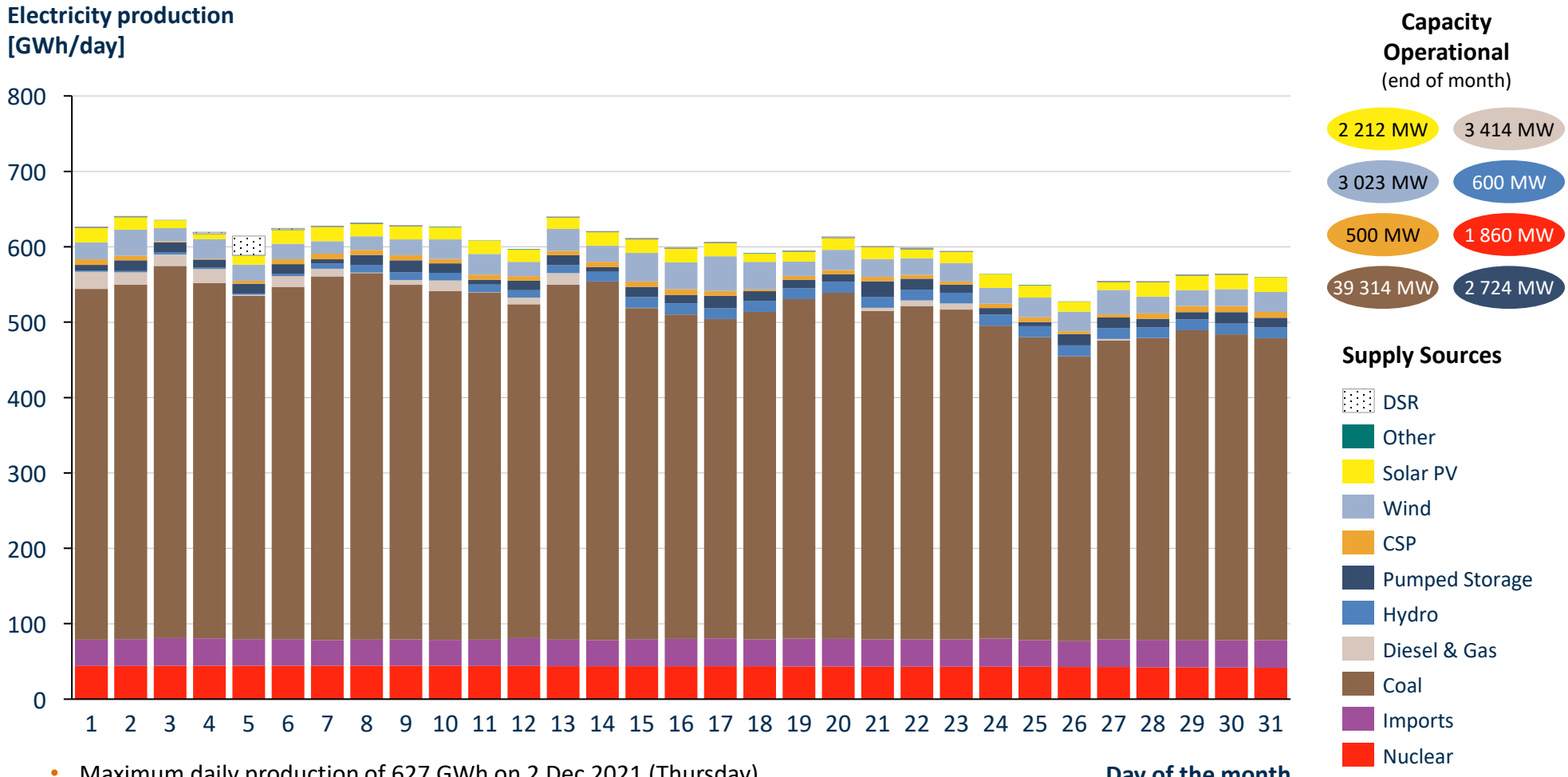
Daily electricity production between 528-640 GWh in Dec 2021

Actual daily production from all power supply sources in South Africa for December 2021



- Maximum daily production of 627 GWh on 2 Dec 2021 (Thursday)
- Minimum daily production of 516 GWh on 26 Dec 2021 (Sunday – National holiday)

Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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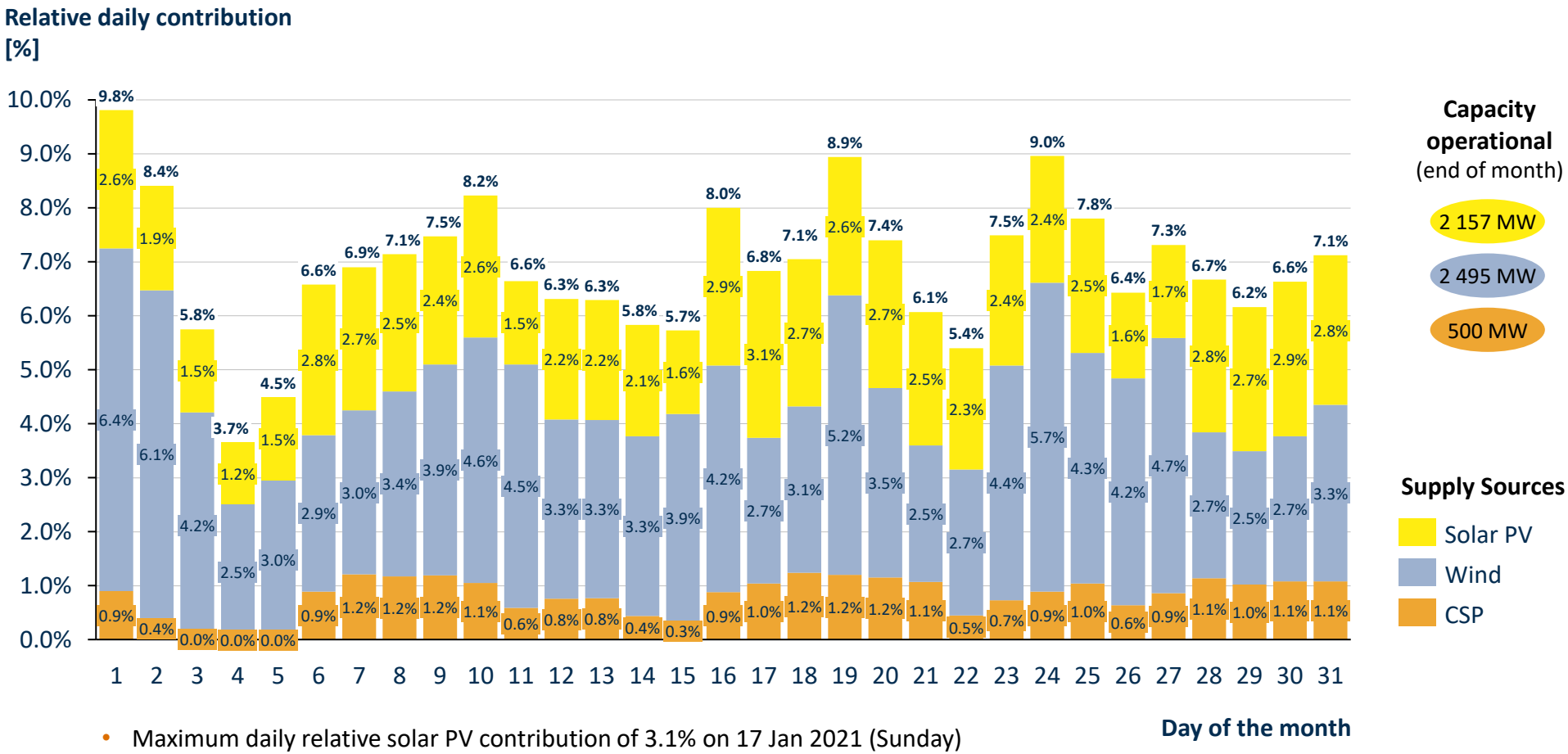
Daily solar PV, wind & CSP contribution of 3.7-9.8% in Jan 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for January 2021



- Maximum daily relative solar PV contribution of 3.1% on 17 Jan 2021 (Sunday)
- Maximum daily relative wind contribution of 6.4% on 1 Jan 2021 (Friday-National Holiday)
- Maximum daily relative CSP contribution of 1.2% on 18 Jan 2021 (Monday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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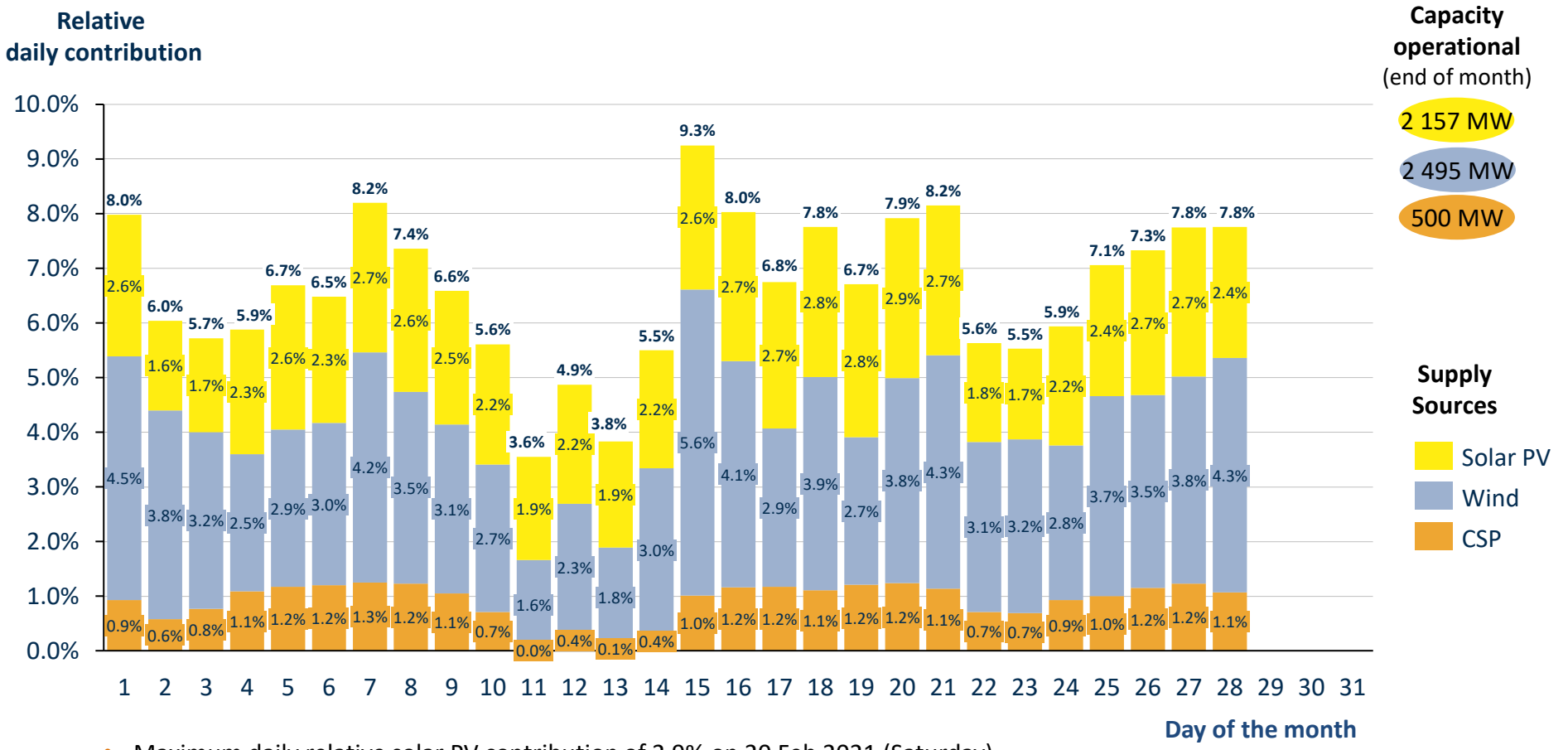
Daily solar PV, wind & CSP contribution of 3.6-9.3% in Feb 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for February 2021



- Maximum daily relative solar PV contribution of 2.9% on 20 Feb 2021 (Saturday)
- Maximum daily relative wind contribution of 5.6% on 15 Feb 2021 (Monday)
- Maximum daily relative CSP contribution of 1.3% on 7 Feb 2021 (Sunday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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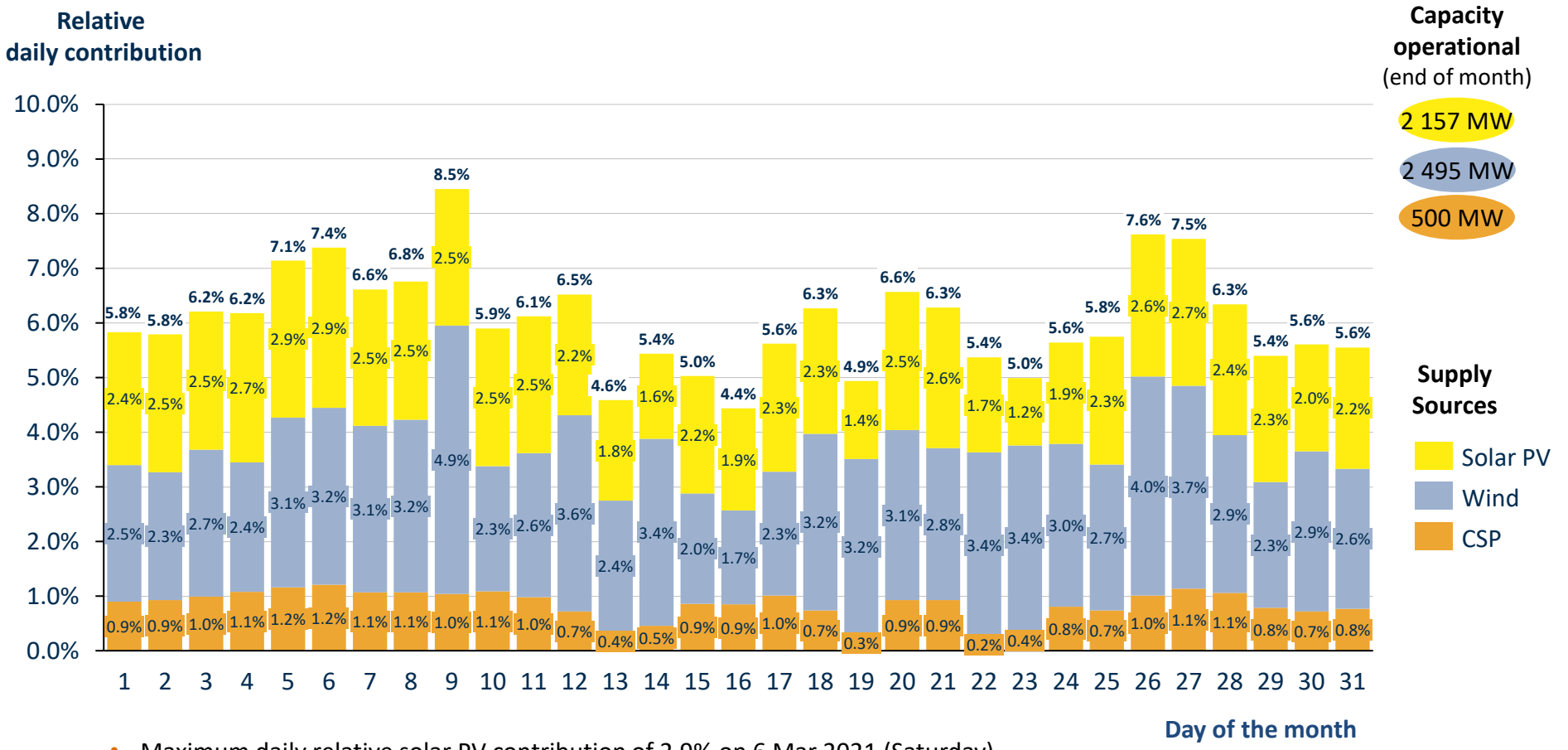
Daily solar PV, wind & CSP contribution of 4.4-8.5% in Mar 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for March 2021



- Maximum daily relative solar PV contribution of 2.9% on 6 Mar 2021 (Saturday)
- Maximum daily relative wind contribution of 4.9% on 9 Mar 2021 (Tuesday)
- Maximum daily relative CSP contribution of 1.2% on 6 Mar 2021 (Saturday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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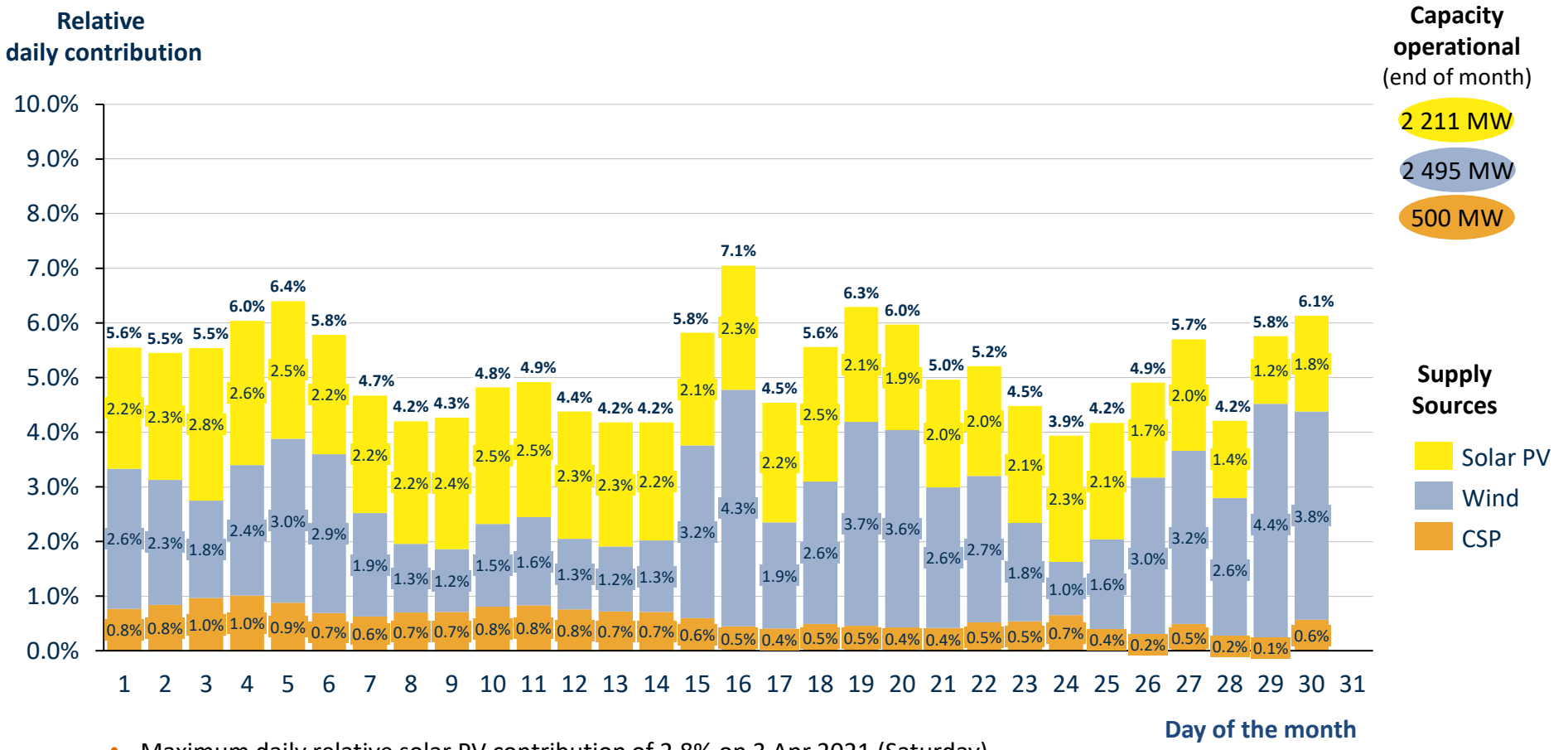
Daily solar PV, wind & CSP contribution of 3.9-7.1% in Apr 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for April 2020



- Maximum daily relative solar PV contribution of 2.8% on 3 Apr 2021 (Saturday)
- Maximum daily relative wind contribution of 4.4% on 29 Apr 2021 (Thursday)
- Maximum daily relative CSP contribution of 1.0% on 4 Apr 2021 (Sunday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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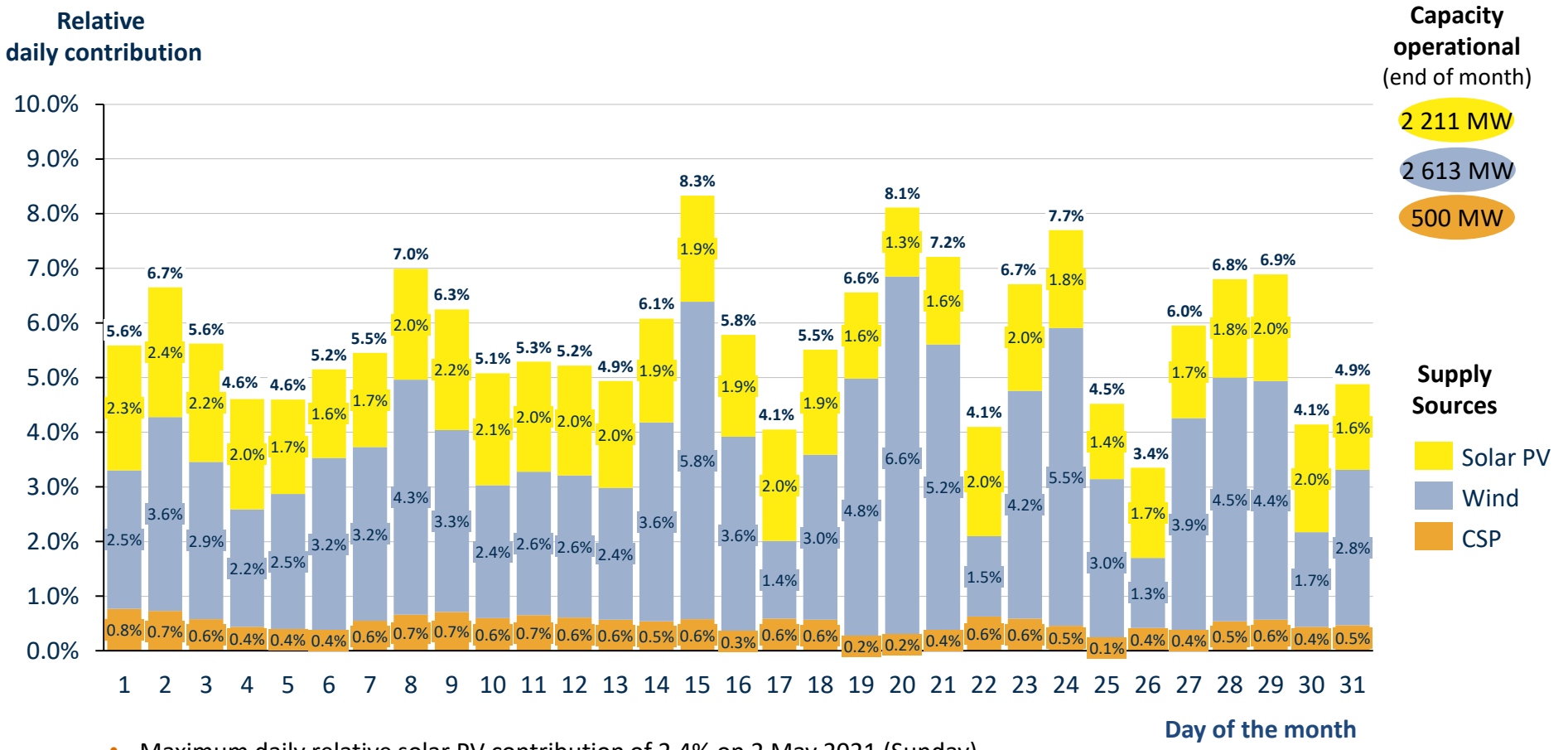
Daily solar PV, wind & CSP contribution of 3.4-8.3% in May 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for May 2021



- Maximum daily relative solar PV contribution of 2.4% on 2 May 2021 (Sunday)
- Maximum daily relative wind contribution of 6.6% on 20 May 2021 (Thursday)
- Maximum daily relative CSP contribution of 0.8% on 1 May 2021 (Saturday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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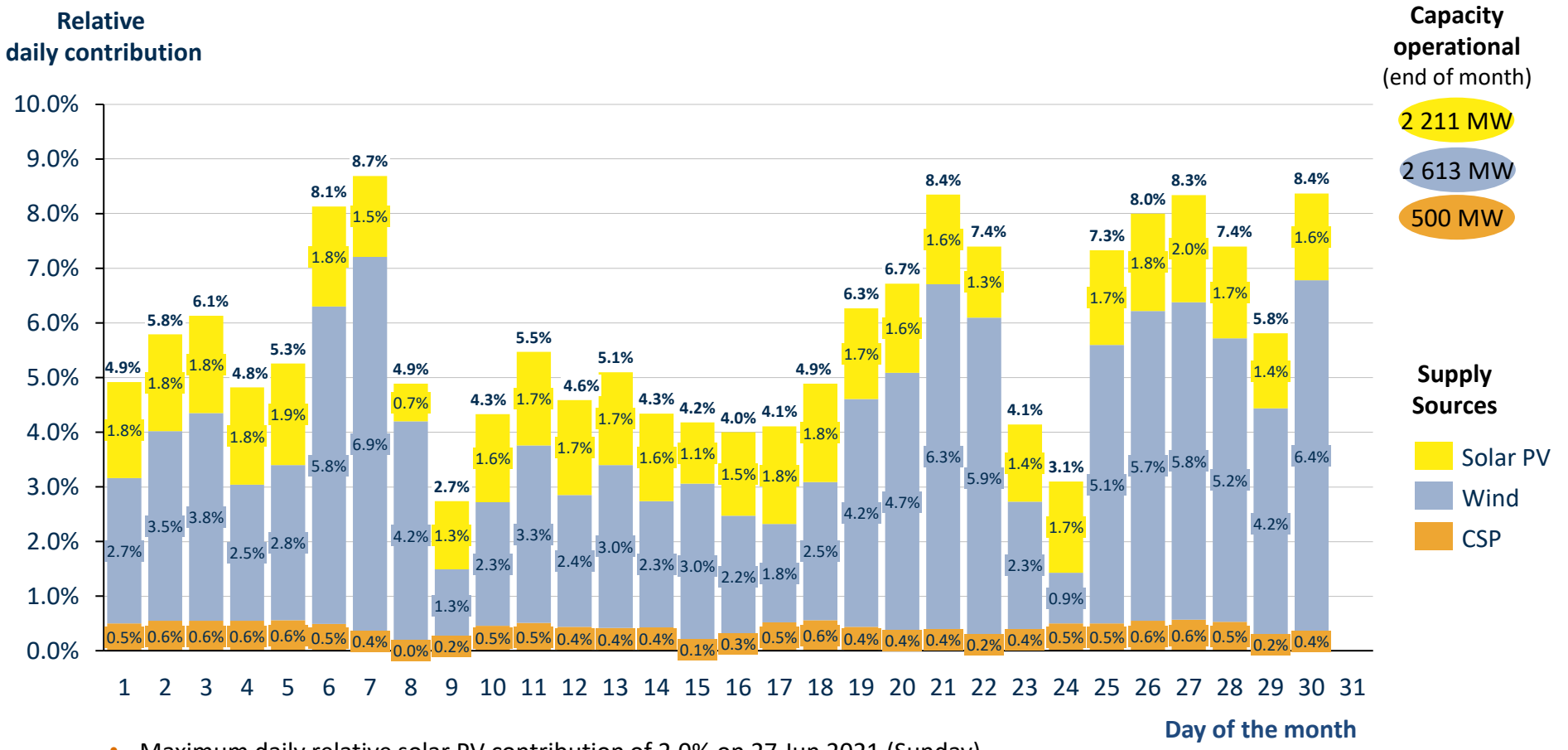
Daily solar PV, wind & CSP contribution of 2.7-8.7% in Jun 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for June 2021



- Maximum daily relative solar PV contribution of 2.0% on 27 Jun 2021 (Sunday)
- Maximum daily relative wind contribution of 6.9% on 7 Jun 2021 (Monday)
- Maximum daily relative CSP contribution of 0.6% on 27 Jun 2021 (Sunday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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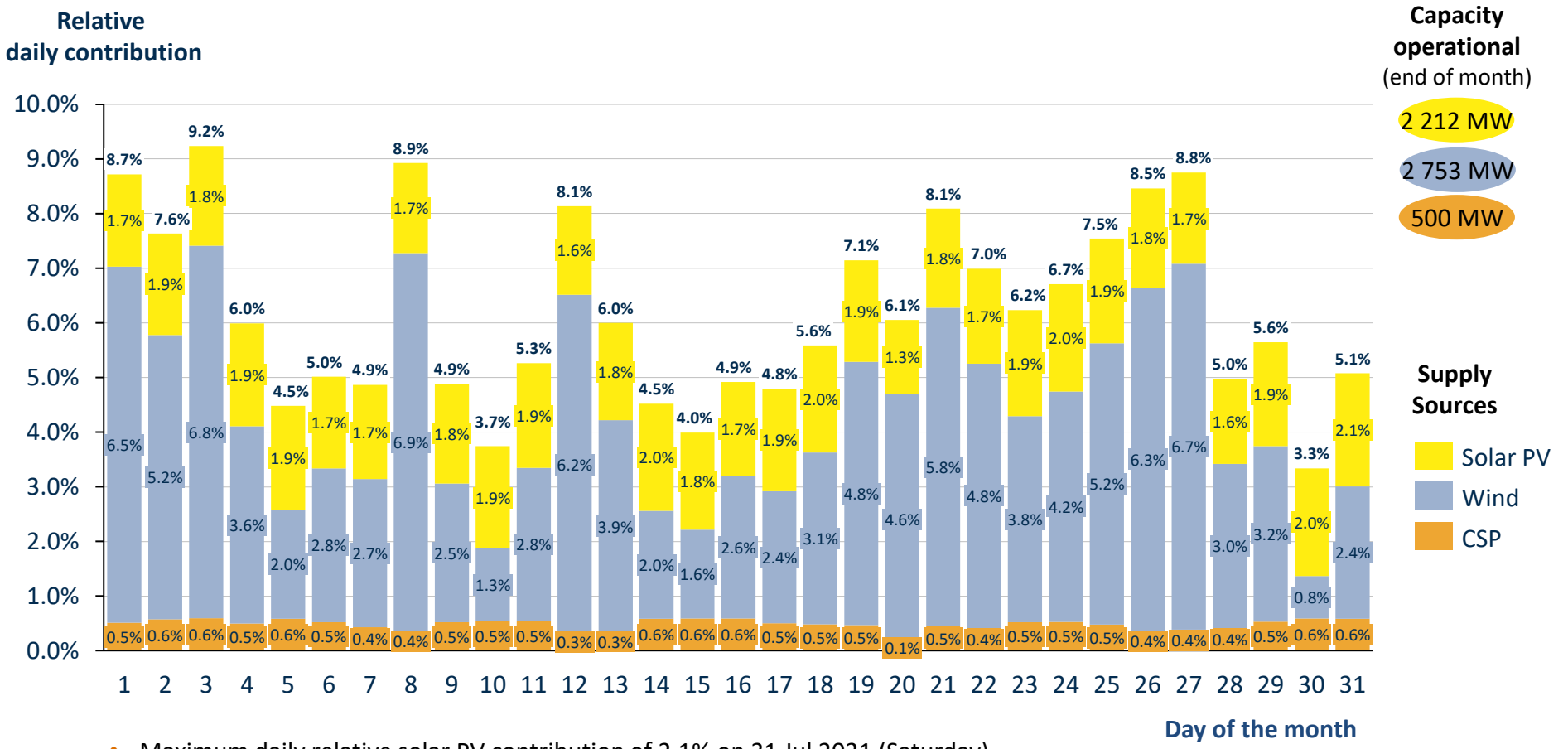
Daily solar PV, wind & CSP contribution of 3.3-9.2% in Jul 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for July 2021



- Maximum daily relative solar PV contribution of 2.1% on 31 Jul 2021 (Saturday)
- Maximum daily relative wind contribution of 6.9% on 8 Jul 2021 (Thursday)
- Maximum daily relative CSP contribution of 0.6% on 3 Jul 2021 (Saturday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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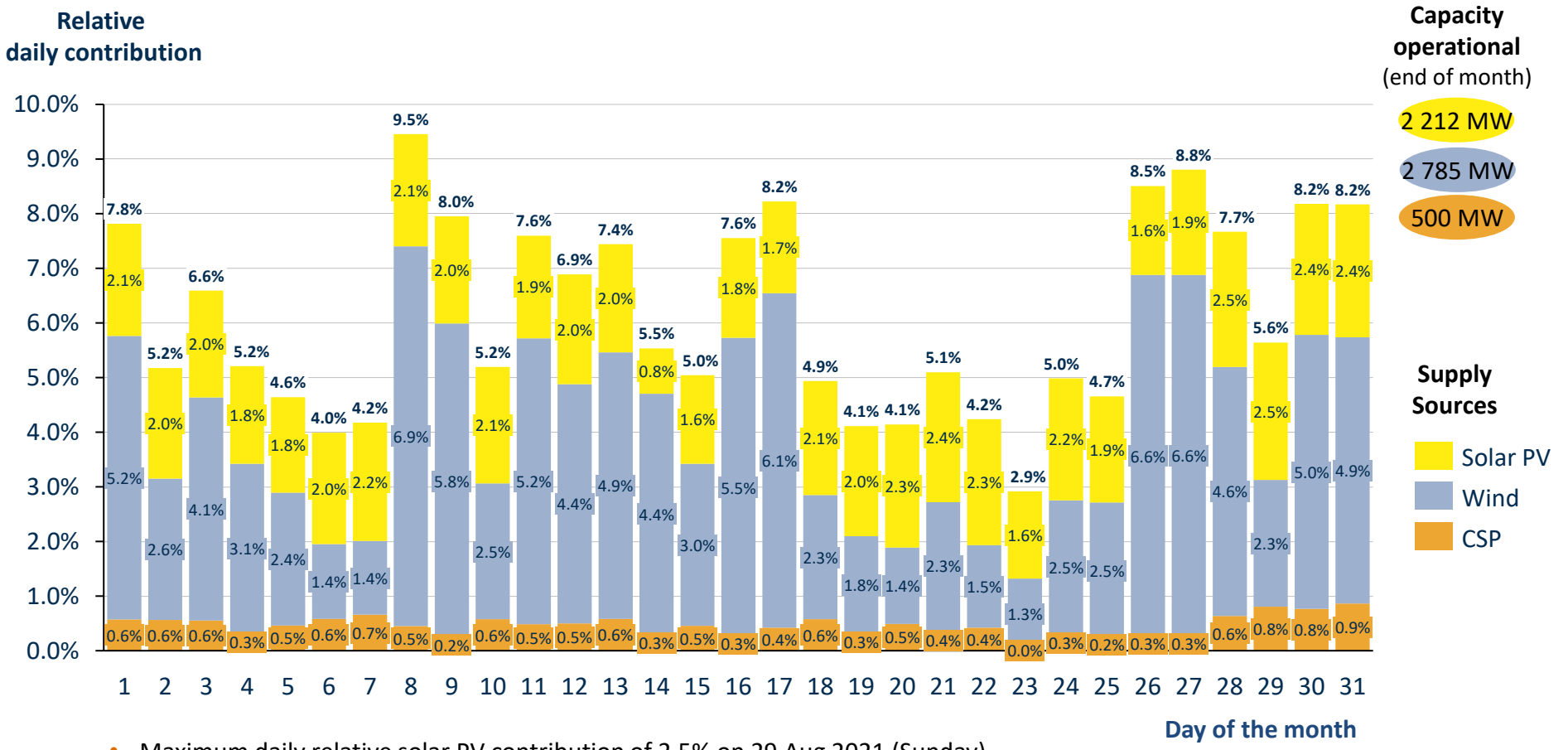
Daily solar PV, wind & CSP contribution of 2.9-9.5% in Aug 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for August 2021



- Maximum daily relative solar PV contribution of 2.5% on 29 Aug 2021 (Sunday)
- Maximum daily relative wind contribution of 6.9% on 8 Aug 2021 (Sunday)
- Maximum daily relative CSP contribution of 0.9% on 31 Aug 2021 (Tuesday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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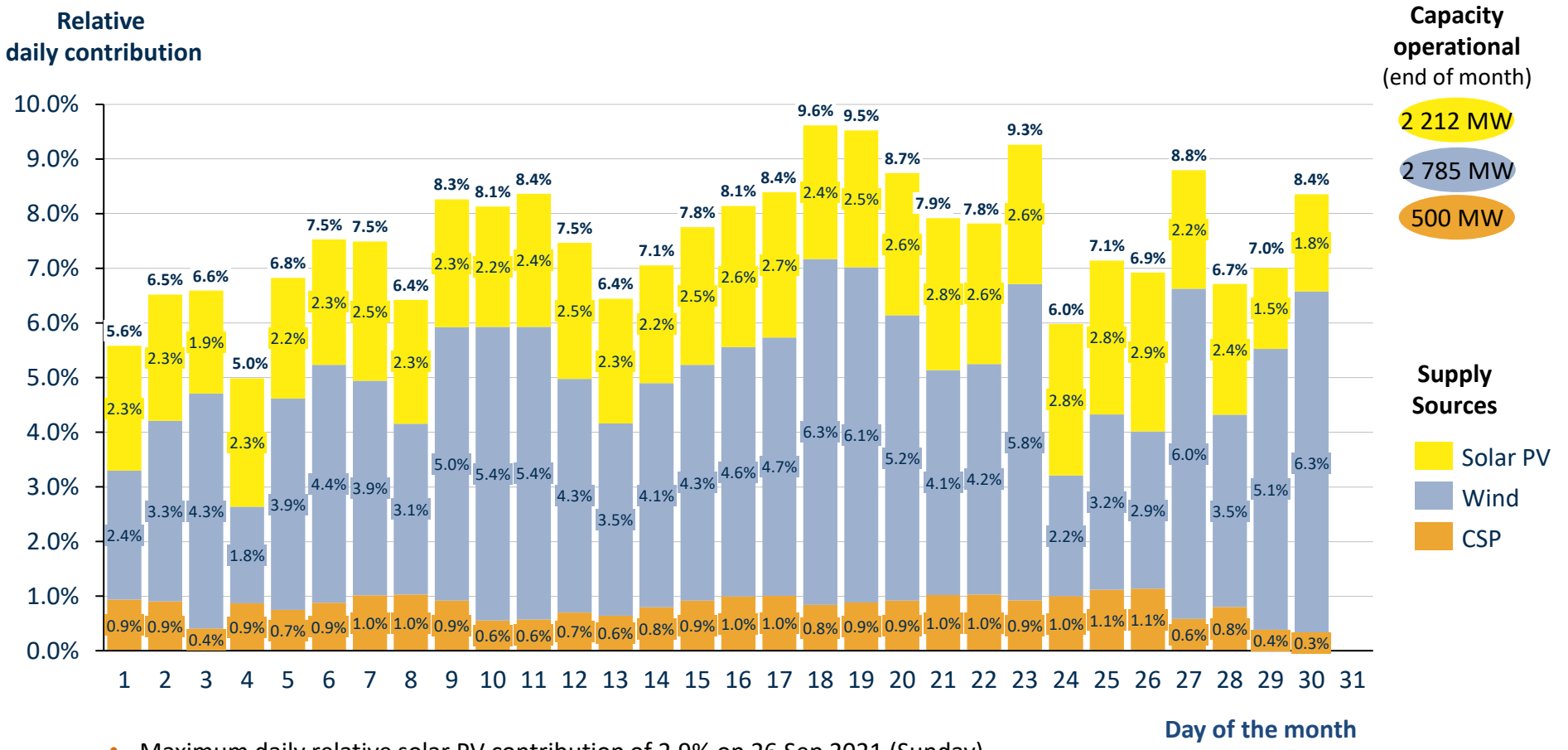
Daily solar PV, wind & CSP contribution of 5.0-9.6% in Sep 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for September 2021



- Maximum daily relative solar PV contribution of 2.9% on 26 Sep 2021 (Sunday)
- Maximum daily relative wind contribution of 6.3% on 18 Sep 2021 (Saturday)
- Maximum daily relative CSP contribution of 1.1% on 26 Sep 2021 (Sunday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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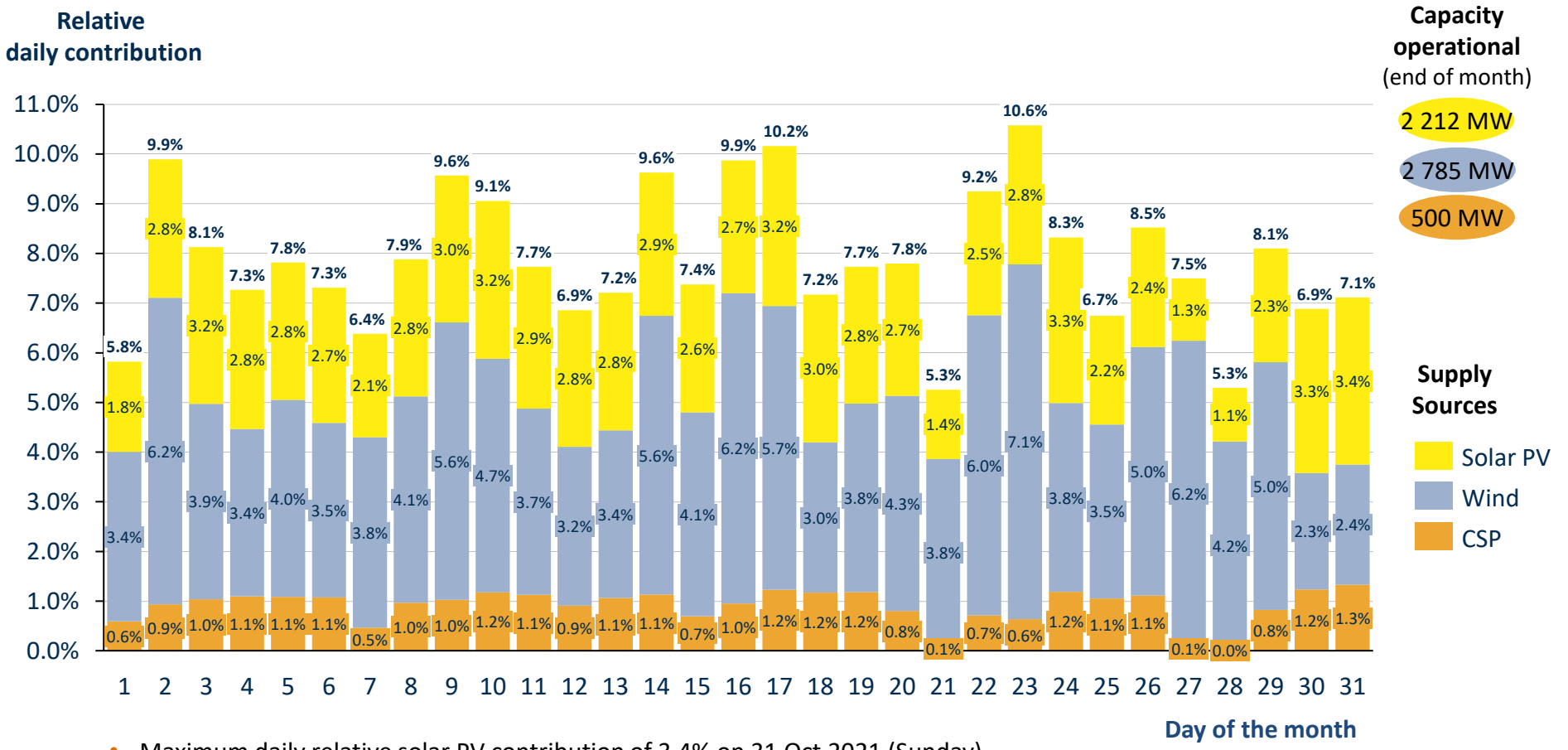
Daily solar PV, wind & CSP contribution of 5.3-10.6% in Oct 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for October 2021



- Maximum daily relative solar PV contribution of 3.4% on 31 Oct 2021 (Sunday)
- Maximum daily relative wind contribution of 7.1% on 23 Oct 2021 (Saturday)
- Maximum daily relative CSP contribution of 1.3% on 31 Oct 2021 (Sunday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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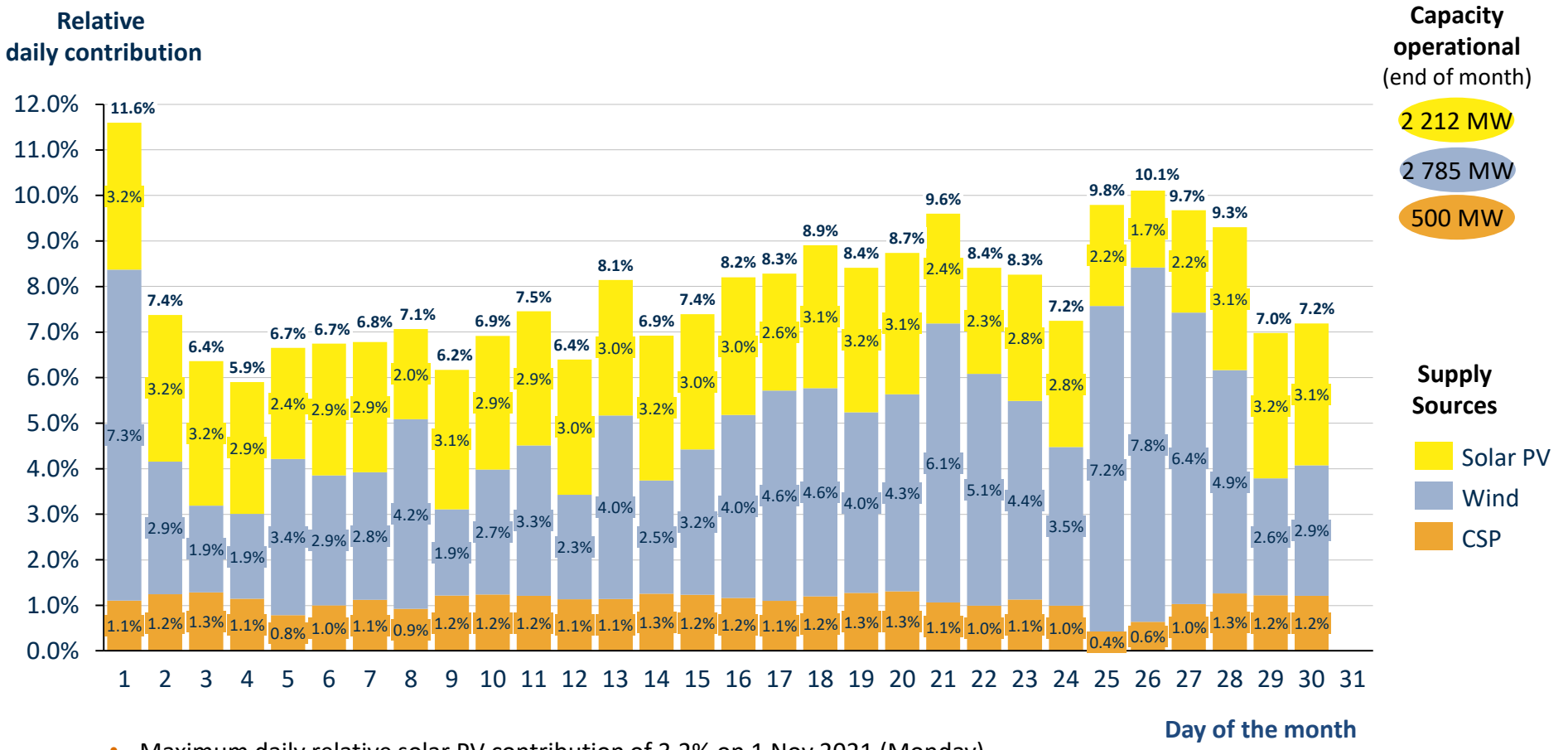
Daily solar PV, wind & CSP contribution of 5.9-11.6% in Nov 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for November 2021



- Maximum daily relative solar PV contribution of 3.2% on 1 Nov 2021 (Monday)
- Maximum daily relative wind contribution of 7.8% on 26 Nov 2021 (Friday)
- Maximum daily relative CSP contribution of 1.3% on 20 Nov 2021 (Saturday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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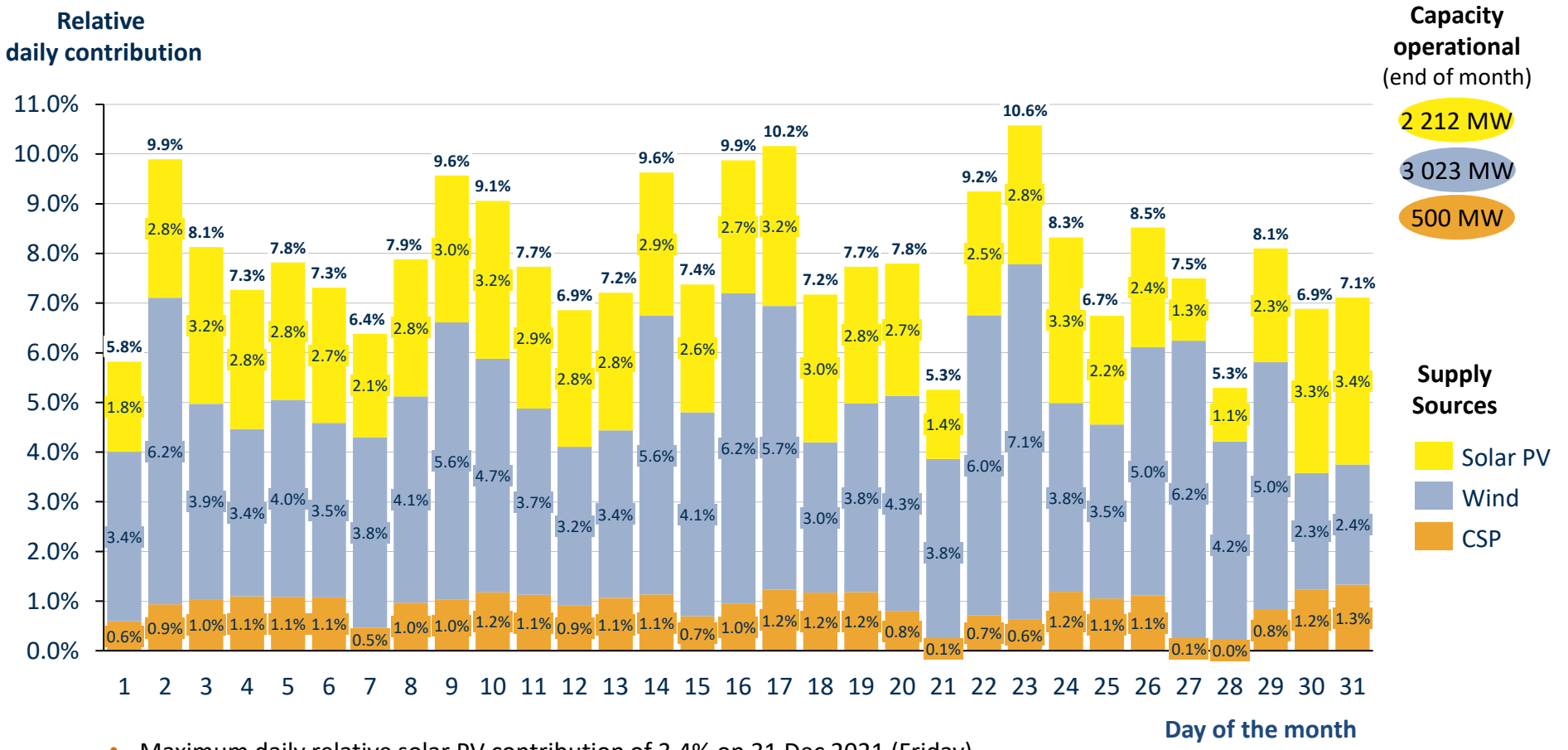
Daily solar PV, wind & CSP contribution of 5.3-10.6% in Dec 2021

Actual daily relative solar PV/wind/CSP contribution as a % of total supply in RSA for December 2021



- Maximum daily relative solar PV contribution of 3.4% on 31 Dec 2021 (Friday)
- Maximum daily relative wind contribution of 7.1% on 23 Dec 2021 (Thursday)
- Maximum daily relative CSP contribution of 1.3% on 31 Dec 2021 (Friday)

Note: Total supply includes generation for pumping load
Sources: Eskom; CSIR Energy Centre analysis

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Agenda

1 Overview actual electricity production (2021)

2 Monthly electricity production (2021)

3 Weekly electricity production (2021)

4 Daily electricity production (2021)

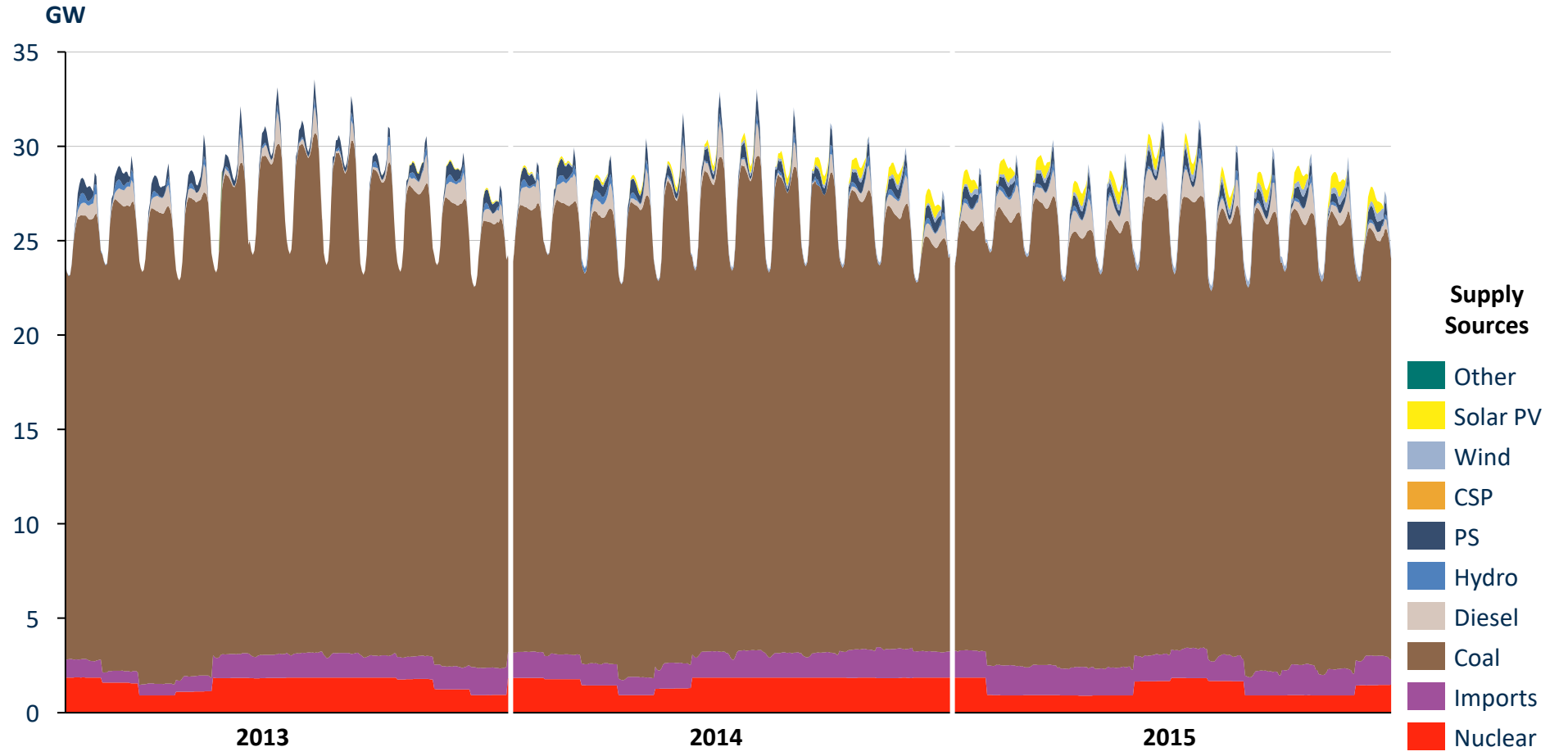
5 Hourly electricity production (2021)

6 Actual load shedding (2021)

7 Other power system statistics

Diurnal Courses of electricity supply sources in RSA

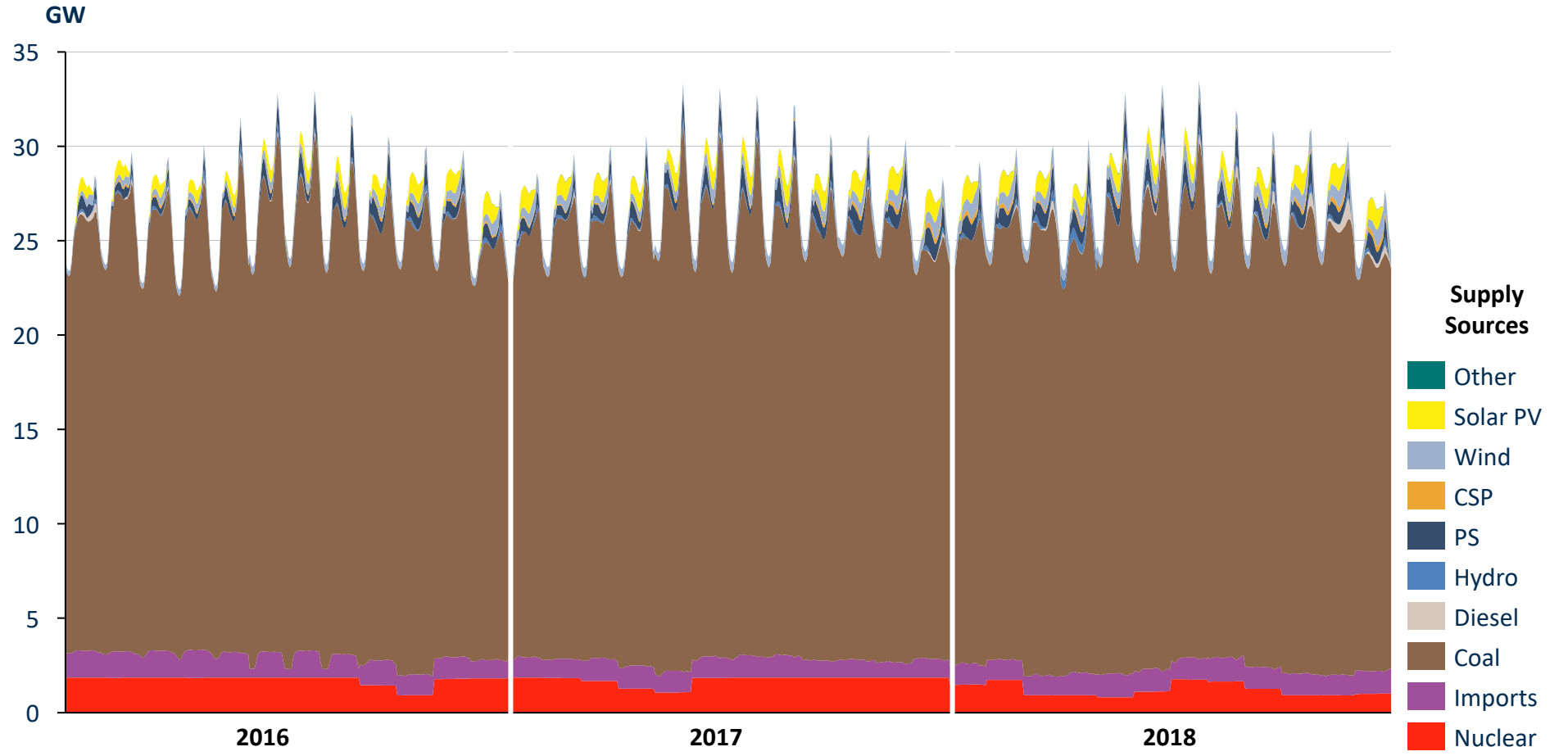
Actual monthly average diurnal courses of total power supply in RSA Jan 2013-Dec 2015



Note: Design as per Fraunhofer ISE. Pumping load excluded.
Sources: Eskom; CSIR Energy Centre analysis

Diurnal Courses of electricity supply sources in RSA

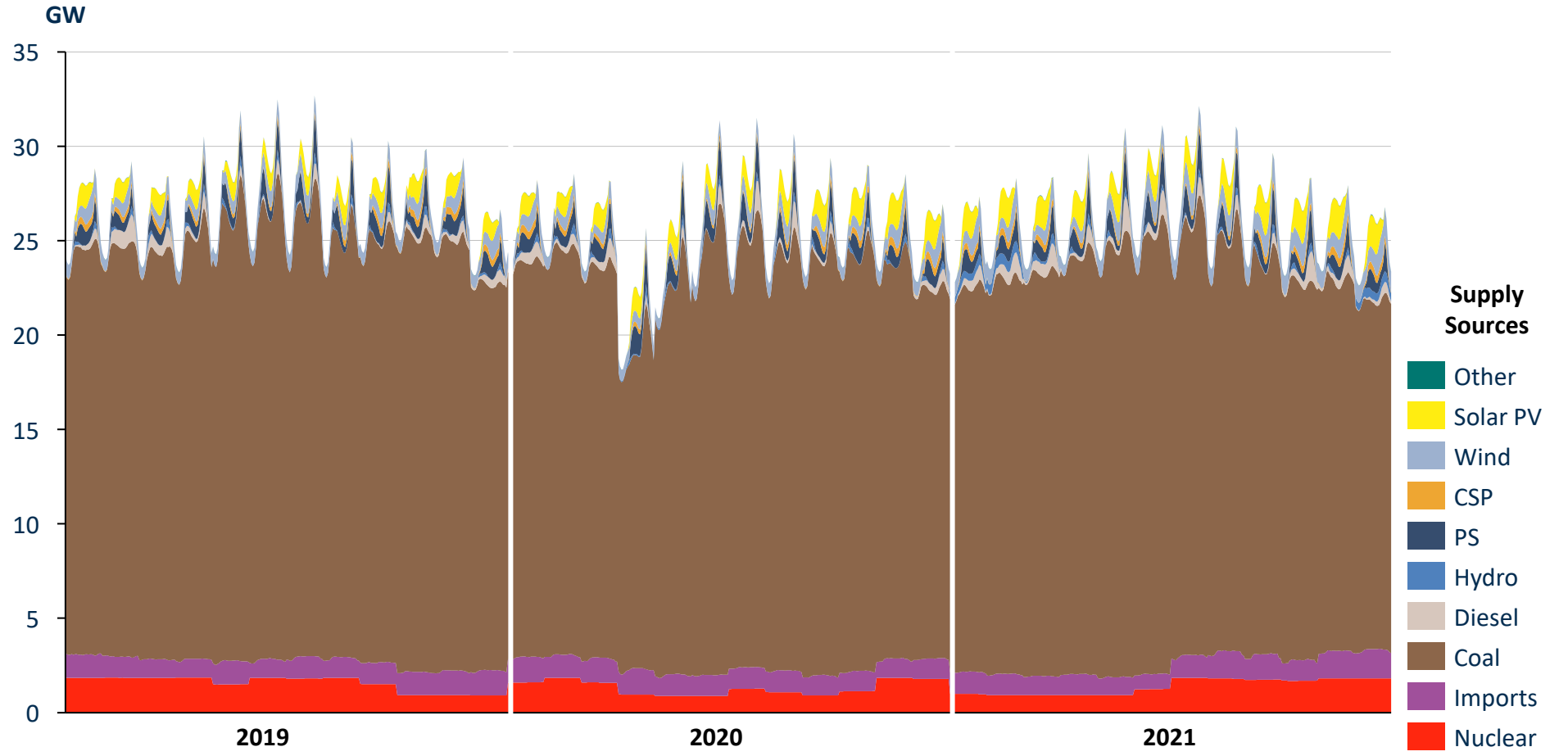
Actual monthly average diurnal courses of total power supply in RSA Jan 2016-Dec 2018



Note: Design as per Fraunhofer ISE. Pumping load excluded.
Sources: Eskom; CSIR Energy Centre analysis

Diurnal Courses of electricity supply sources in RSA

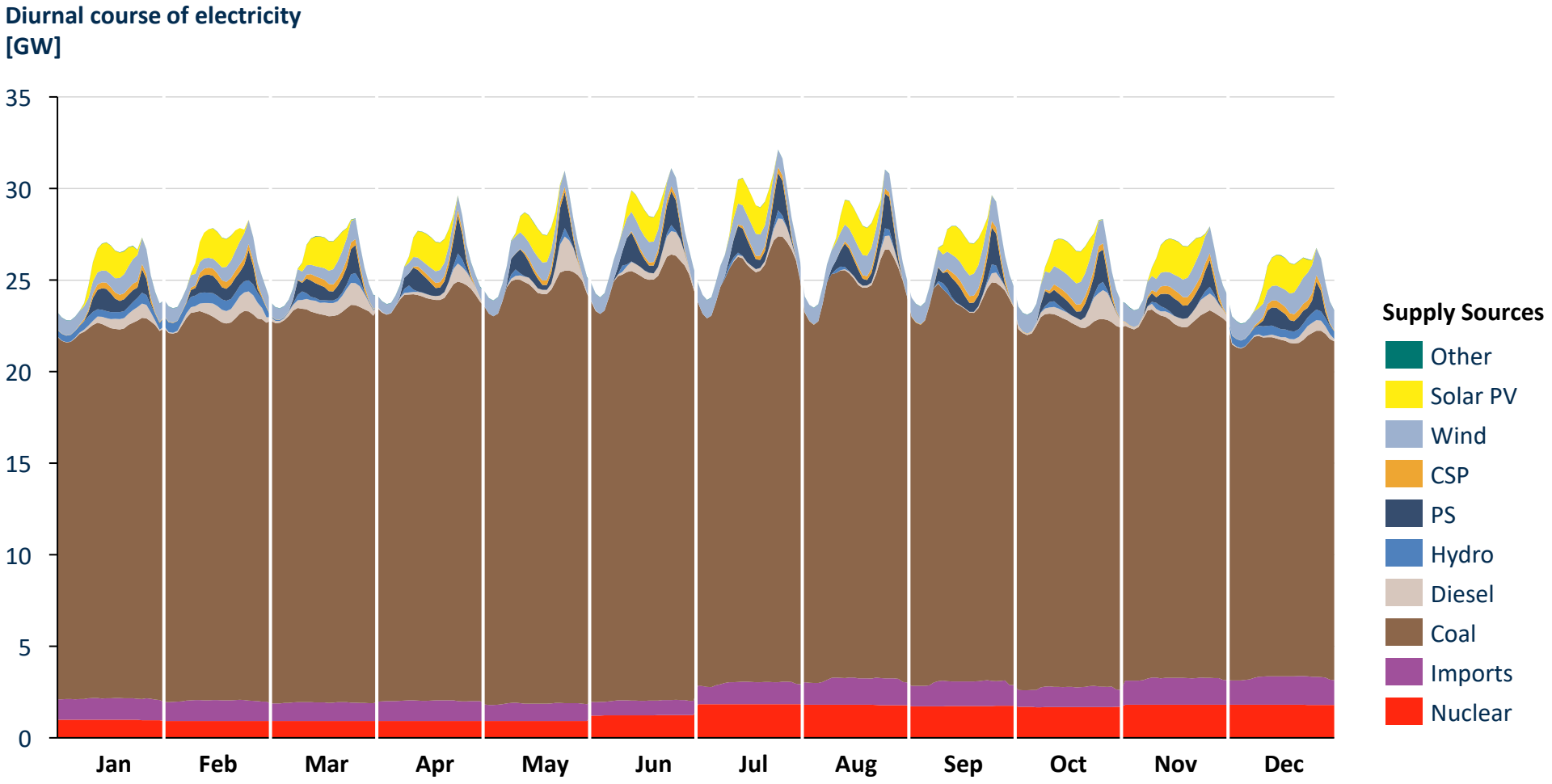
Actual monthly average diurnal courses of total power supply in RSA from Jan 2019-Dec 2021



Note: Design as per Fraunhofer ISE. Pumping load excluded.
Sources: Eskom; CSIR Energy Centre analysis

Diurnal Courses of electricity supply sources in RSA in 2021

Actual monthly average diurnal courses of the total power supply in RSA from Jan-Dec 2021



Note: Pumping load excluded.
Sources: Eskom; CSIR Energy Centre analysis

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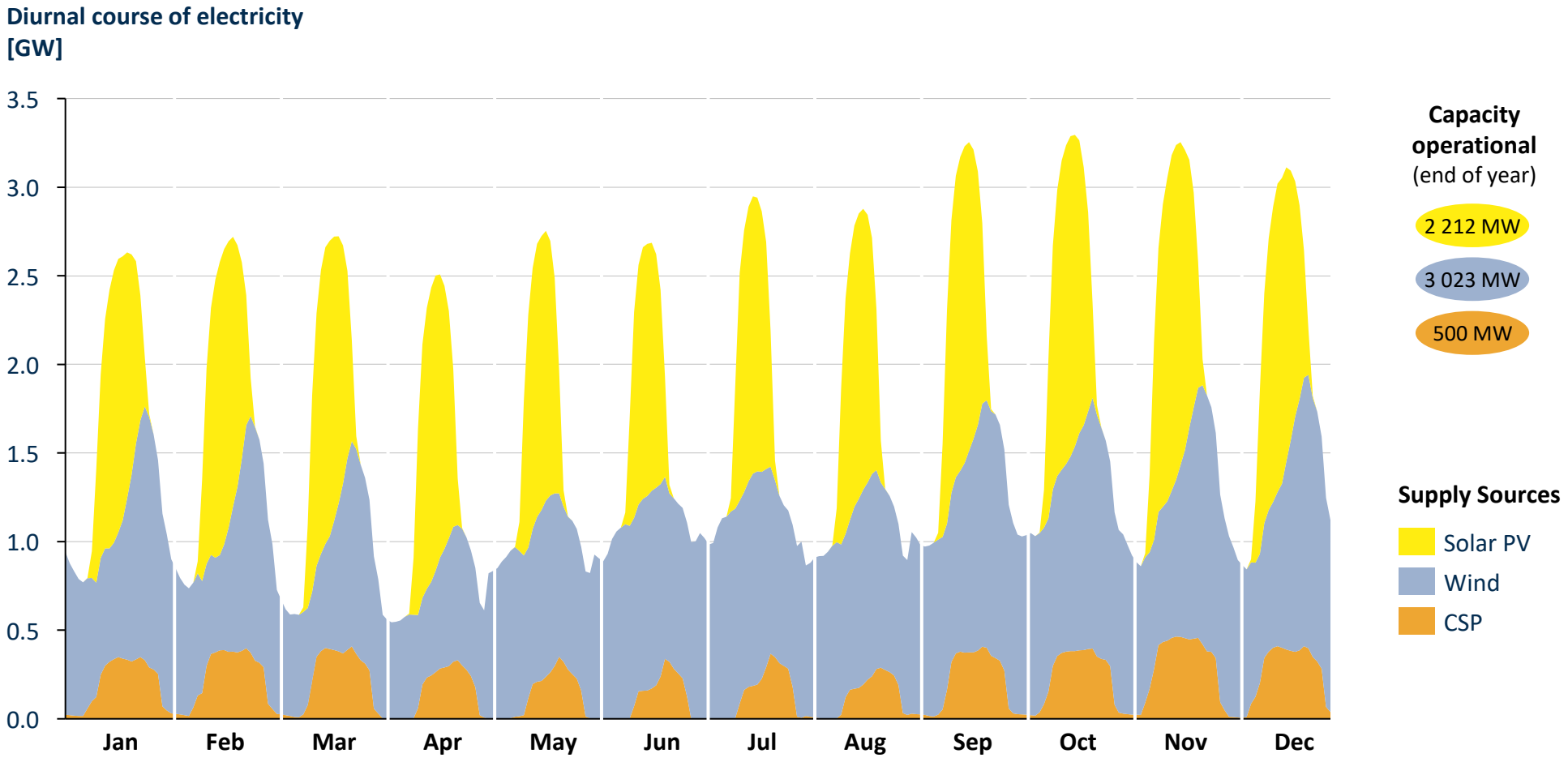
Diurnal Courses for renewable energy supply

Actual monthly average diurnal courses of solar PV, wind and CSP in RSA for the months Jan-Dec 2021



Note: Design as per Fraunhofer ISE
Sources: Eskom; CSIR Energy Centre analysis

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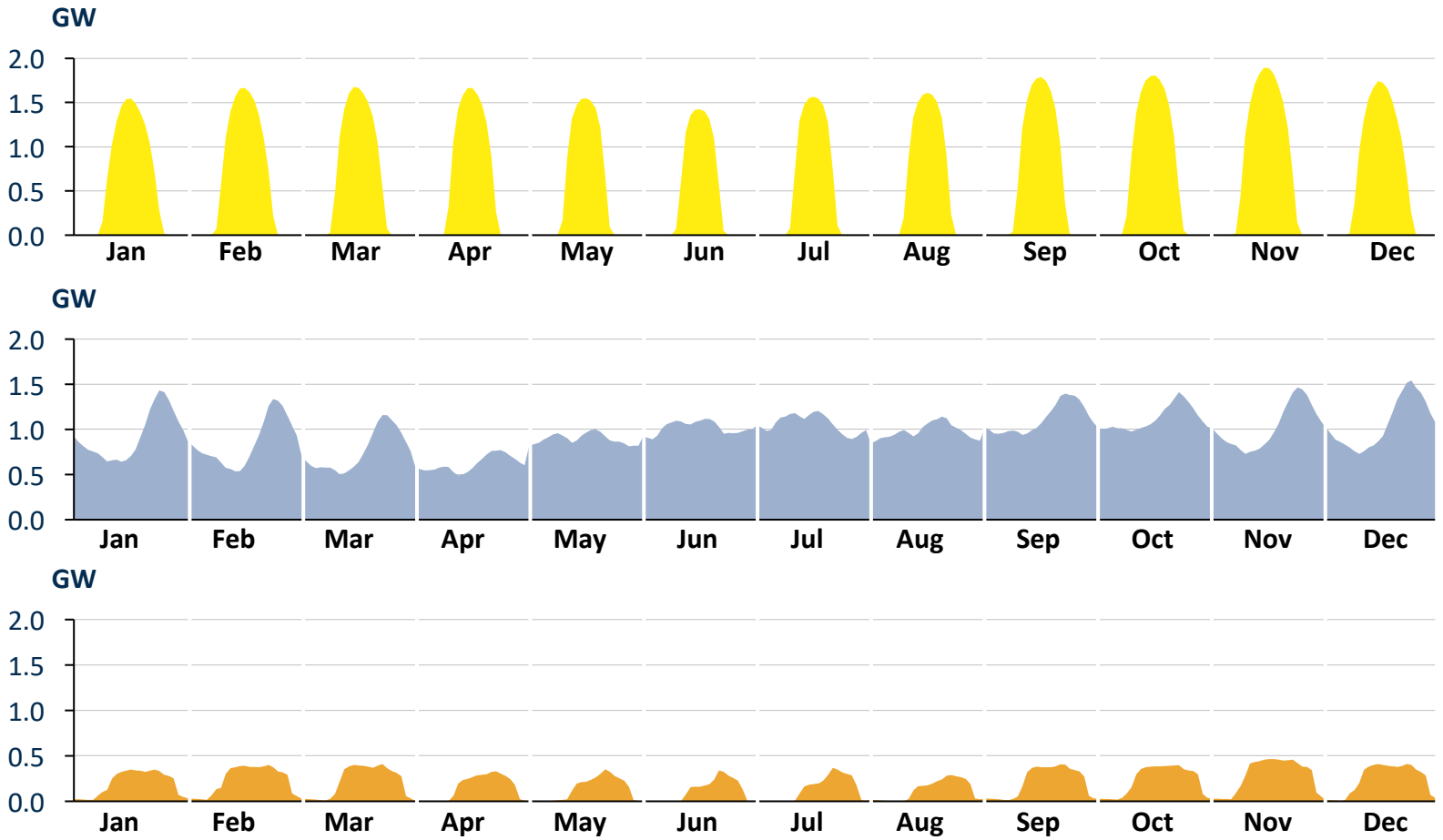
Diurnal Courses for renewable energy supply

Actual monthly average diurnal courses of solar PV, wind & CSP in RSA from Jan-Dec 2021



Capacity operational (end of year)

2 212 MW

3 023 MW

500 MW

Supply Sources

Solar PV

Wind

CSP

Note: Design as per Fraunhofer ISE

Sources: Eskom; CSIR Energy Centre analysis

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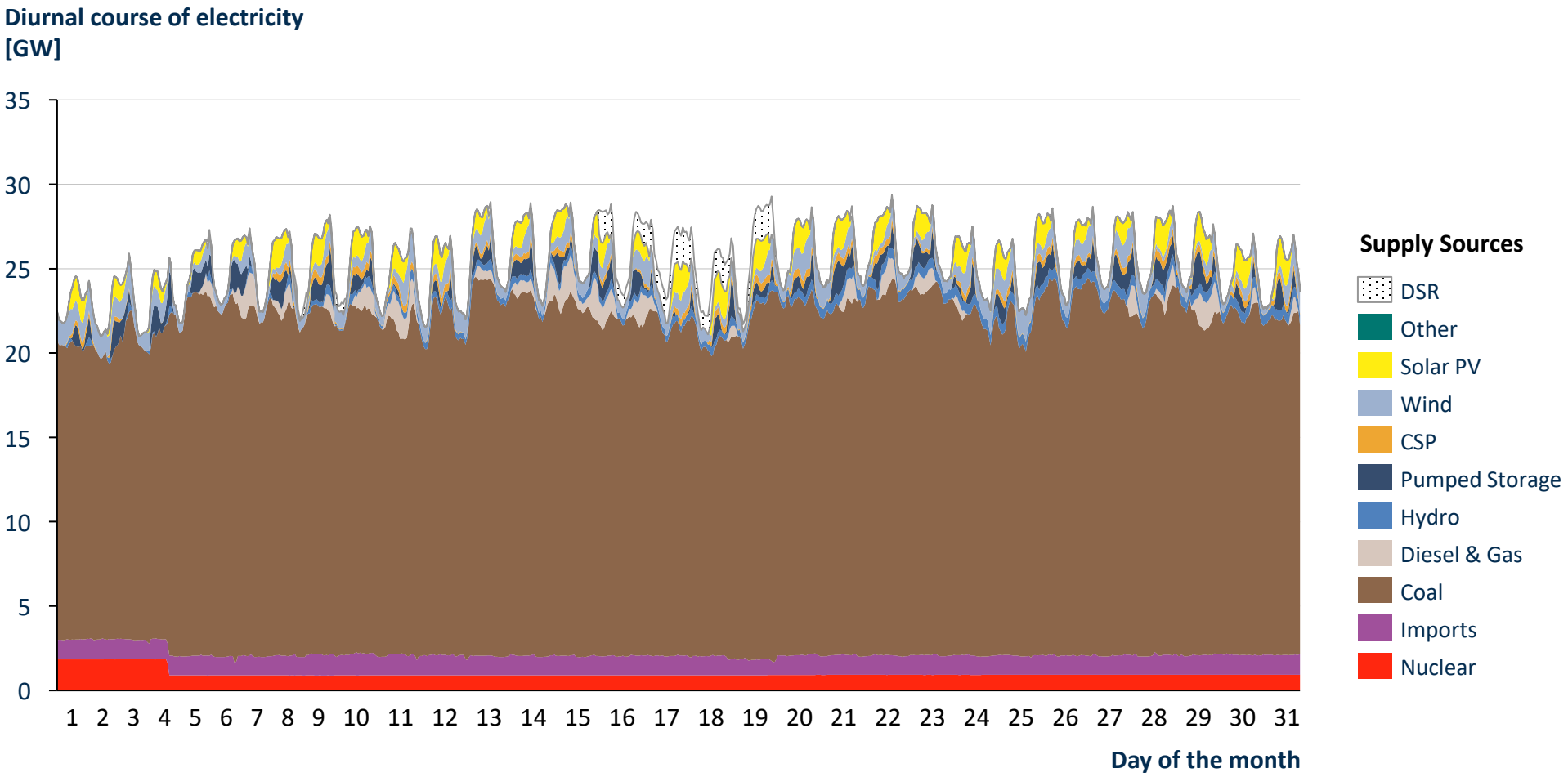
Hourly electricity production in Jan 2021

Actual hourly production from all power supply sources in RSA for January 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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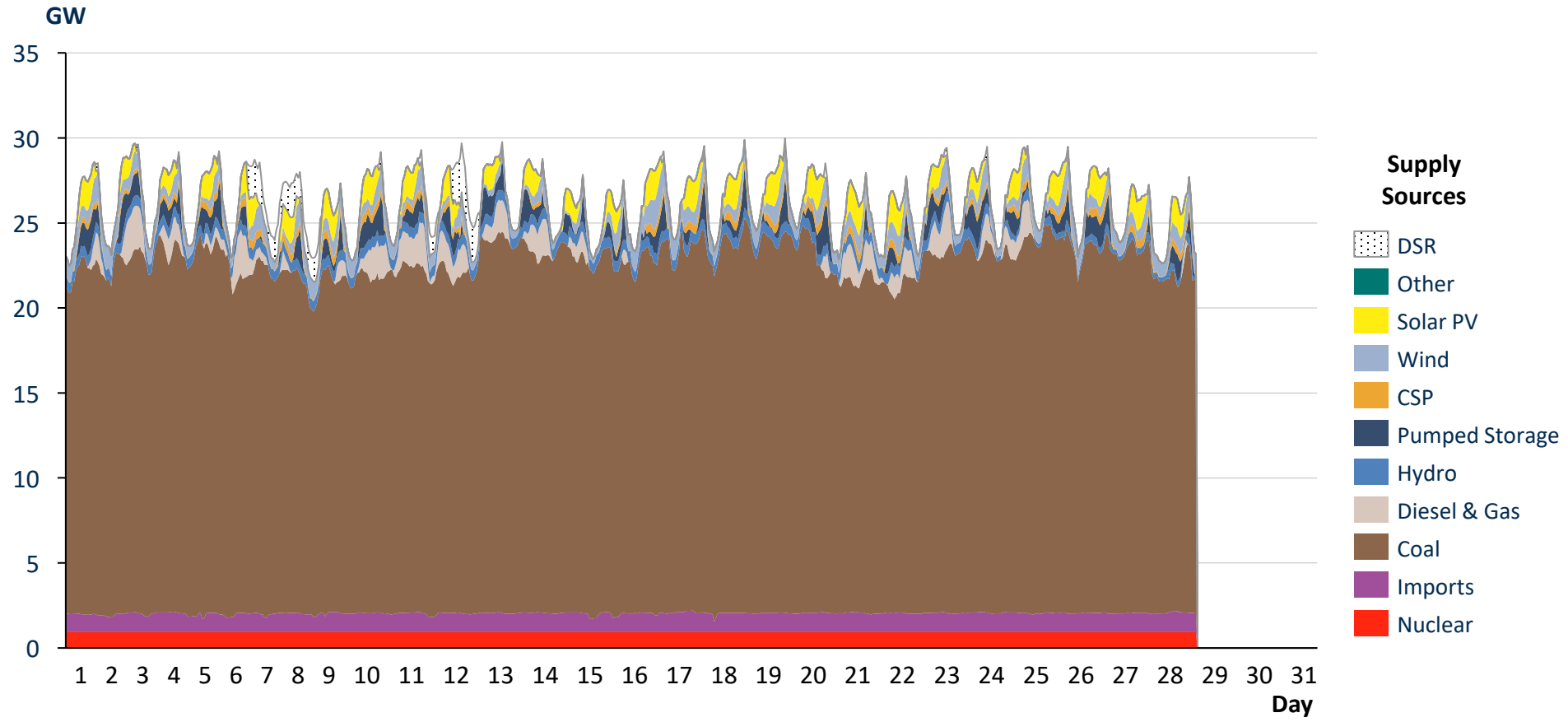
Hourly electricity production in Feb 2021

Actual hourly production from all power supply sources in RSA for February 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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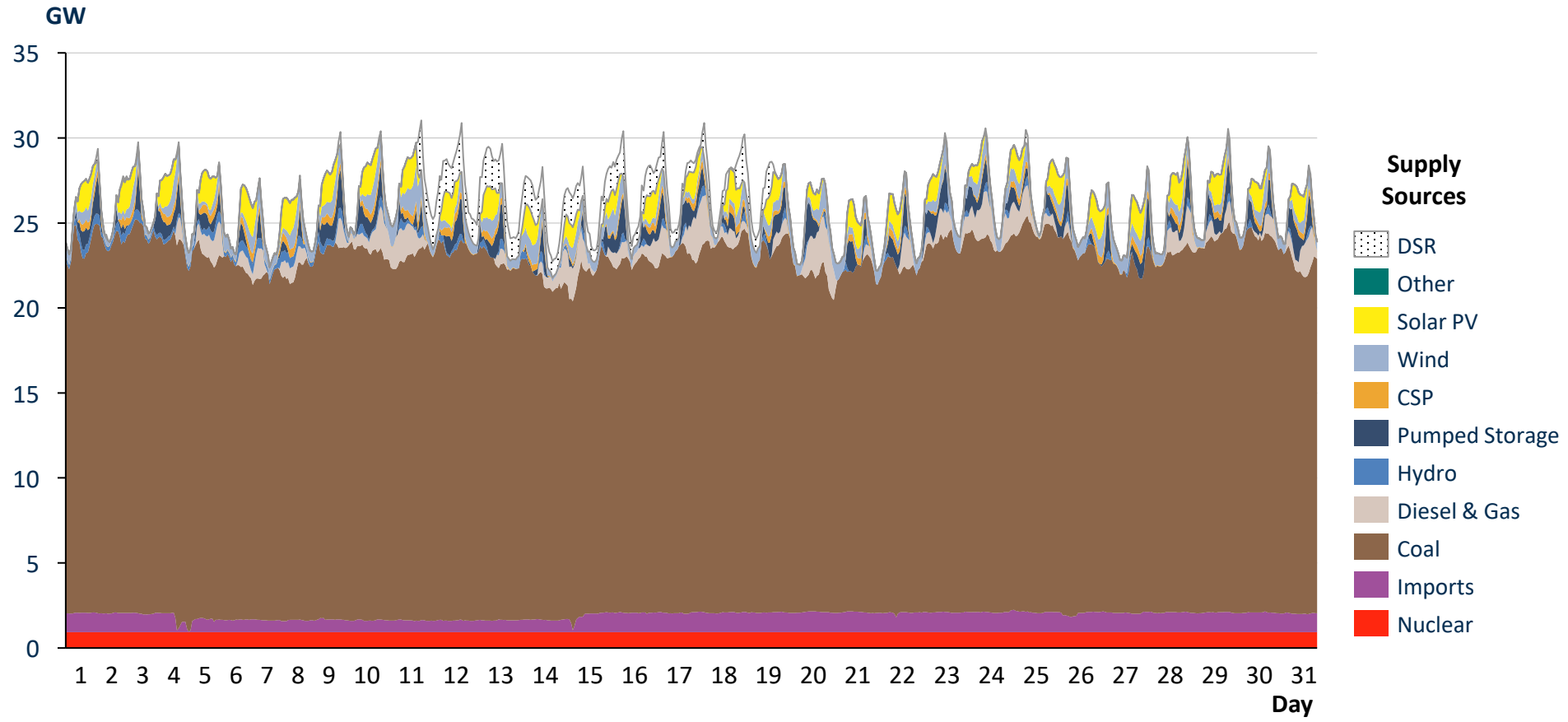
Hourly electricity production in Mar 2021

Actual hourly production from all power supply sources in RSA for March 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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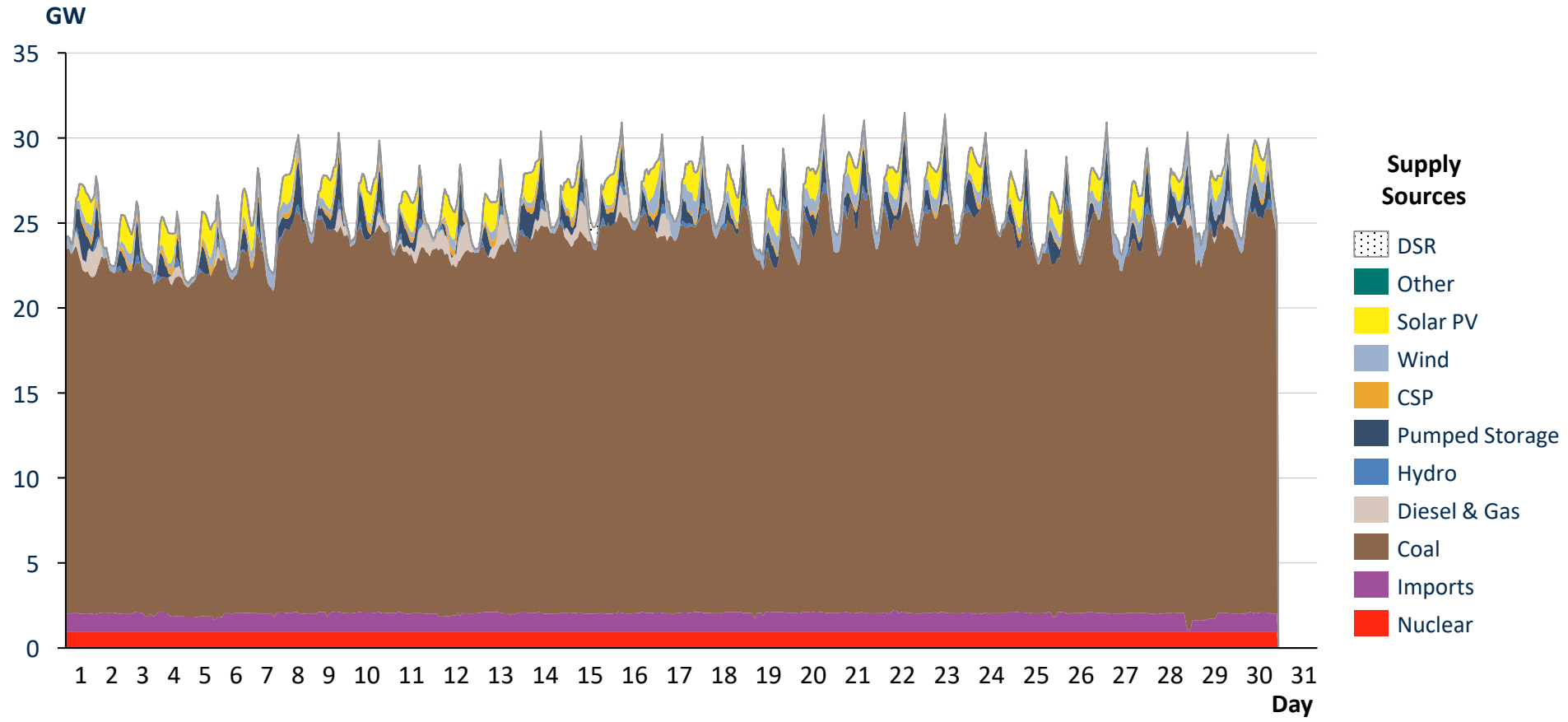
Hourly electricity production in Apr 2021

Actual hourly production from all power supply sources in RSA for April 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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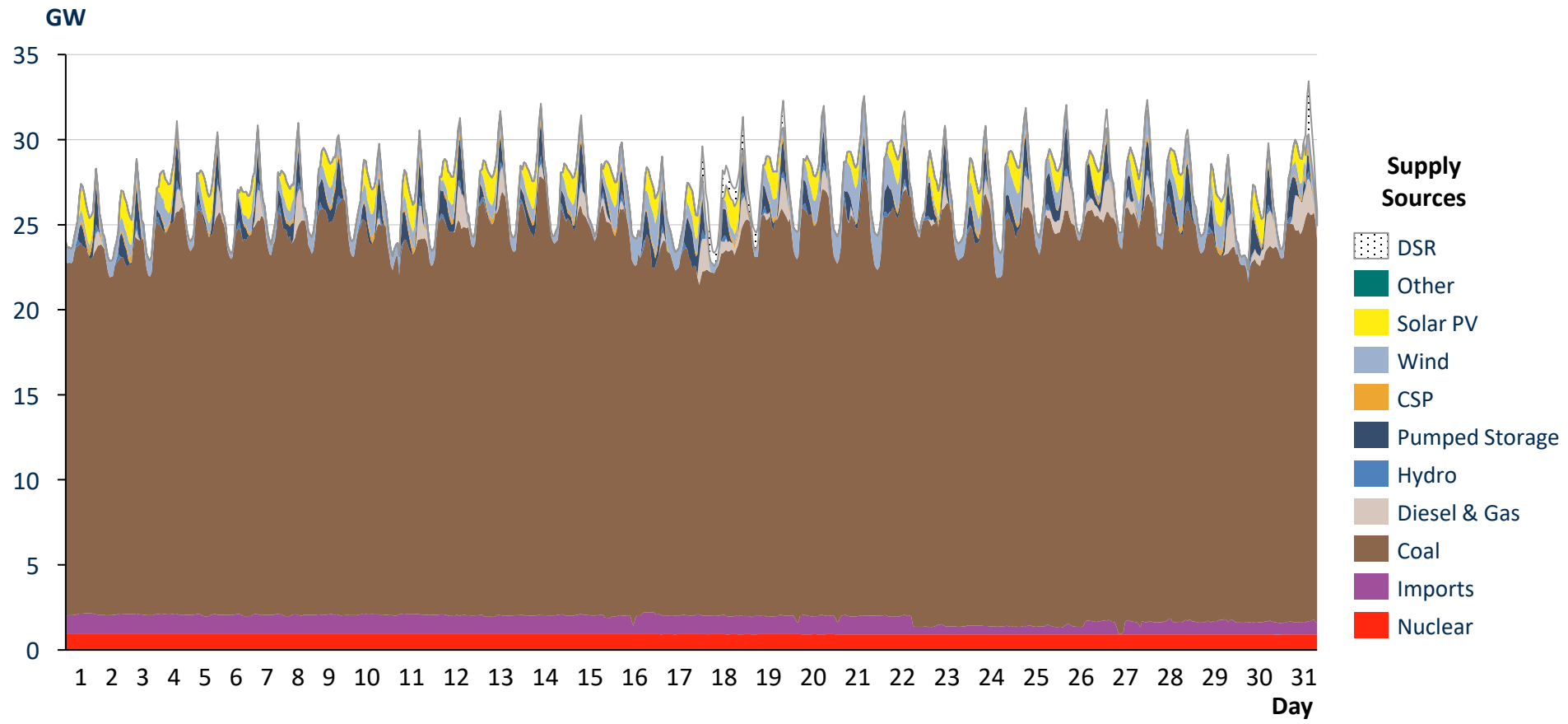
Hourly electricity production in May 2021

Actual hourly production from all power supply sources in RSA for May 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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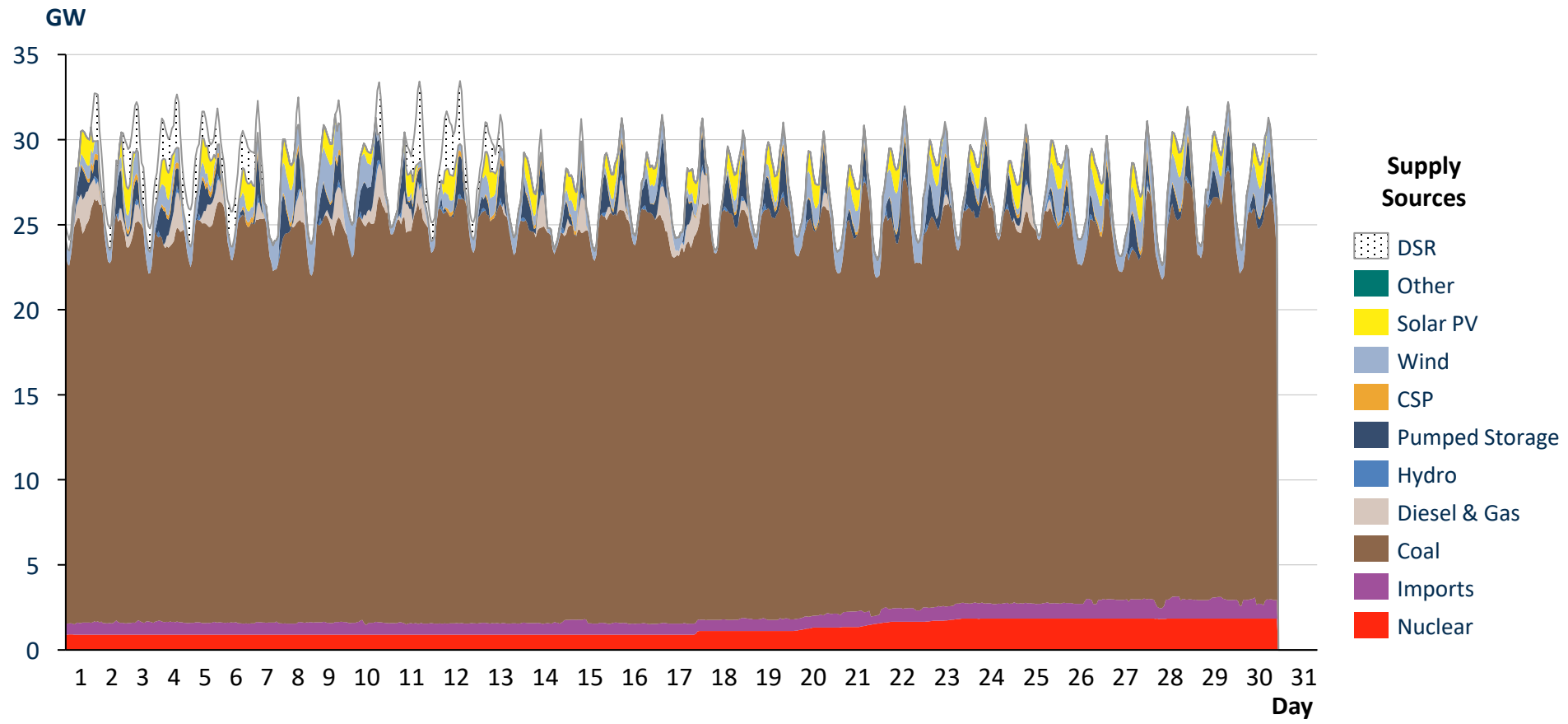
Hourly electricity production in Jun 2021

Actual hourly production from all power supply sources in RSA for June 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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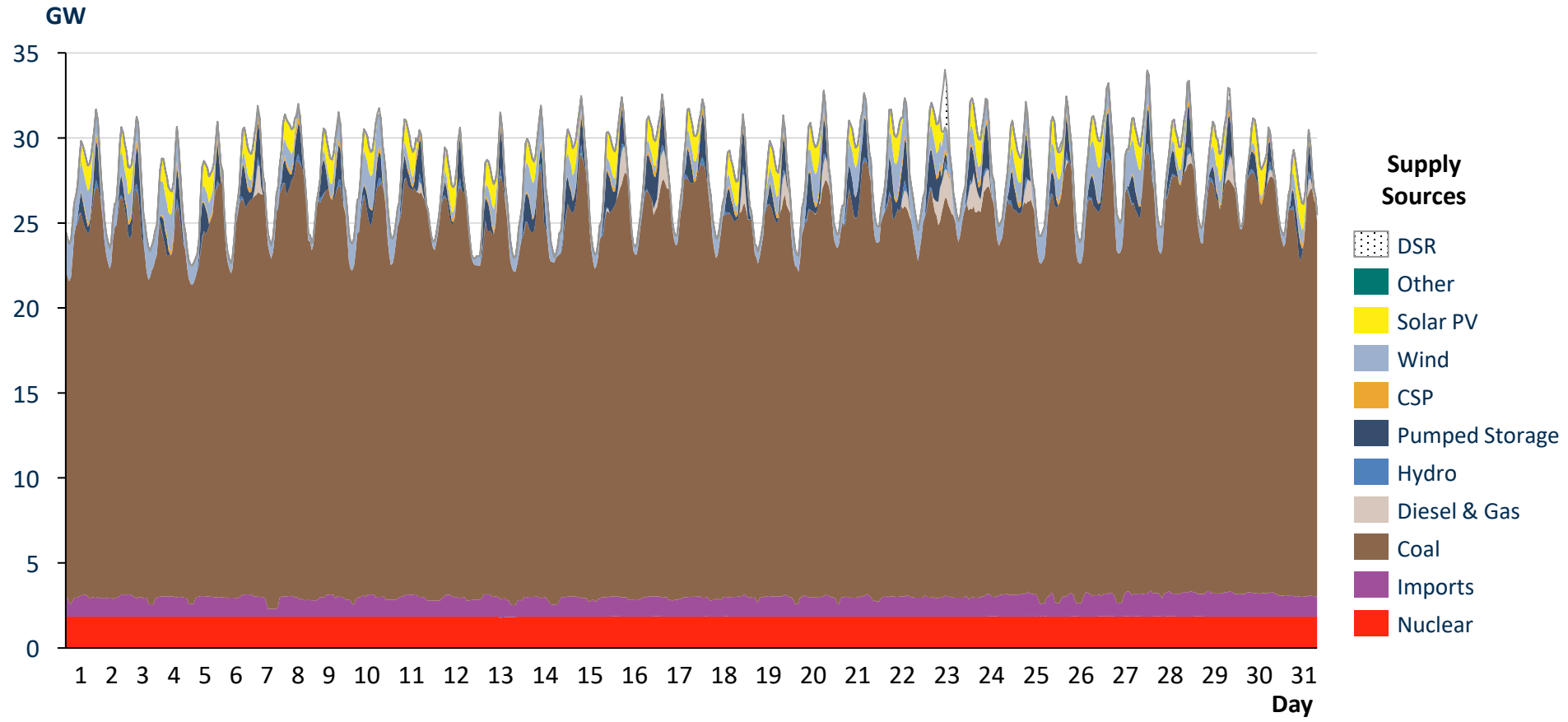
Hourly electricity production in Jul 2021

Actual hourly production from all power supply sources in RSA for July 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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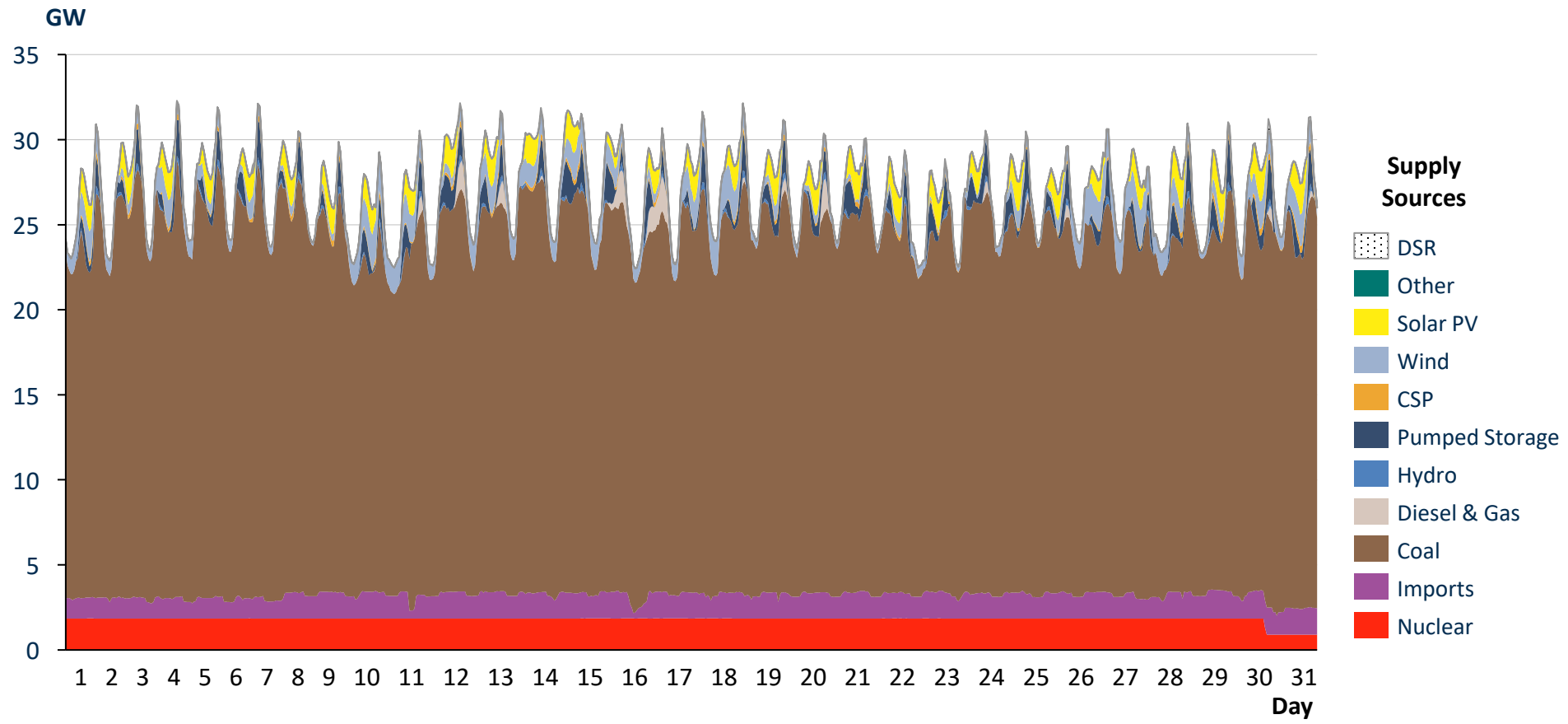
Hourly electricity production in Aug 2021

Actual hourly production from all power supply sources in RSA for August 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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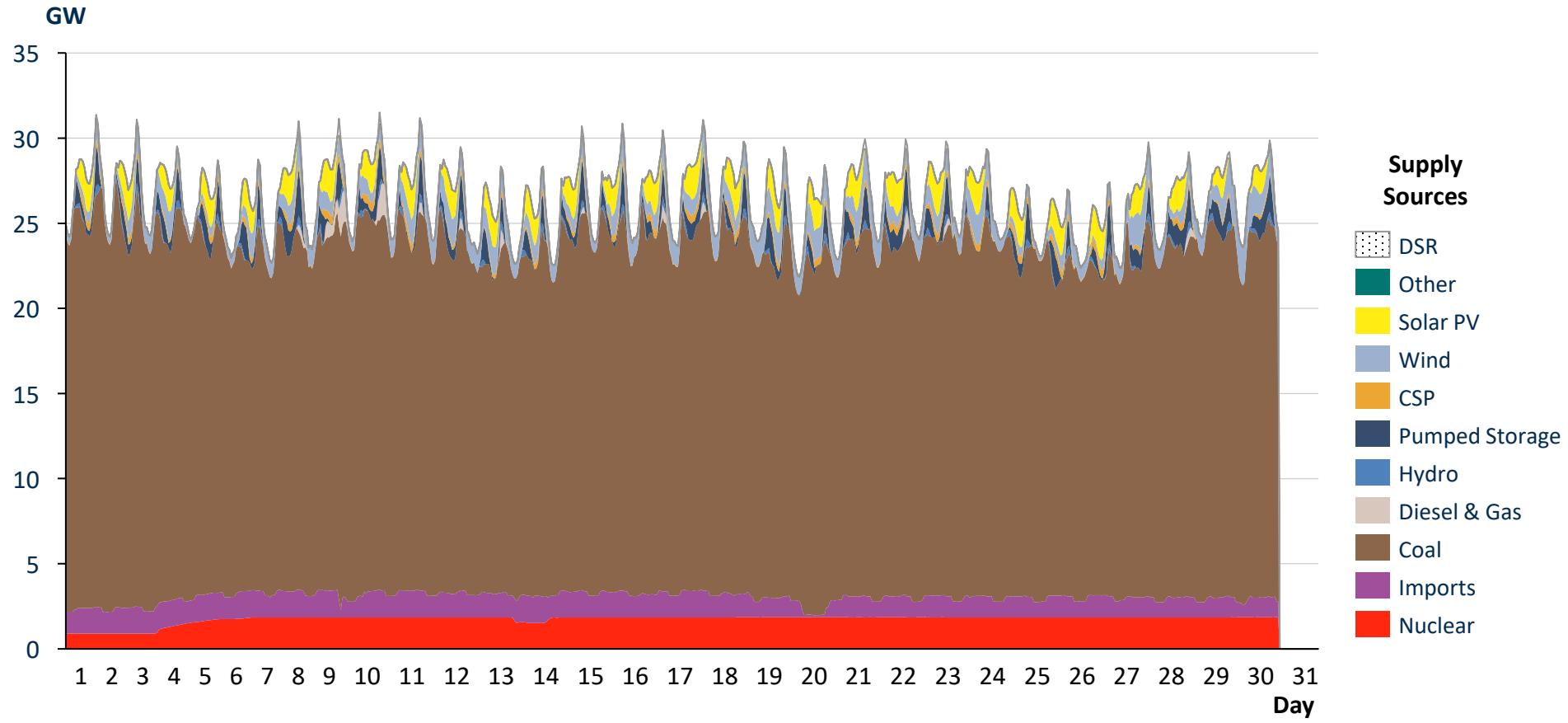
Hourly electricity production in Sep 2021

Actual hourly production from all power supply sources in RSA for September 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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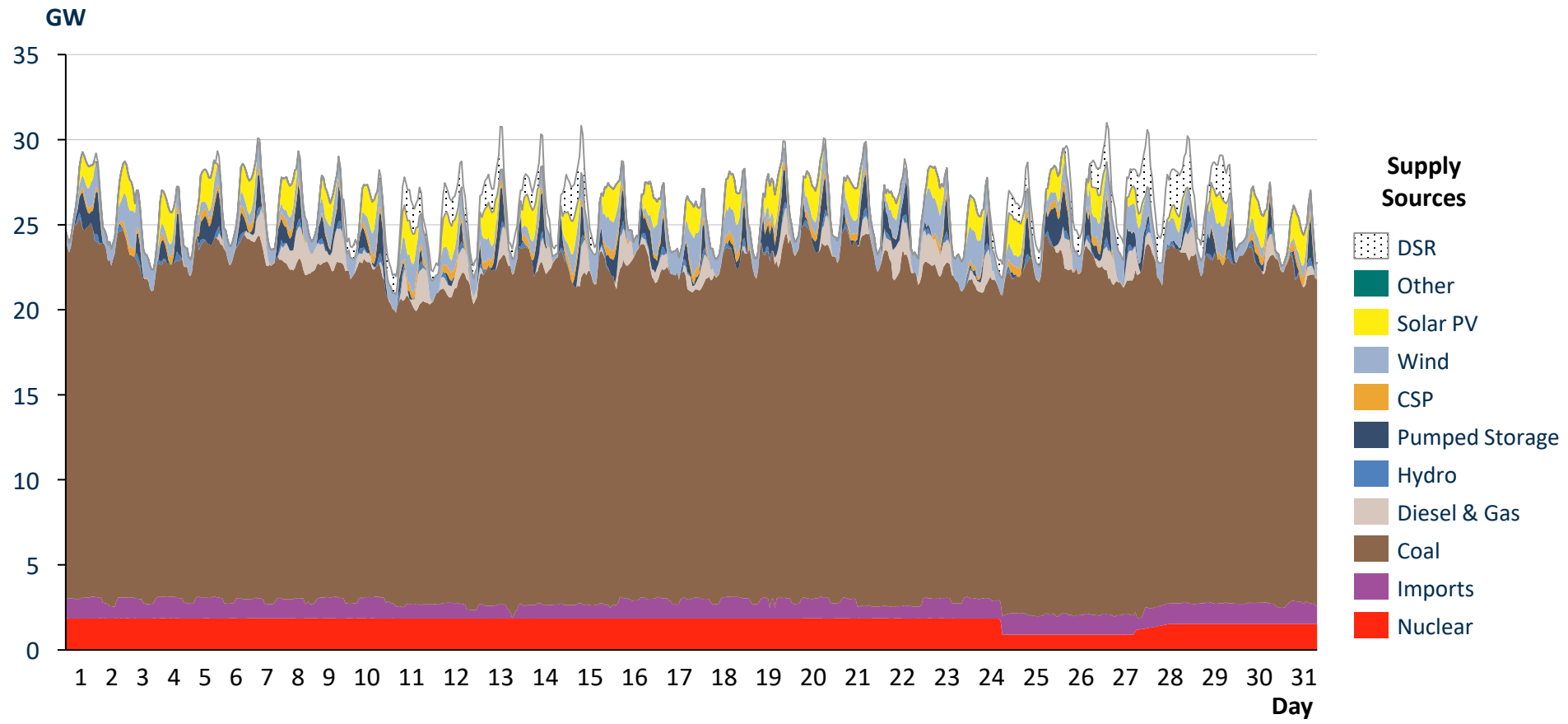
Hourly electricity production in Oct 2021

Actual hourly production from all power supply sources in RSA for October 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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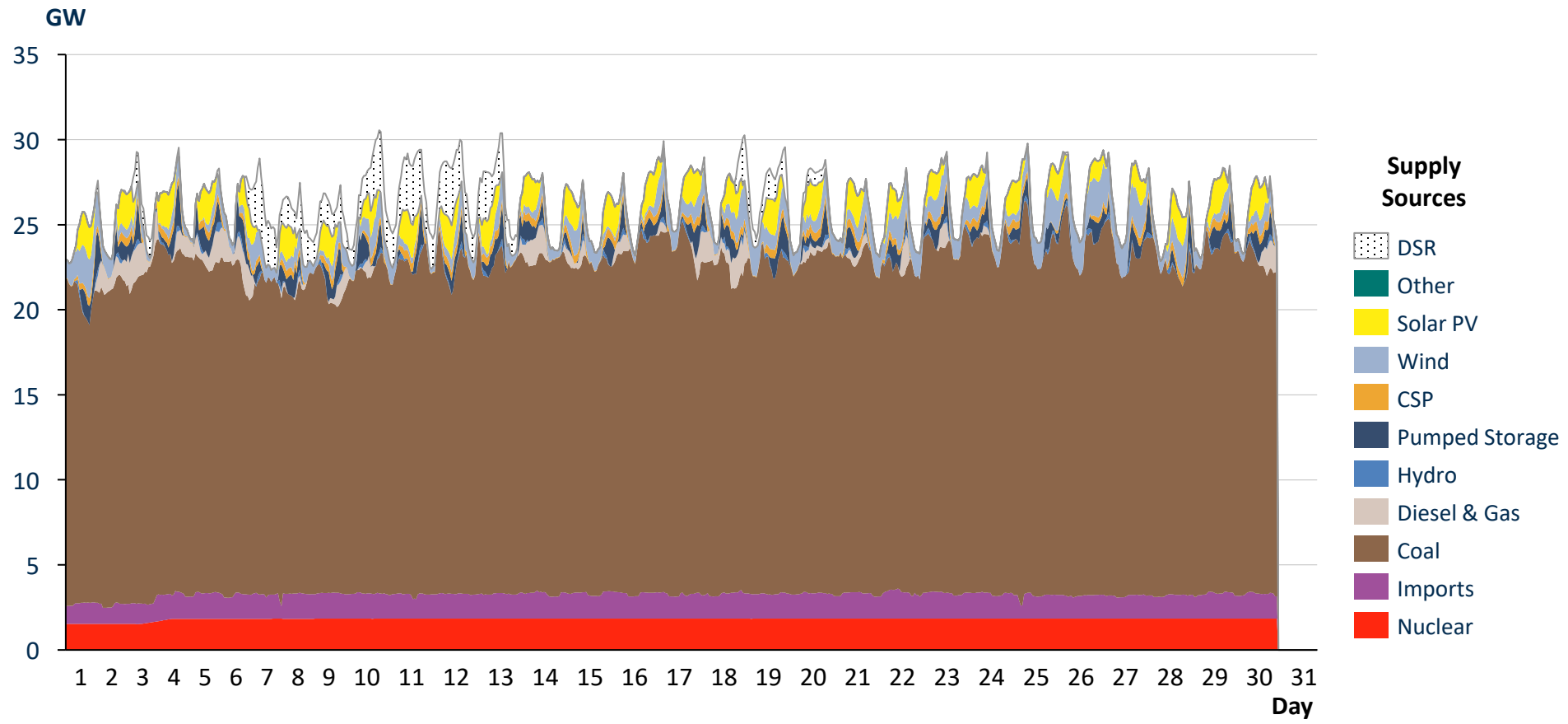
Hourly electricity production in Nov 2021

Actual hourly production from all power supply sources in RSA for November 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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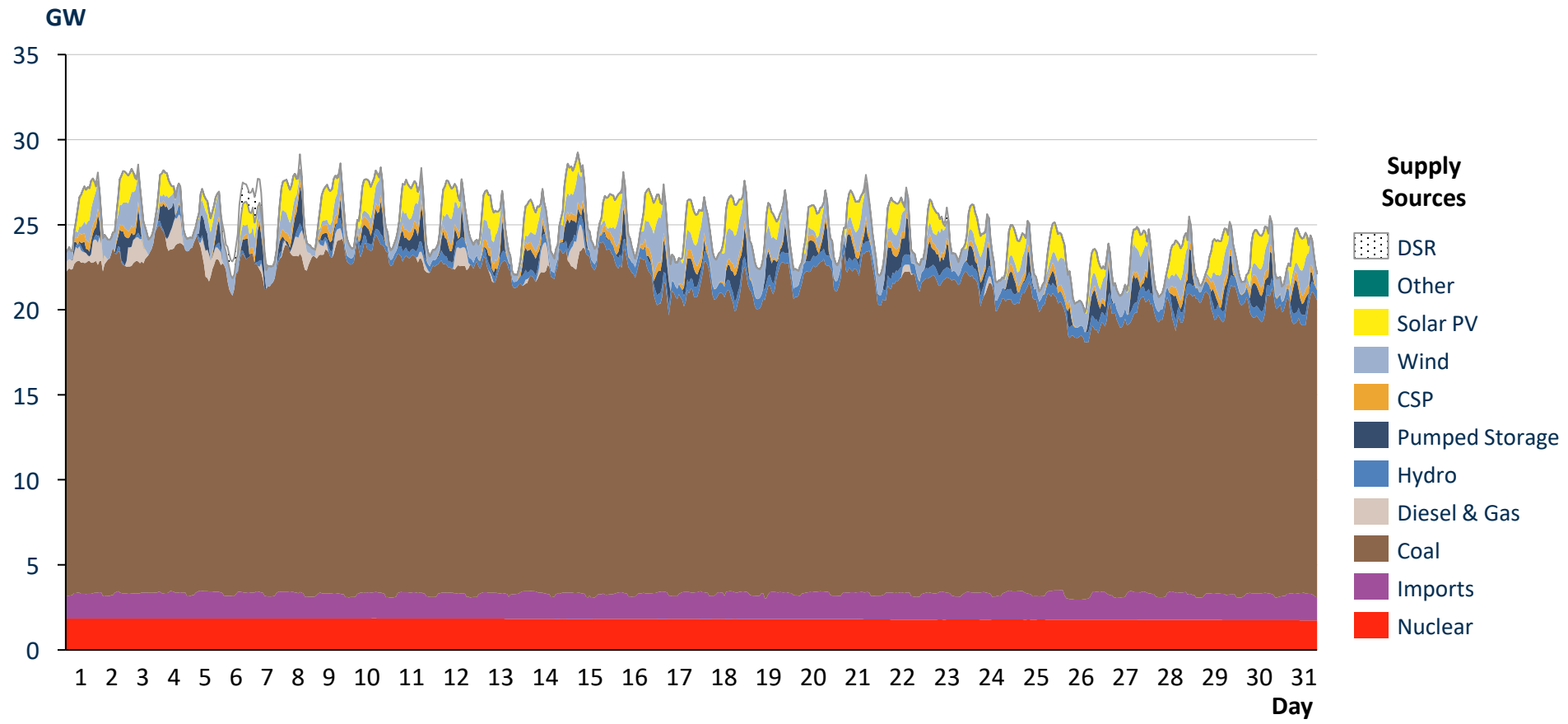
Hourly electricity production in Dec 2021

Actual hourly production from all power supply sources in RSA for December 2021



Note: Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

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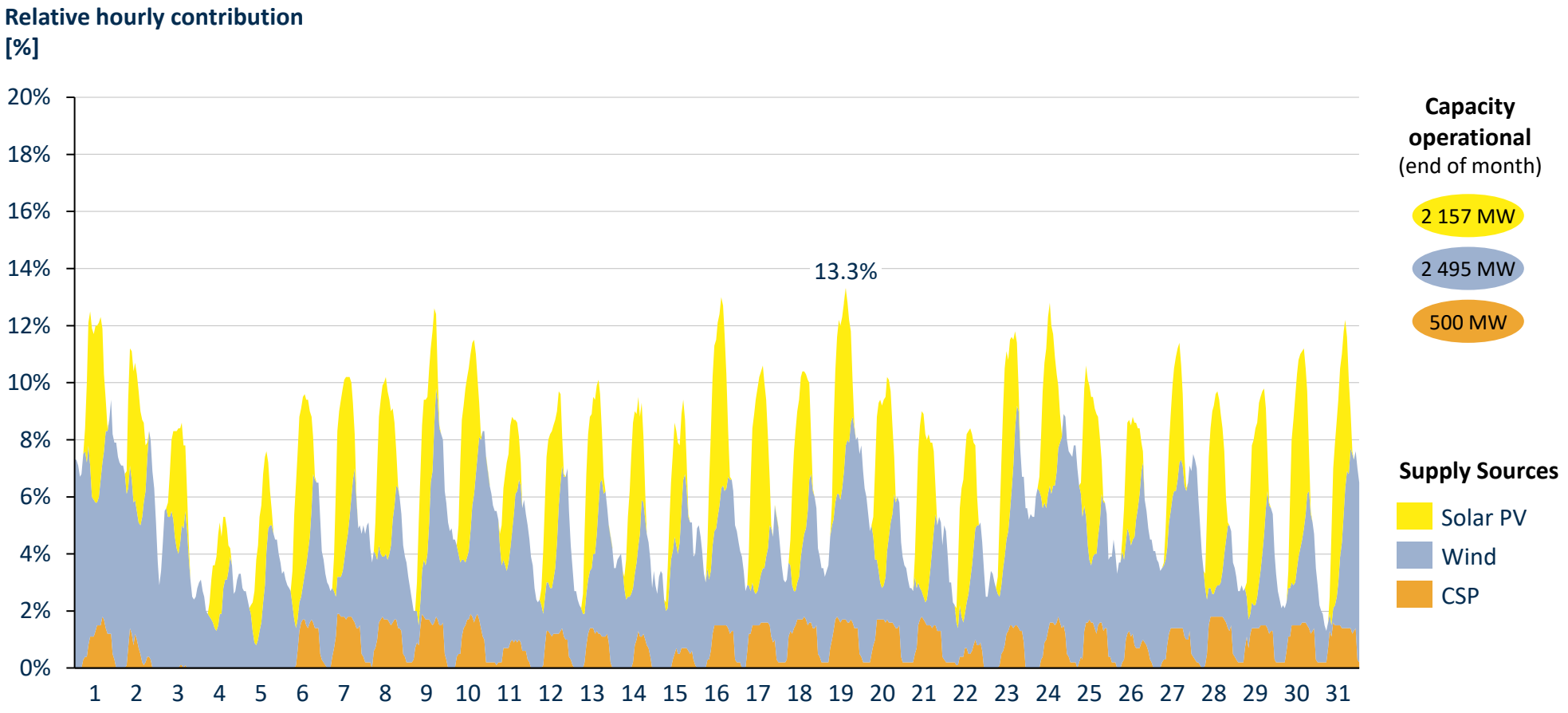
Hourly solar PV, wind & CSP contribution of 1.3-13.3% in Jan 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of the total supply in RSA for January 2021



- Solar PV maximum relative contribution of 7.2% between 12h00 and 13h00 on 17 Jan 2021
- Wind maximum relative contribution of 8.2% between 21h00 and 22h00 on 1 Jan 2021
- CSP maximum relative contribution of 1.9% between 09h00 and 10h00 on 7 Jan 2021

Sources: Eskom; CSIR Energy Centre analysis

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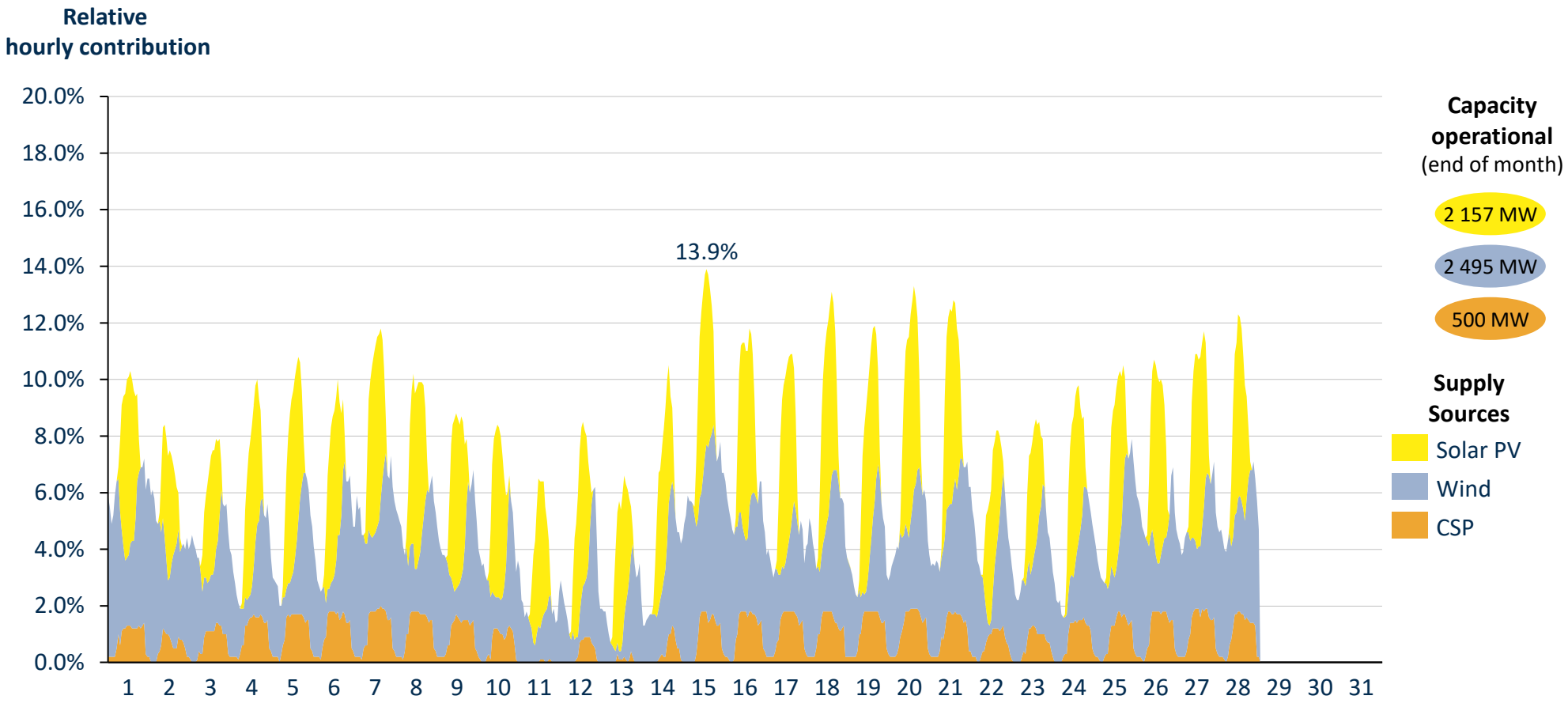
Hourly solar PV, wind & CSP contribution of 0.7-13.9% in Feb 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for February 2021



- Maximum solar PV relative contribution of 7.3% between 13h00 and 14h00 on 20 Feb 2021
- Maximum wind relative contribution of 6.7% between 17h00 and 18h00 on 15 Feb 2021
- Maximum CSP relative contribution of 2.0% between 15h00 and 16h00 on 7 Feb 2021

Sources: Eskom; CSIR Energy Centre analysis

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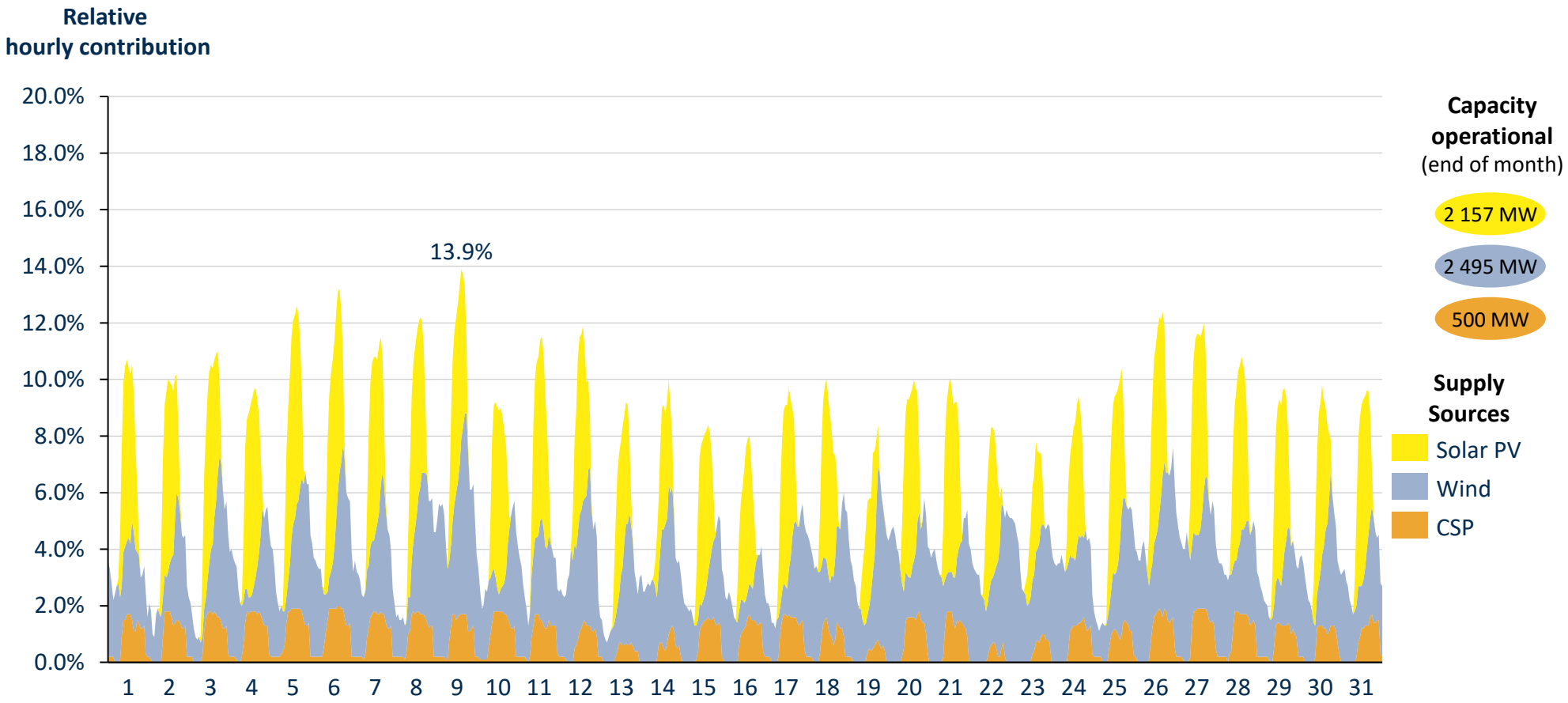
Hourly solar PV, wind & CSP contribution of 0.7-13.9% in Mar 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for March 2021



- Maximum solar PV relative contribution of 7.3% between 12h00 and 13h00 on 6 Mar 2021
- Maximum wind relative contribution of 7.1% between 17h00 and 18h00 on 9 Mar 2021
- Maximum CSP relative contribution of 2.0% between 15h00 and 16h00 on 6 Mar 2021

Sources: Eskom; CSIR Energy Centre analysis

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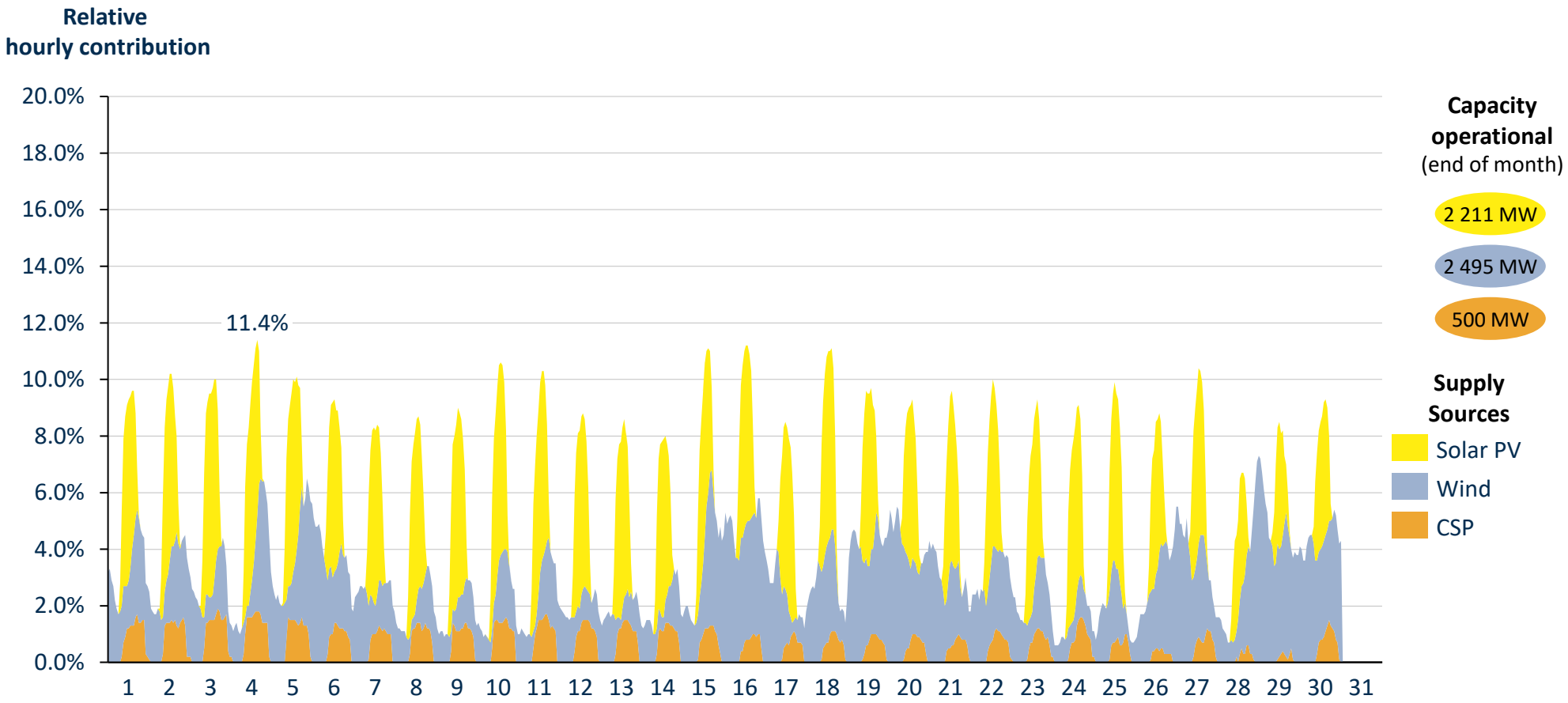
Hourly solar PV, wind & CSP contribution of 0.6-11.4% in Apr 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for April 2021



- Maximum solar PV relative contribution of 7.3% between 13h00 and 14h00 on 3 Apr 2021
- Maximum wind relative contribution of 7.3% between 23h00 and 24h00 on 29 Apr 2021
- Maximum CSP relative contribution of 1.9% between 16h00 and 17h00 on 3 Apr 2021

Sources: Eskom; CSIR Energy Centre analysis

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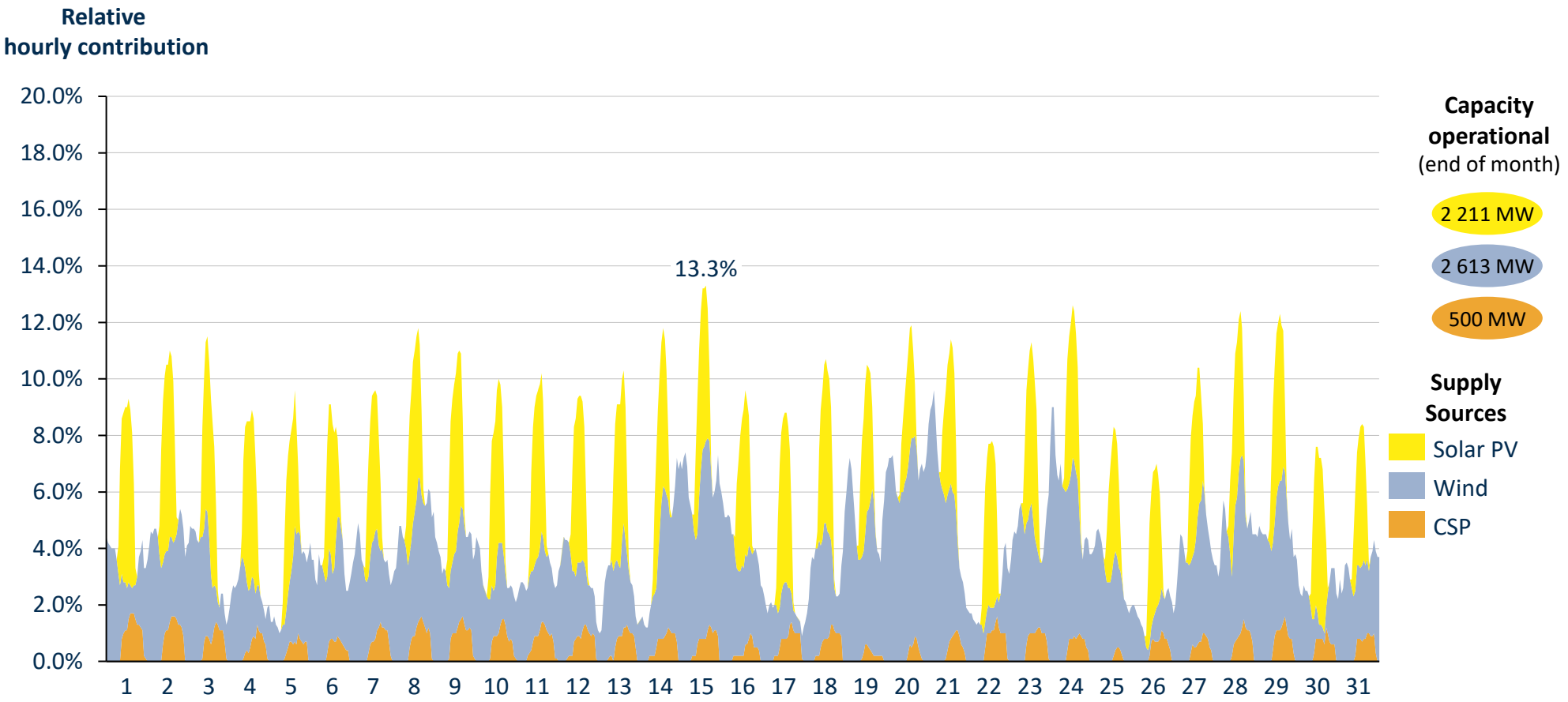
Hourly solar PV, wind & CSP contribution of 0.9-13.3% in May 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for May 2021



- Maximum solar PV relative contribution of 6.6% between 13h00 and 14h00 on 2 May 2020
- Maximum wind relative contribution of 9.6% between 03h00 and 04h00 on 21 May 2021
- Maximum CSP relative contribution of 1.7% between 16h00 and 17h00 on 1 May 2021

Sources: Eskom; CSIR Energy Centre analysis

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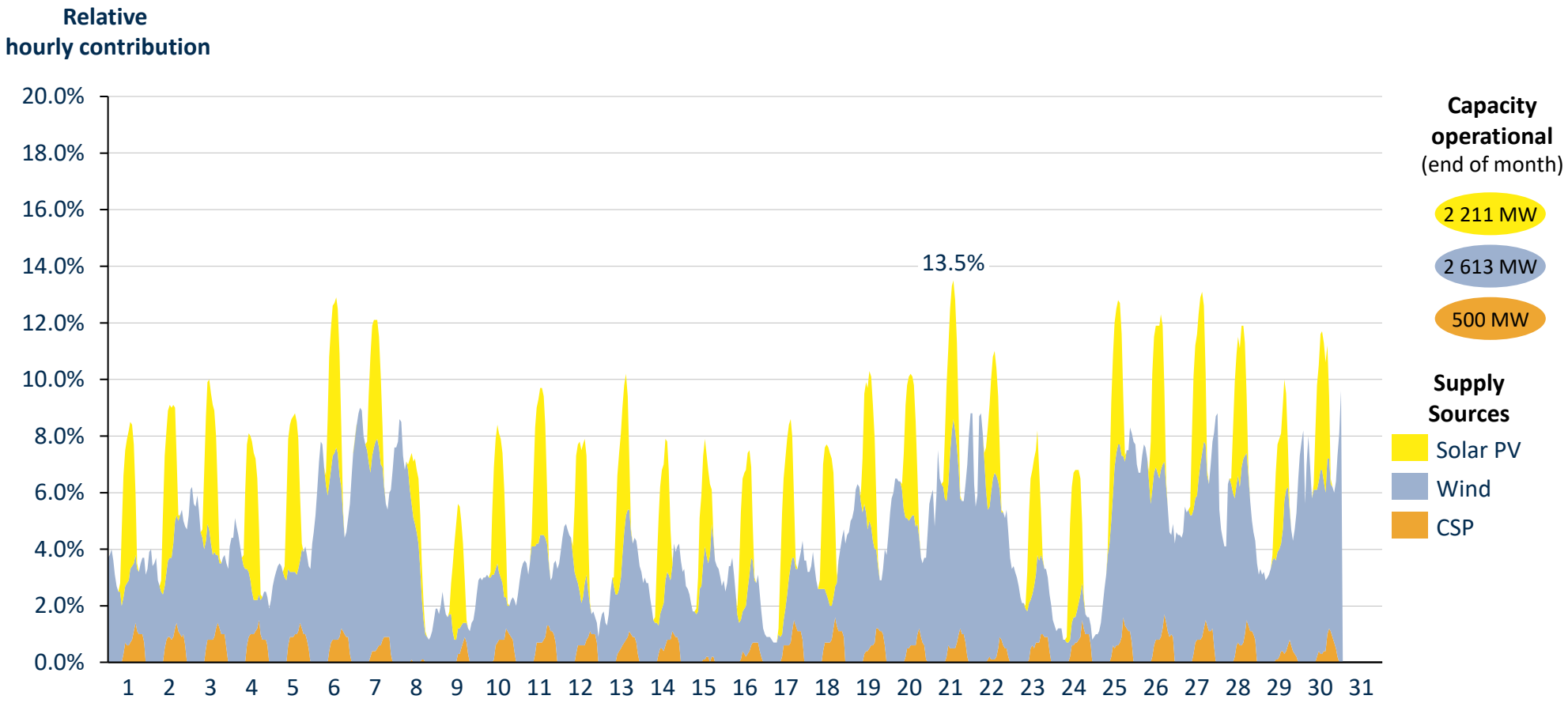
Hourly solar PV, wind & CSP contribution of 0.7-13.5% in Jun 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for June 2021



- Maximum solar PV relative contribution of 5.9% between 13h00 and 14h00 on 27 Jun 2021
- Maximum wind relative contribution of 9.6% between 23h00 and 00h00 on 31 Jun 2021
- Maximum CSP relative contribution of 1.7% between 16h00 and 17h00 on 26 Jun 2021

Sources: Eskom; CSIR Energy Centre analysis

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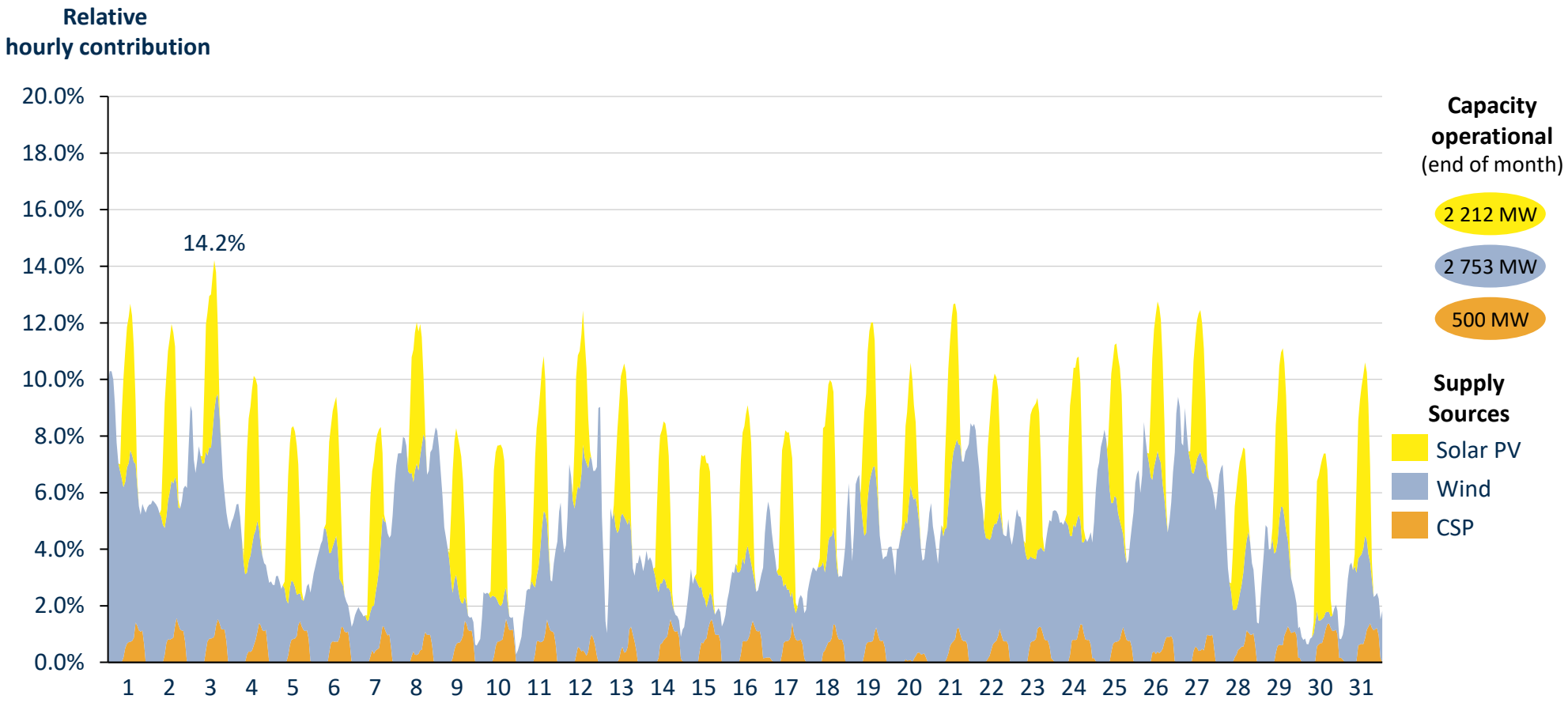
Hourly solar PV, wind & CSP contribution of 0.3-14.2% in Jul 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for July 2021



- Maximum solar PV relative contribution of 6.1% between 14h00 and 15h00 on 31 Jul 2021
- Maximum wind relative contribution of 10.3% between 01h00 and 02h00 on 1 Jul 2021
- Maximum CSP relative contribution of 1.6% between 16h00 and 17h00 on 2 Jul 2021

Sources: Eskom; CSIR Energy Centre analysis

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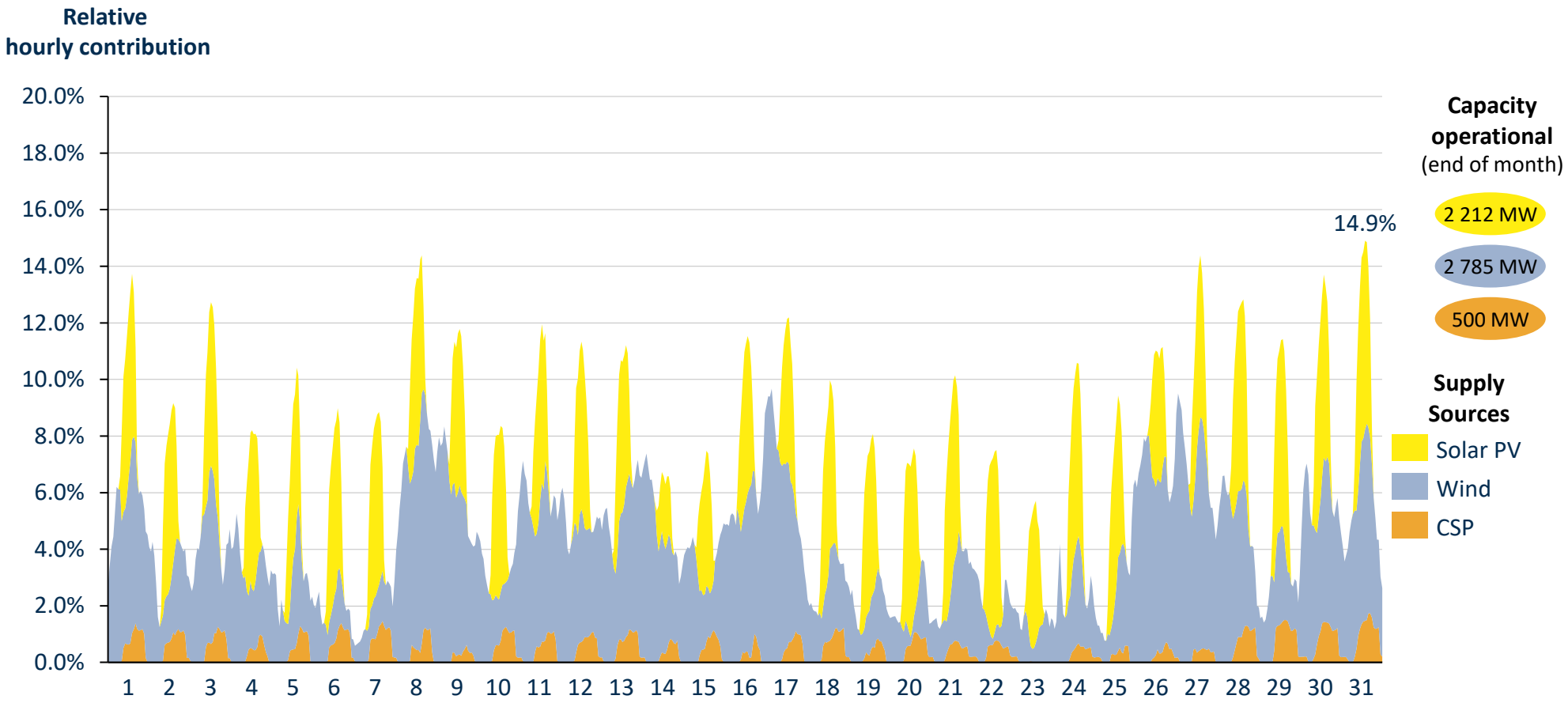
Hourly solar PV, wind & CSP contribution of 0.6-14.9% in Aug 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for August 2021



- Maximum solar PV relative contribution of 6.7% between 13h00 and 14h00 on 31 Aug 2021
- Maximum wind relative contribution of 9.7% between 03h00 and 04h00 on 17 Aug 2021
- Maximum CSP relative contribution of 1.7% between 16h00 and 17h00 on 31 Aug 2021

Sources: Eskom; CSIR Energy Centre analysis

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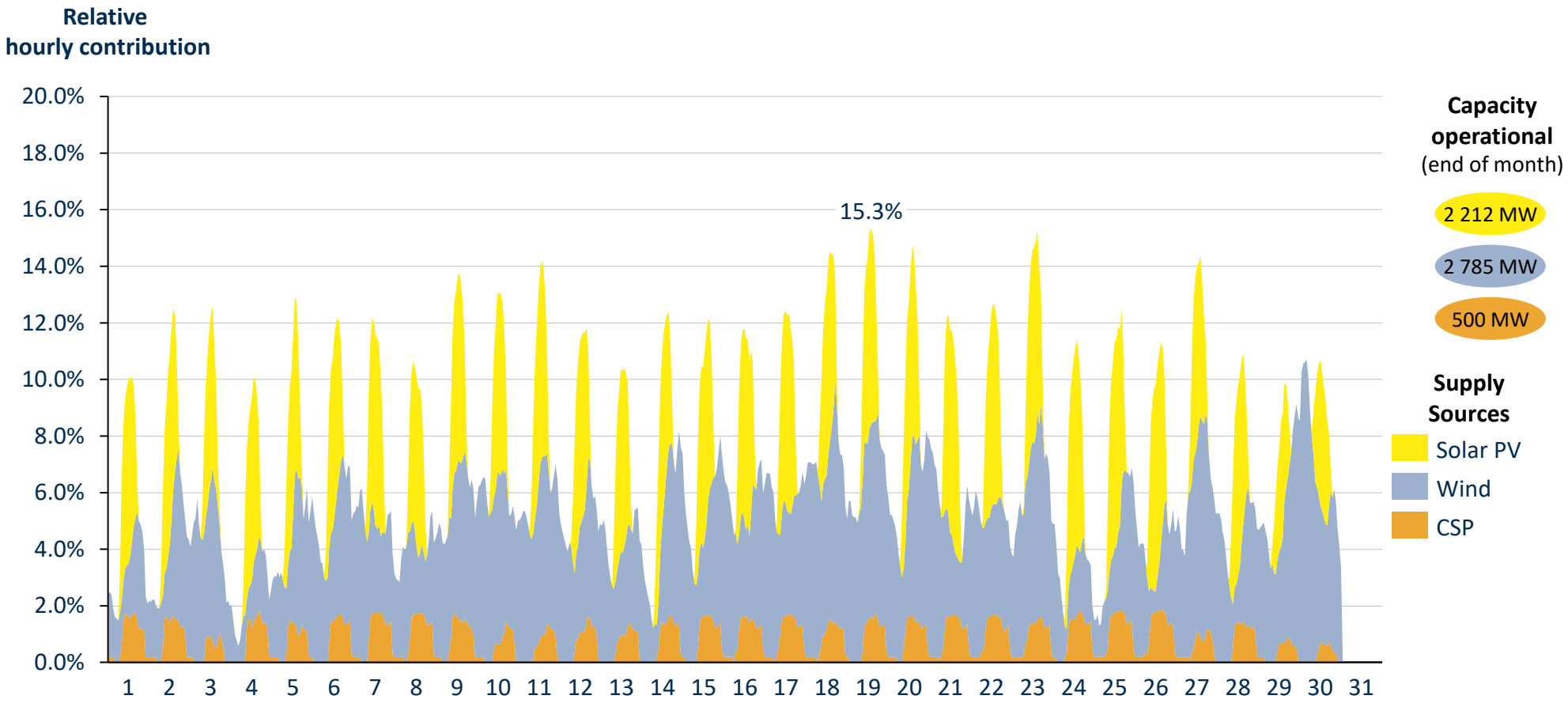
Hourly solar PV, wind & CSP contribution of 0.6-15.3% in Sep 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for September 2021



- Maximum solar PV relative contribution of 7.5% between 12h00 and 13h00 on 26 Sep 2021
- Maximum wind relative contribution of 10.7% between 03h00 and 04h00 on 30 Sep 2021
- Maximum CSP relative contribution of 1.9% between 16h00 and 17h00 on 4 Sep 2021

Sources: Eskom; CSIR Energy Centre analysis

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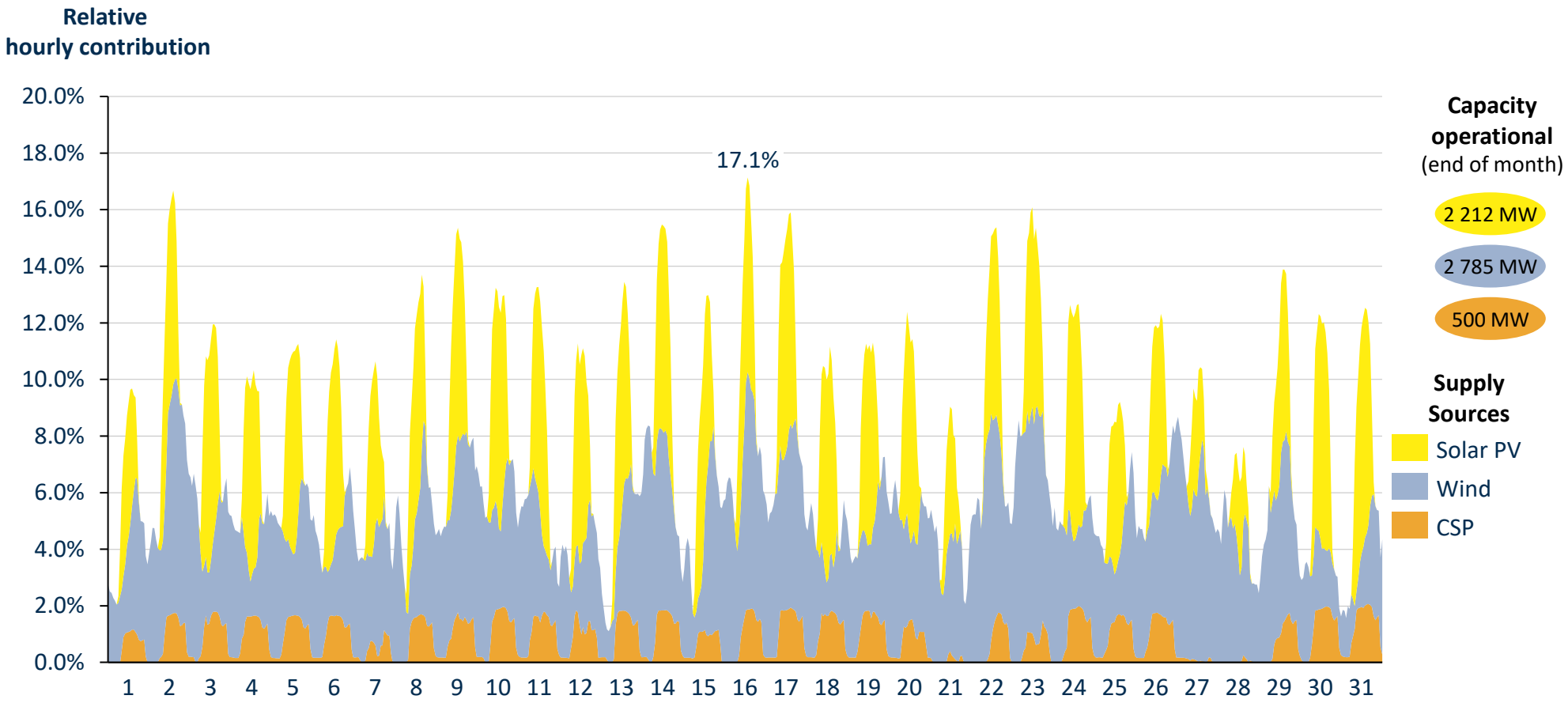
Hourly solar PV, wind & CSP contribution of 1.1-17.1% in Oct 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for October 2021



- Maximum solar PV relative contribution of 8.2% between 12h00 and 13h00 on 31 Oct 2021
- Maximum wind relative contribution of 8.6% between 03h00 and 04h00 on 23 Oct 2021
- Maximum CSP relative contribution of 2.1% between 15h00 and 16h00 on 31 Oct 2021

Sources: Eskom; CSIR Energy Centre analysis

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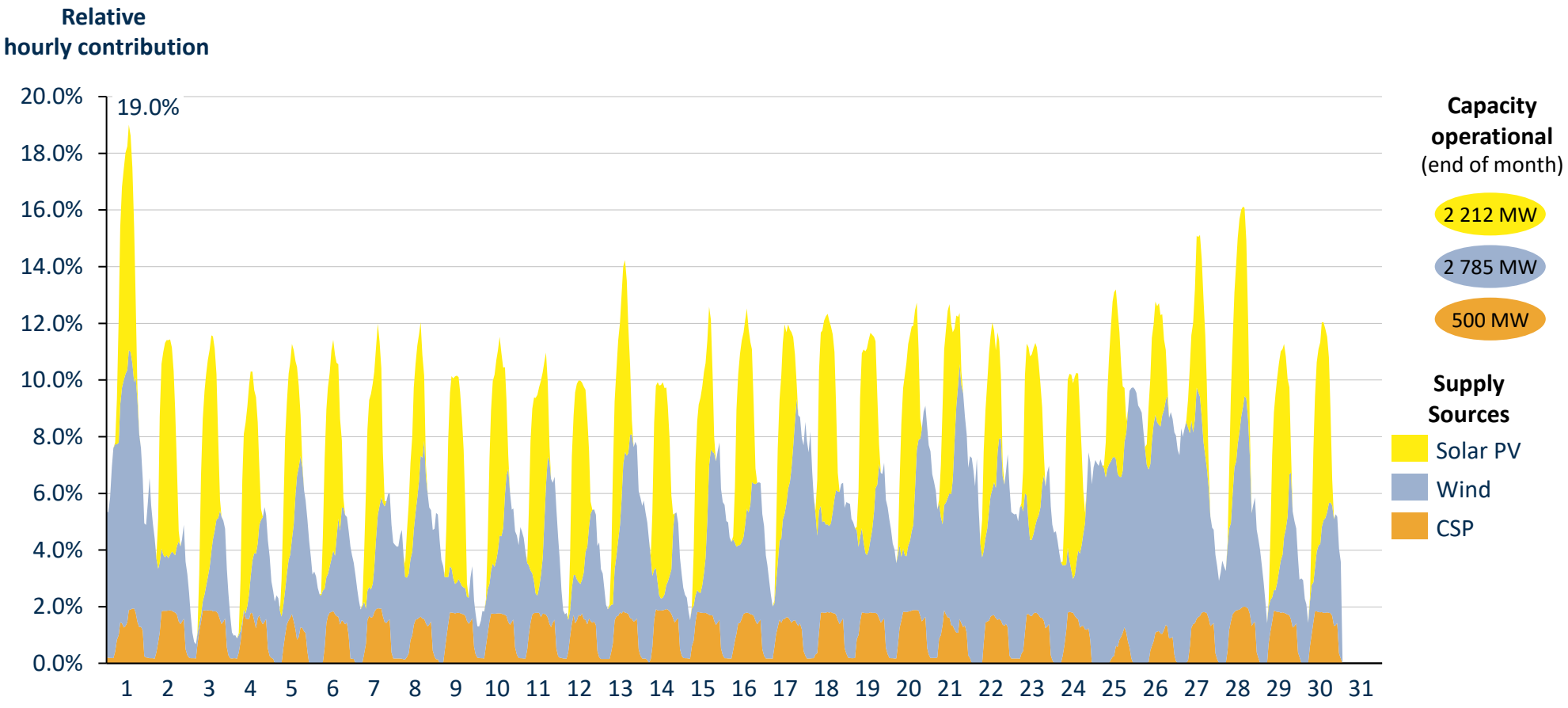
Hourly solar PV, wind & CSP contribution of 0.7-19.0% in Nov 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for November 2021



- Maximum solar PV relative contribution of 8.0% between 13h00 and 14h00 on 1 Nov 2021
- Maximum wind relative contribution of 9.7% between 22h00 and 23h00 on 25 Nov 2021
- Maximum CSP relative contribution of 2.0% between 15h00 and 16h00 on 28 Nov 2021

Sources: Eskom; CSIR Energy Centre analysis

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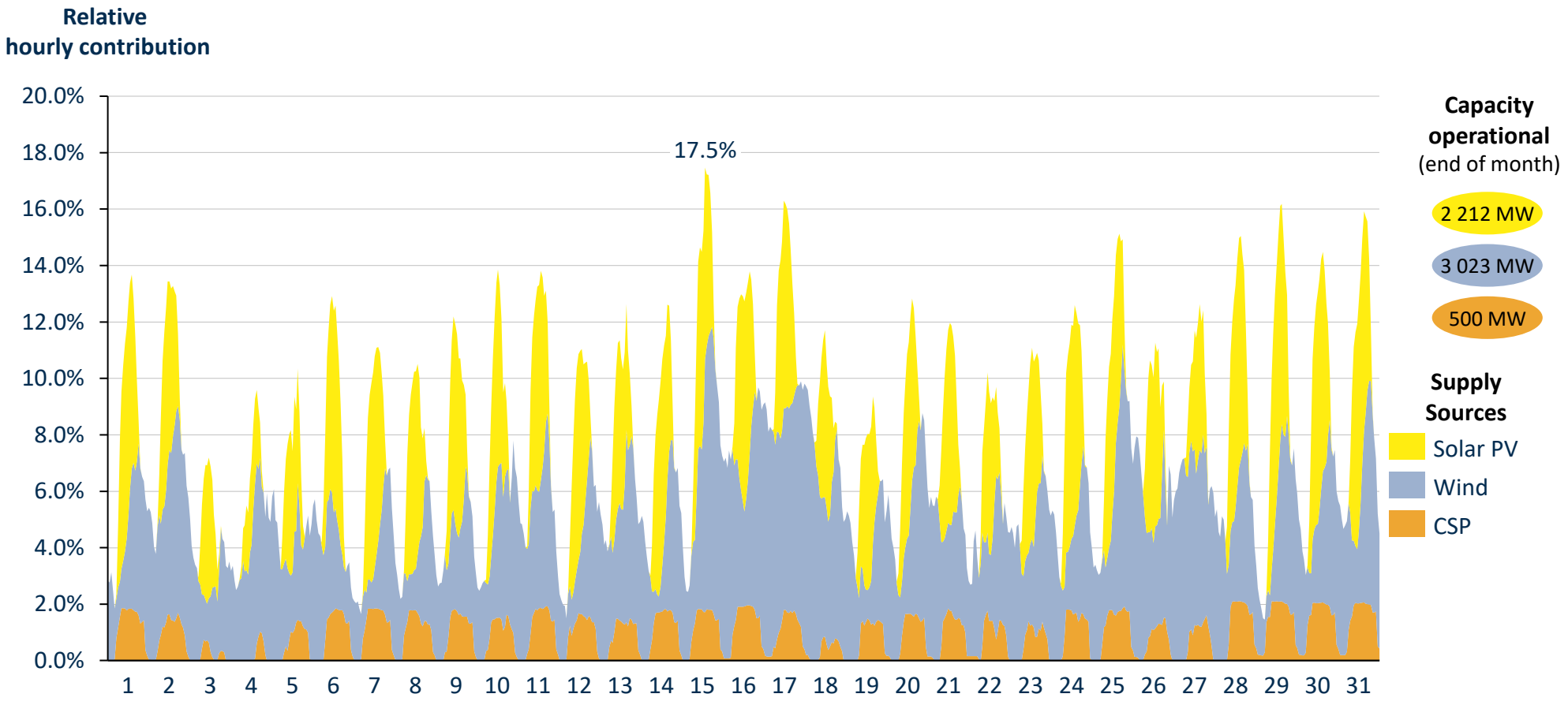
Hourly solar PV, wind & CSP contribution of 1.4-17.5% in Dec 2021

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for December 2021



- Maximum solar PV relative contribution of 8.4% between 12h00 and 13h00 on 1 Dec 2021
- Maximum wind relative contribution of 10.0% between 17h00 and 18h00 on 25 Dec 2021
- Maximum CSP relative contribution of 2.1% between 11h00 and 12h00 on 29 Dec 2021

Sources: Eskom; CSIR Energy Centre analysis

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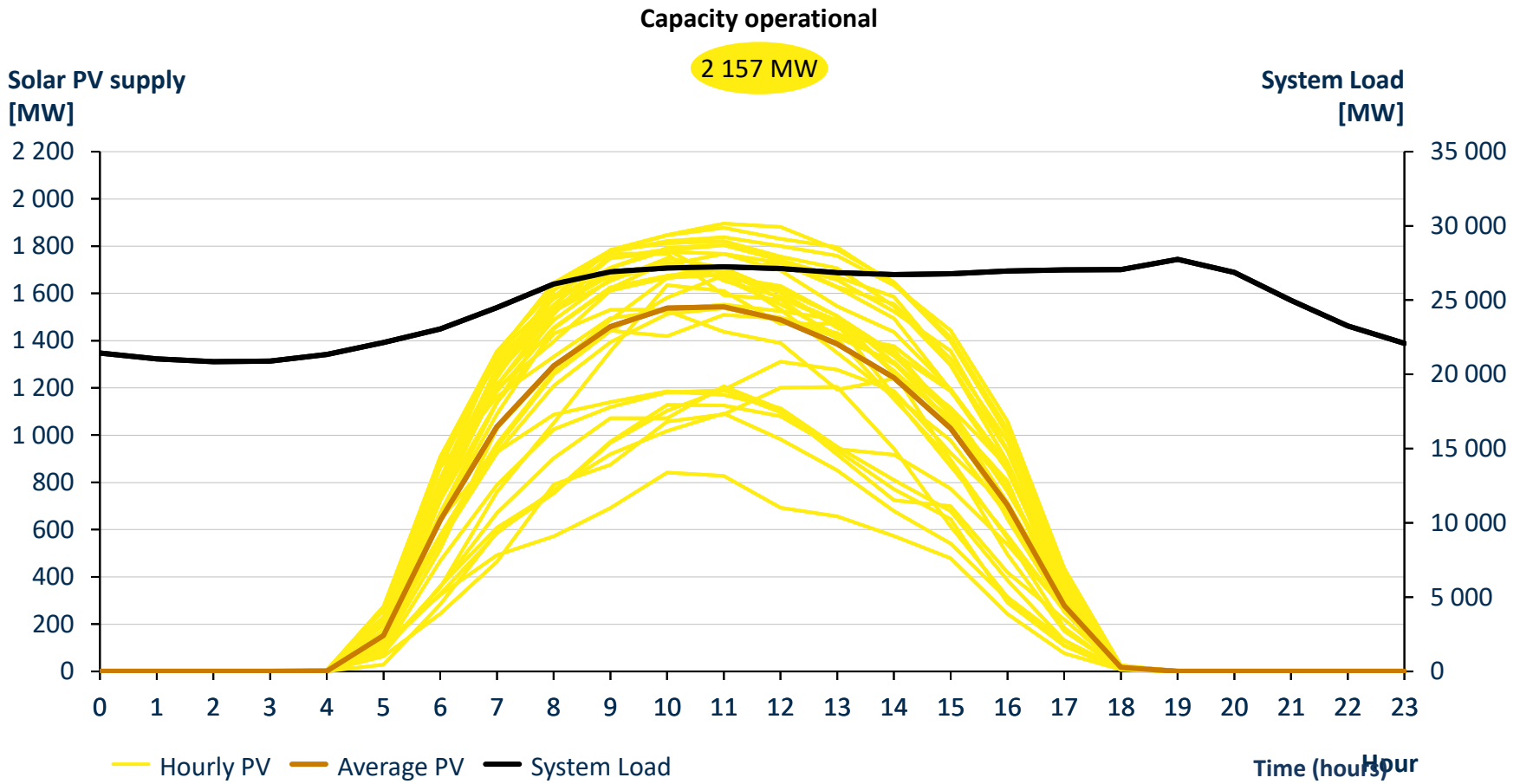
Solar PV supply in Jan 2021 was very stable

Hourly solar PV production for all 31 days of January 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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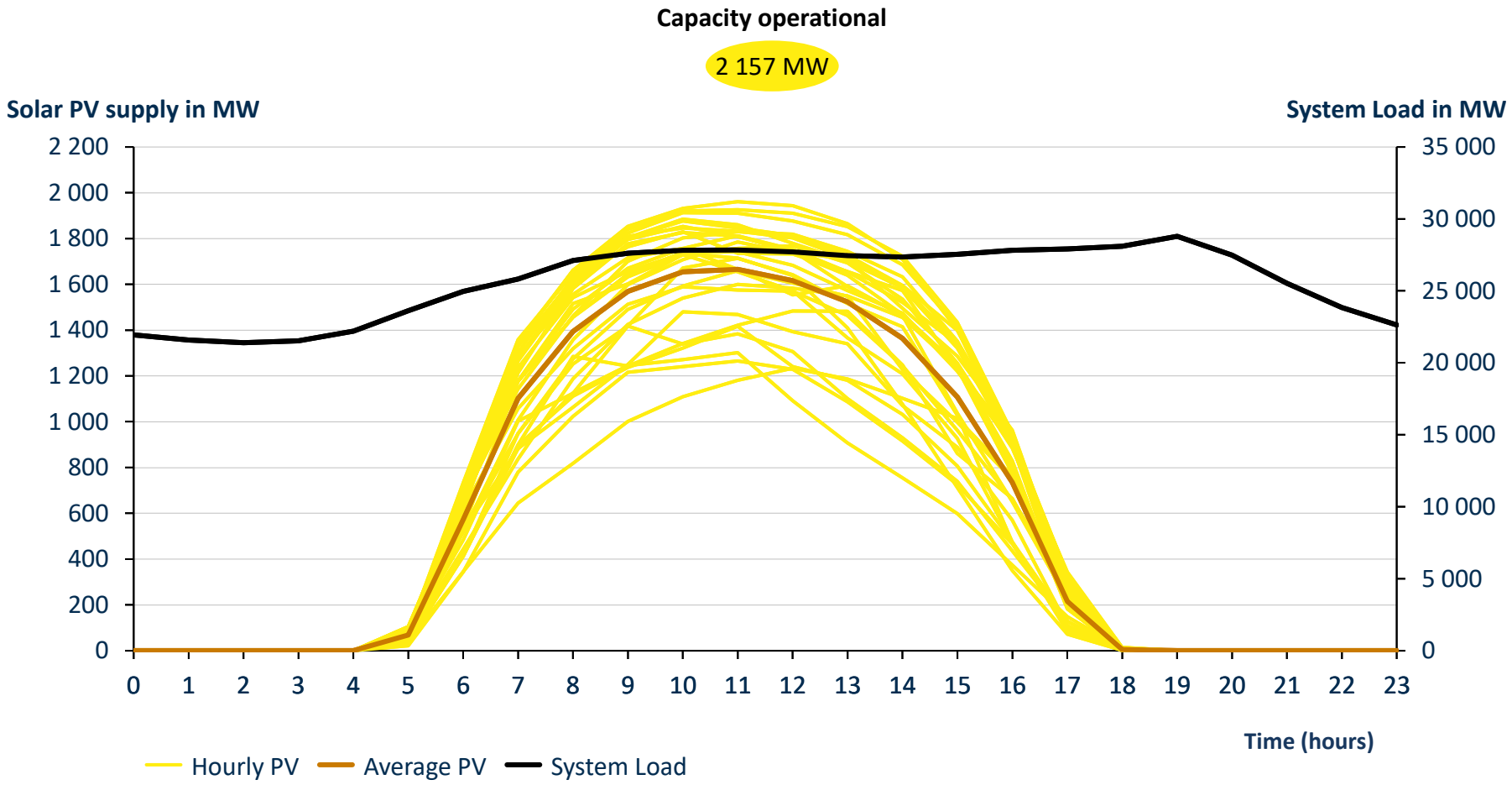
Solar PV supply in Feb 2021 was very stable

Hourly solar PV production for all 28 days of February 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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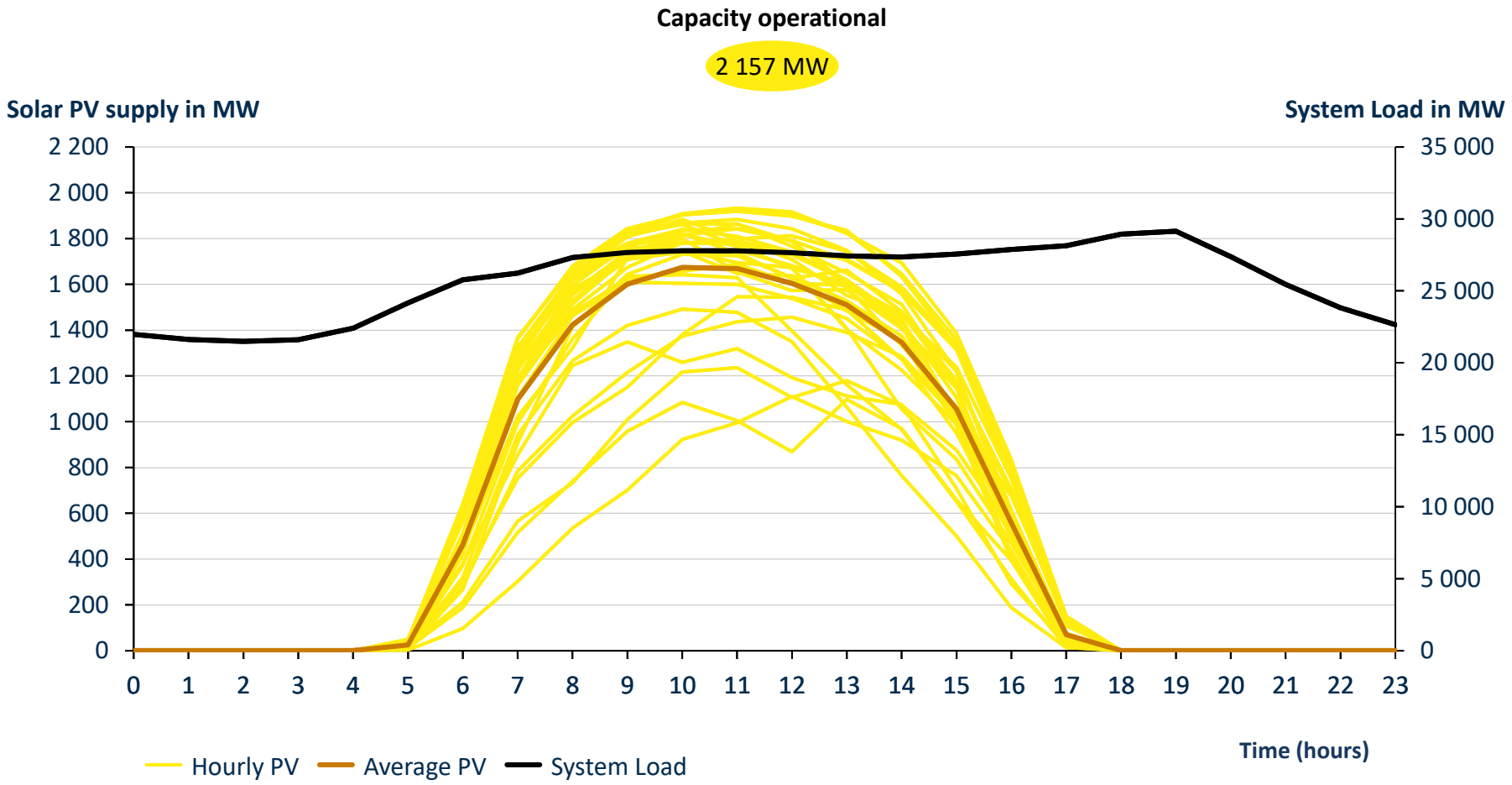
Solar PV supply in Mar 2021 was very stable

Hourly solar PV production for all 31 days of March 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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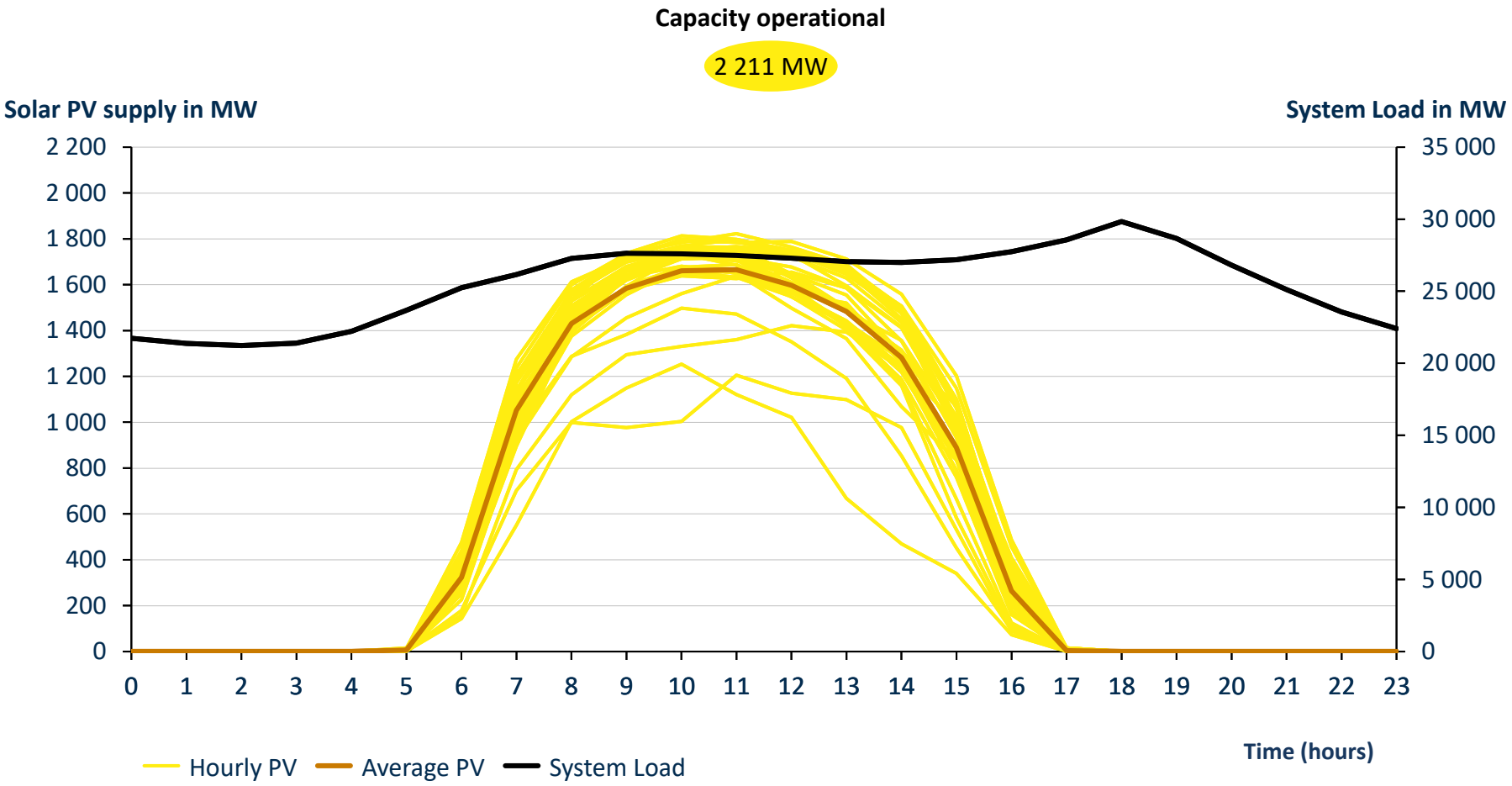
Solar PV supply in Apr 2021 very stable

Hourly solar PV production for all 30 days of April 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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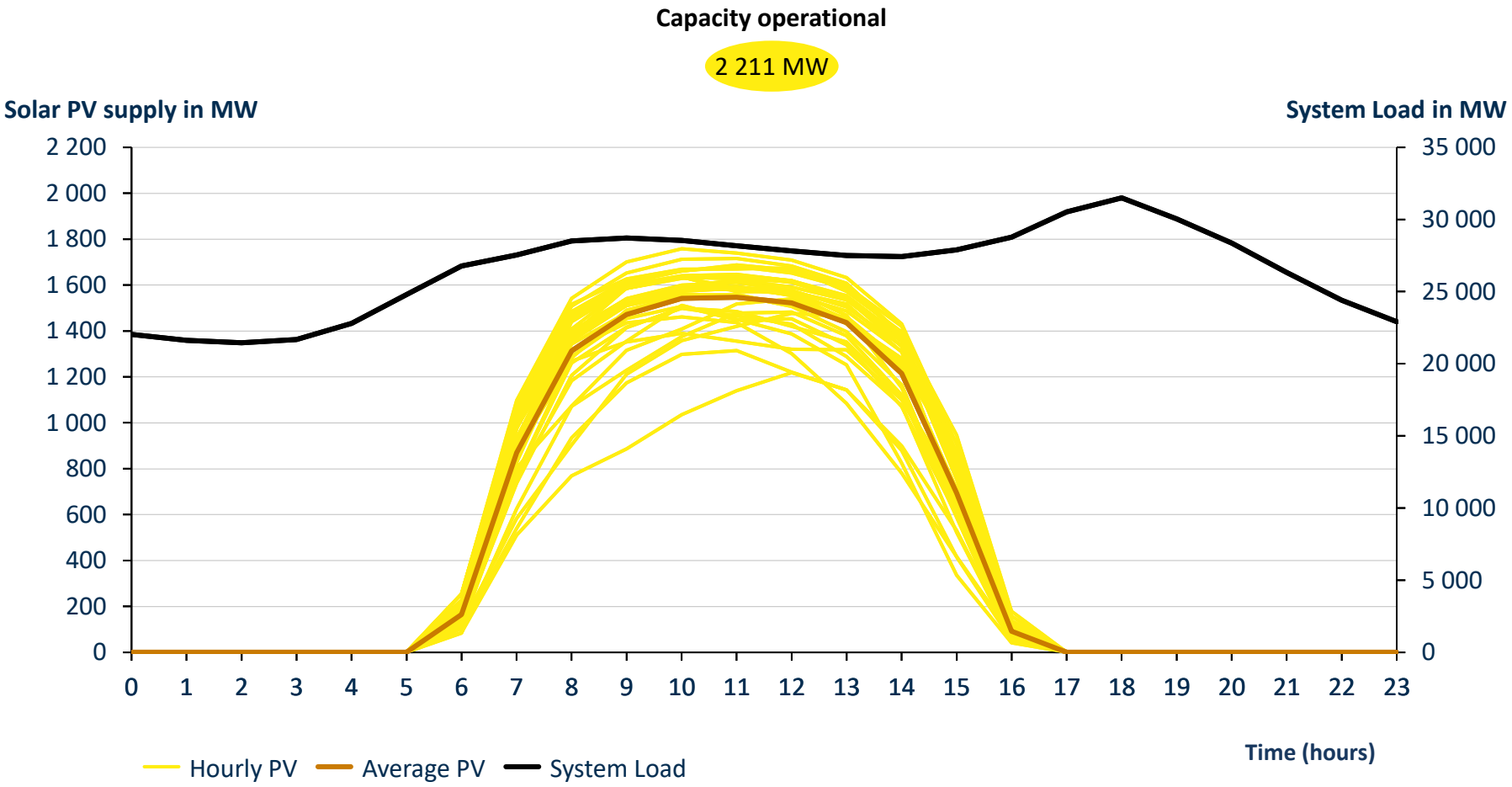
Solar PV supply in May 2021 very stable

Hourly solar PV production for all 31 days of May 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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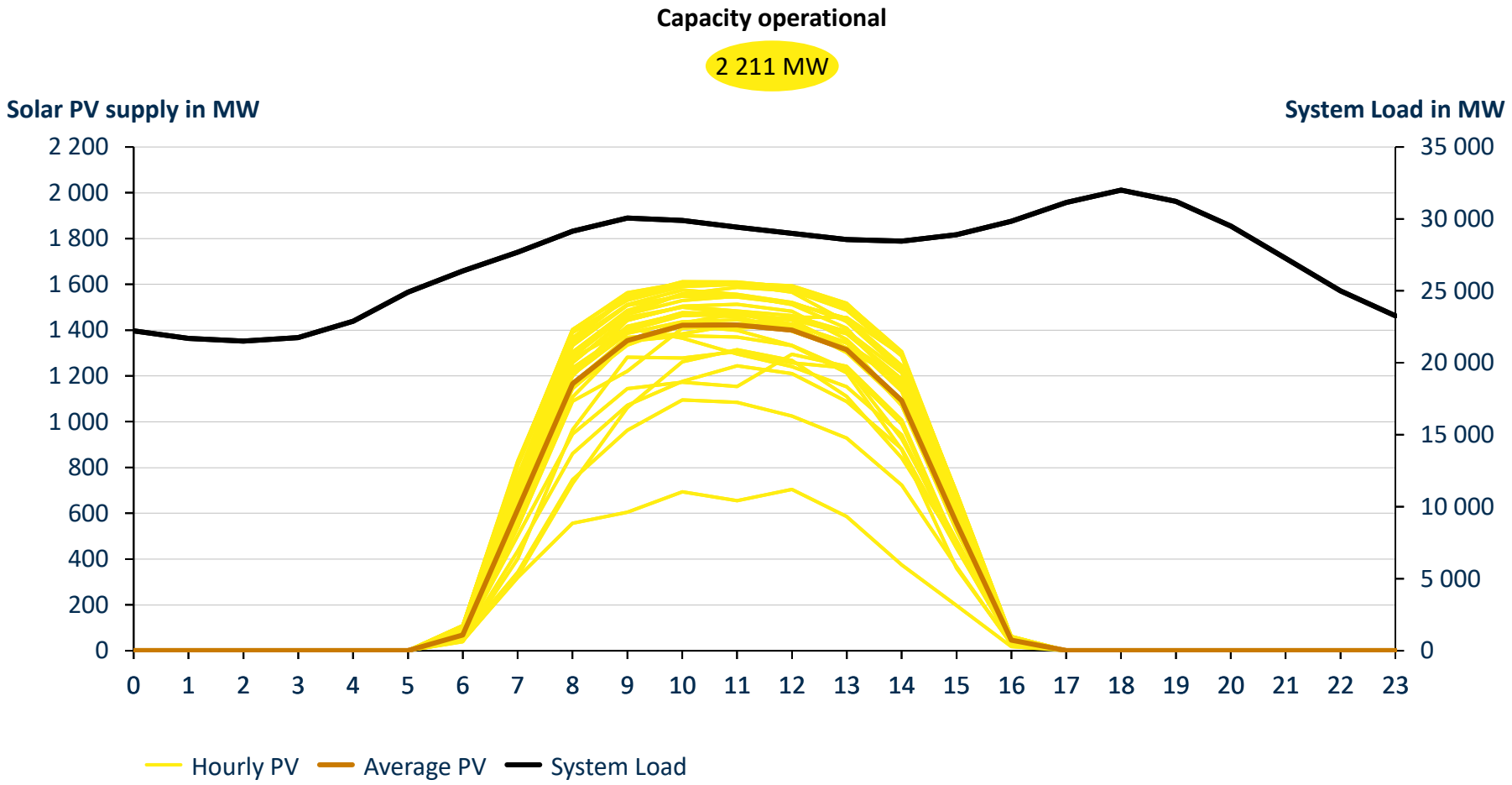
Solar PV supply in Jun 2021 very stable

Hourly solar PV production for all 30 days of June 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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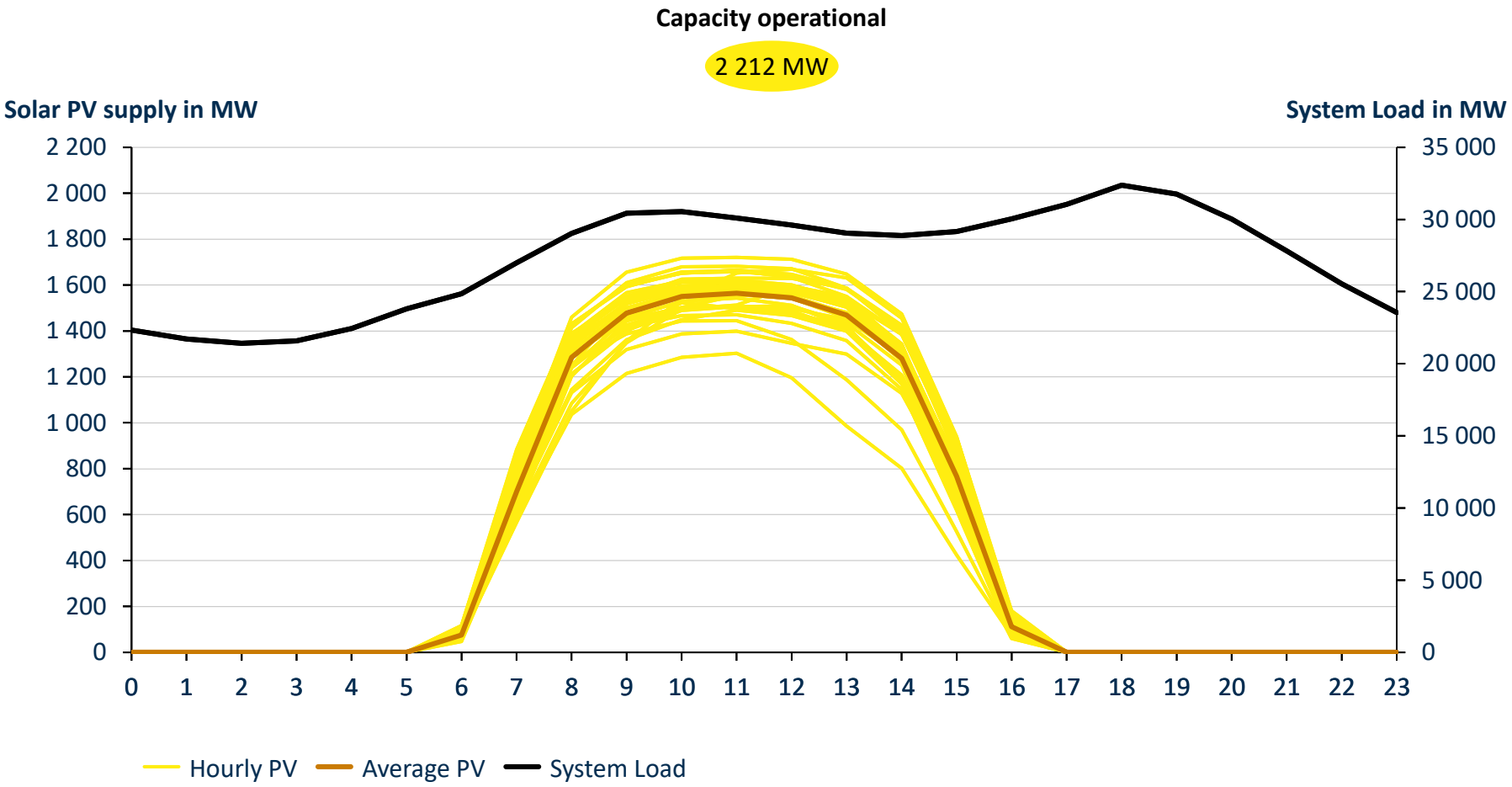
Solar PV supply in Jul 2021 very stable

Hourly solar PV production for all 31 days of July 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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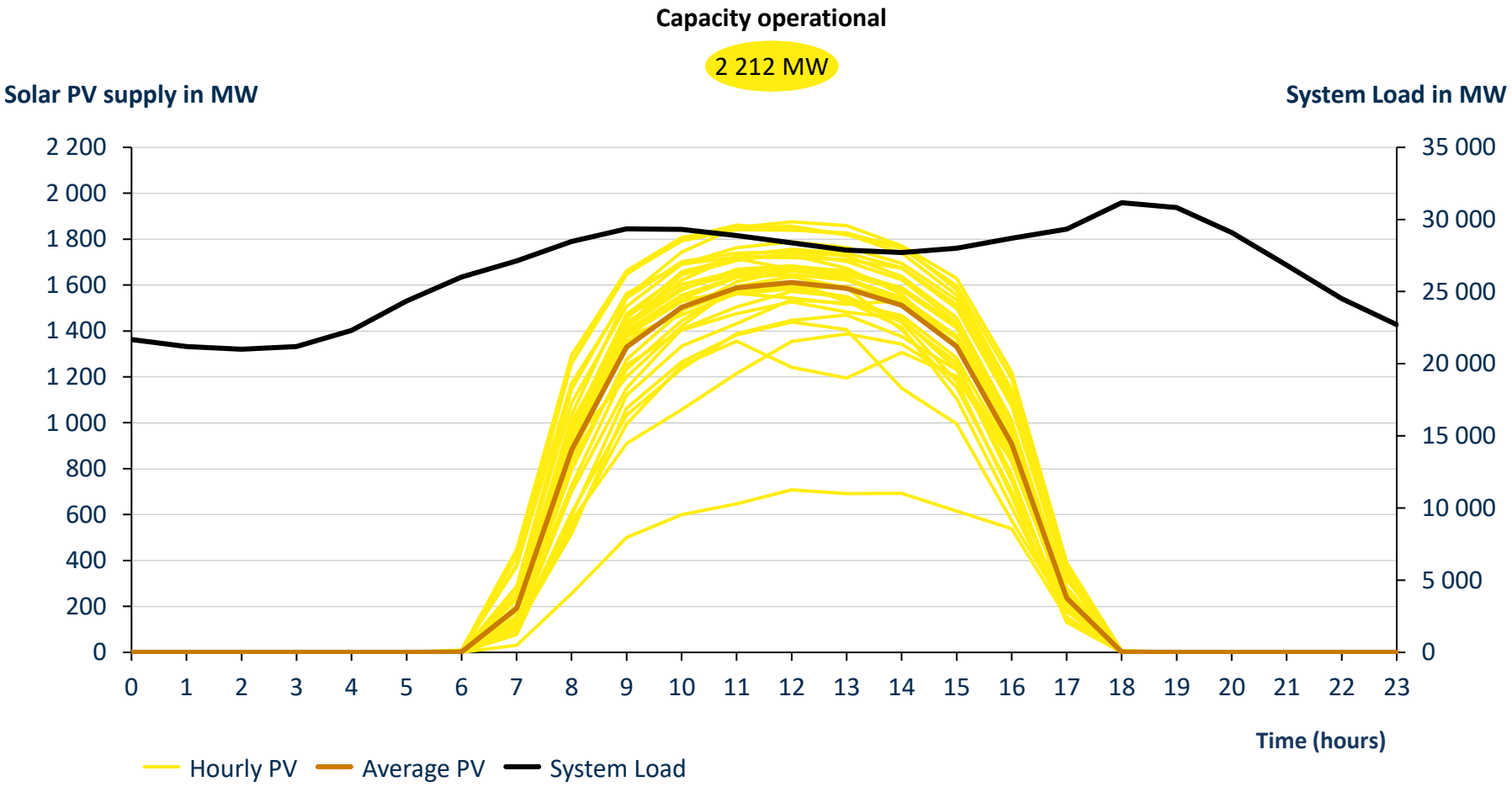
Solar PV supply in Aug 2021 very stable

Hourly solar PV production for all 31 days of August 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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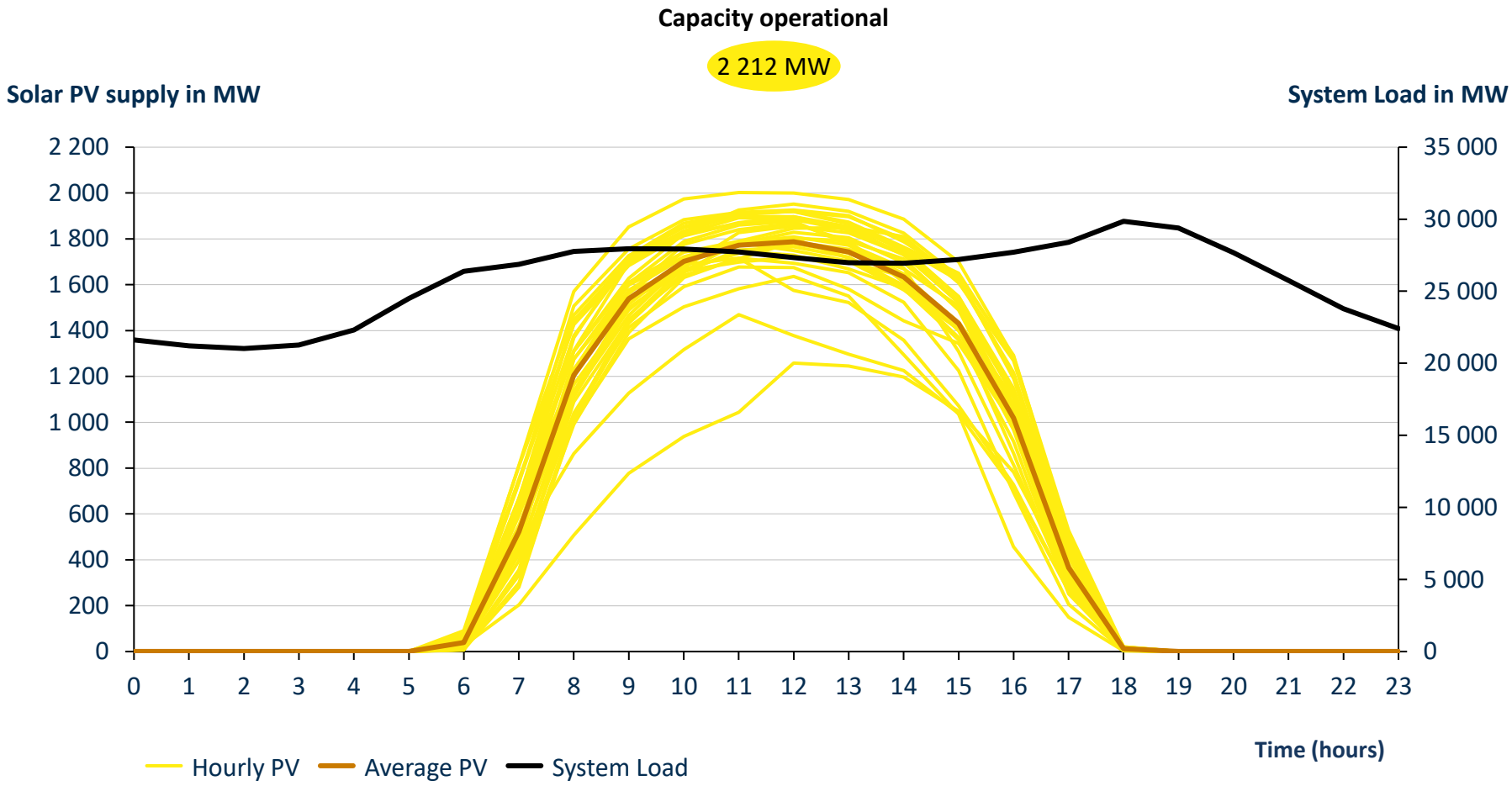
Solar PV supply in Sep 2021 very stable

Hourly solar PV production for all 30 days of September 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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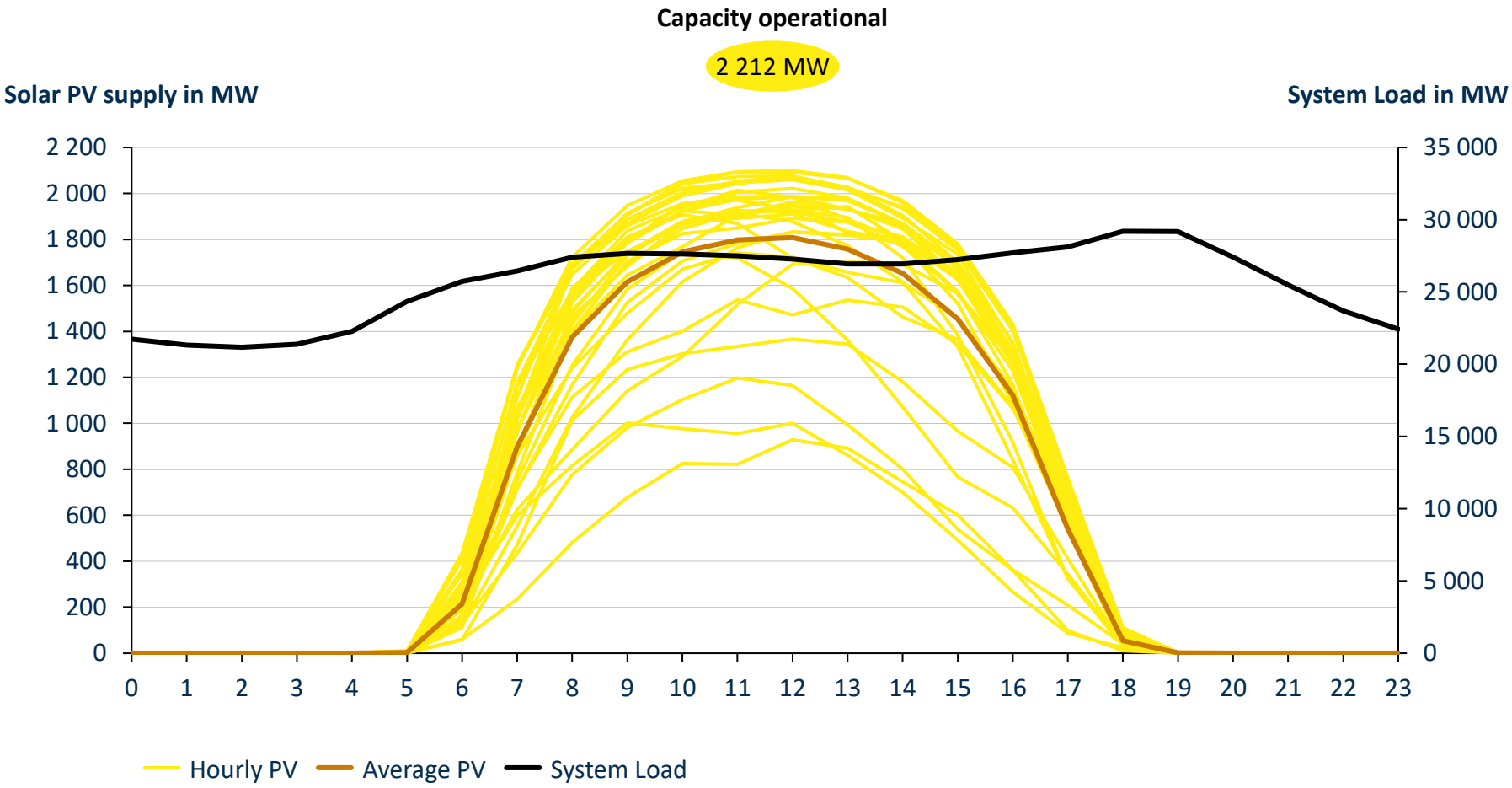
Solar PV supply in Oct 2021 very stable

Hourly solar PV production for all 31 days of October 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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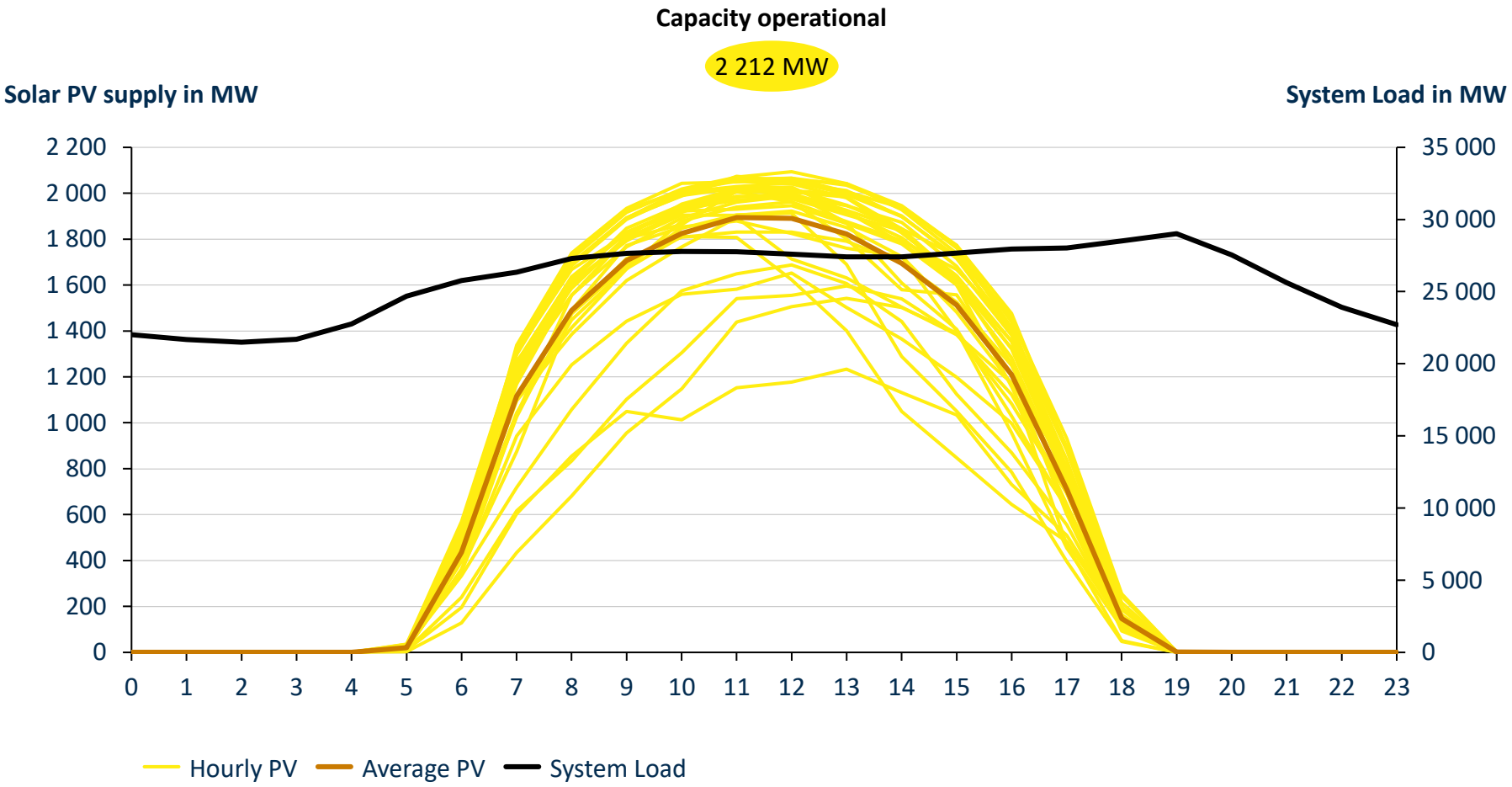
Solar PV supply in Nov 2021 very stable

Hourly solar PV production for all 30 days of November 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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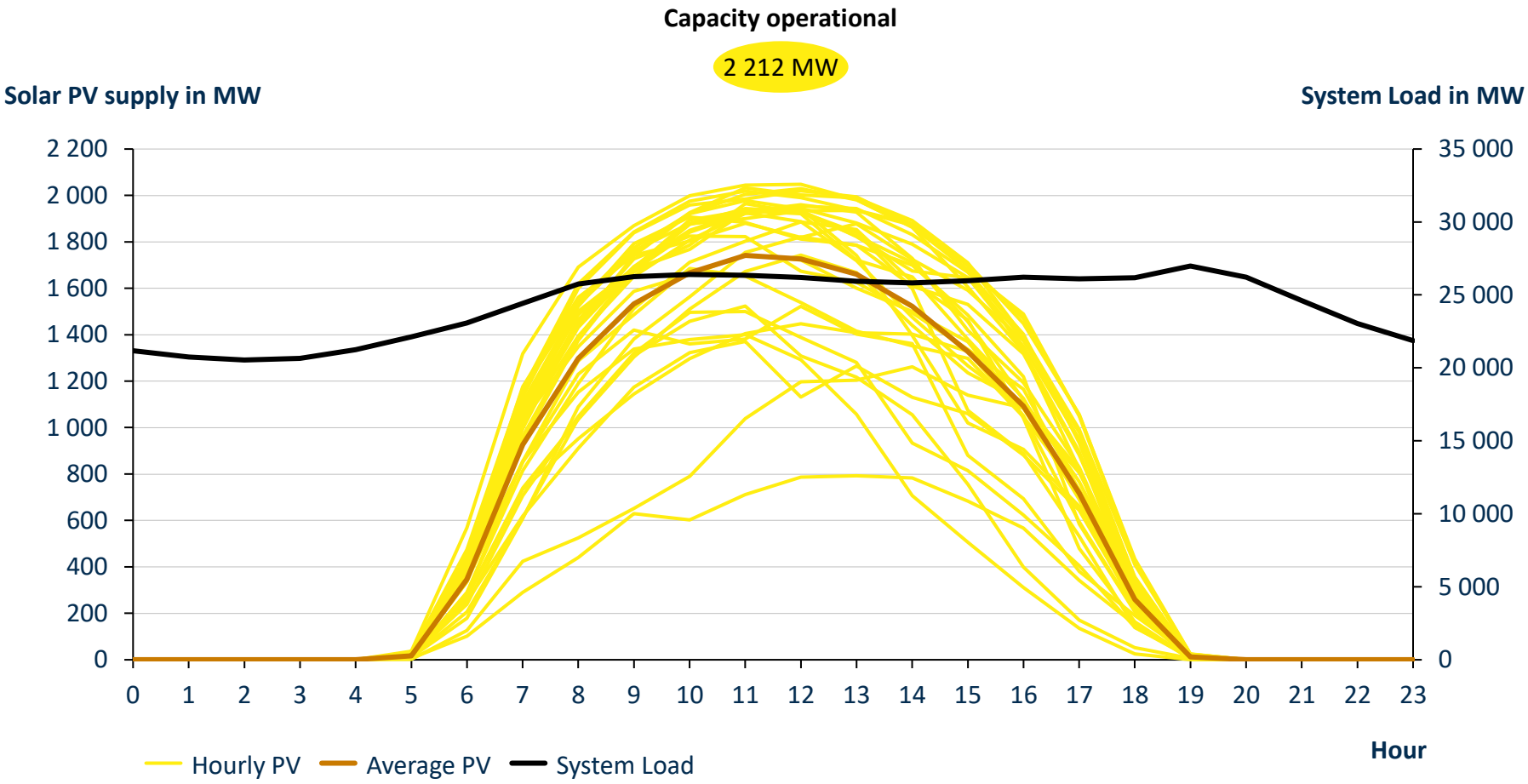
Solar PV supply in Dec 2021 very stable

Hourly solar PV production for all 31 days of December 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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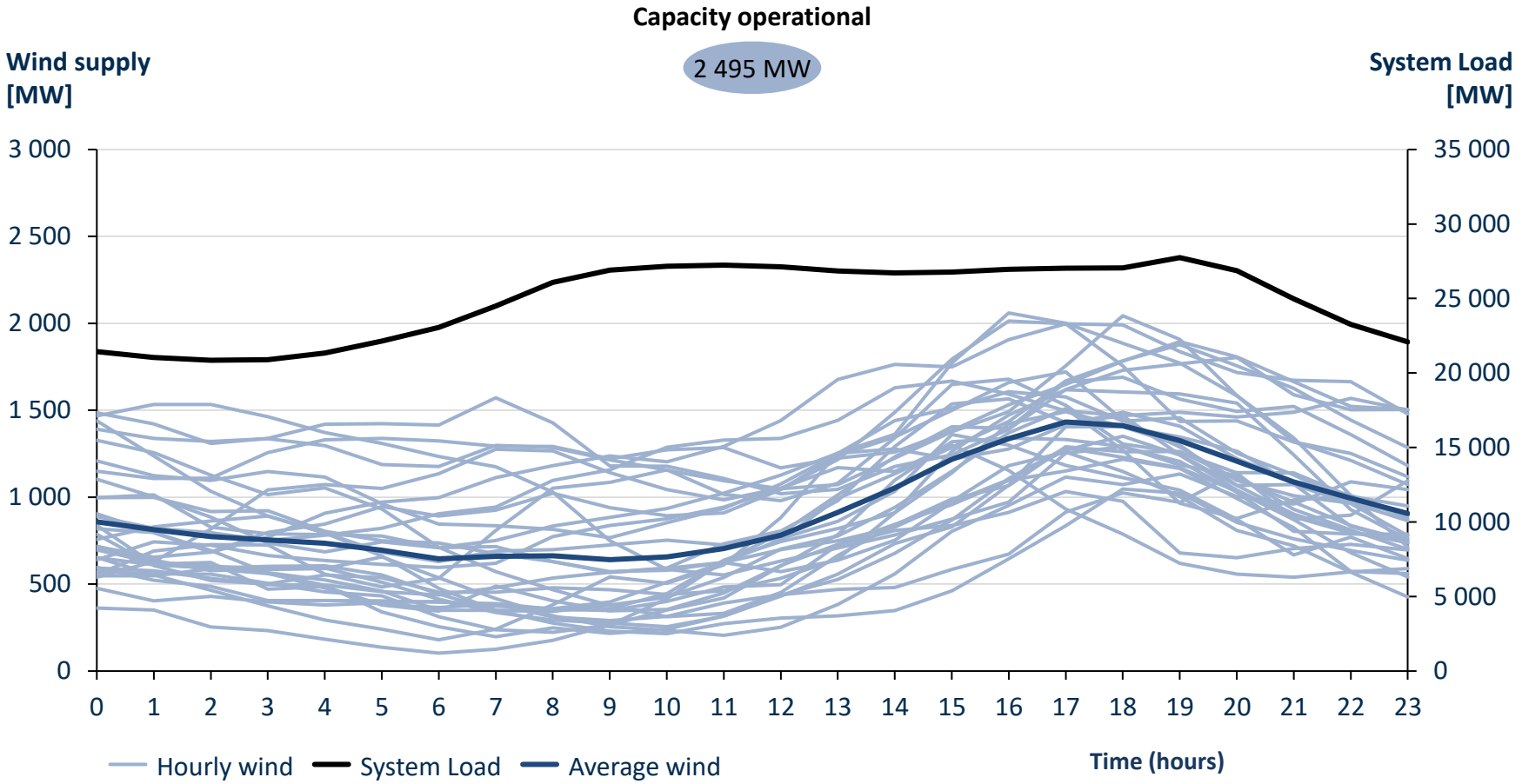
In Jan 2021, wind supply increased in the evenings

Hourly wind production for all 31 days of January 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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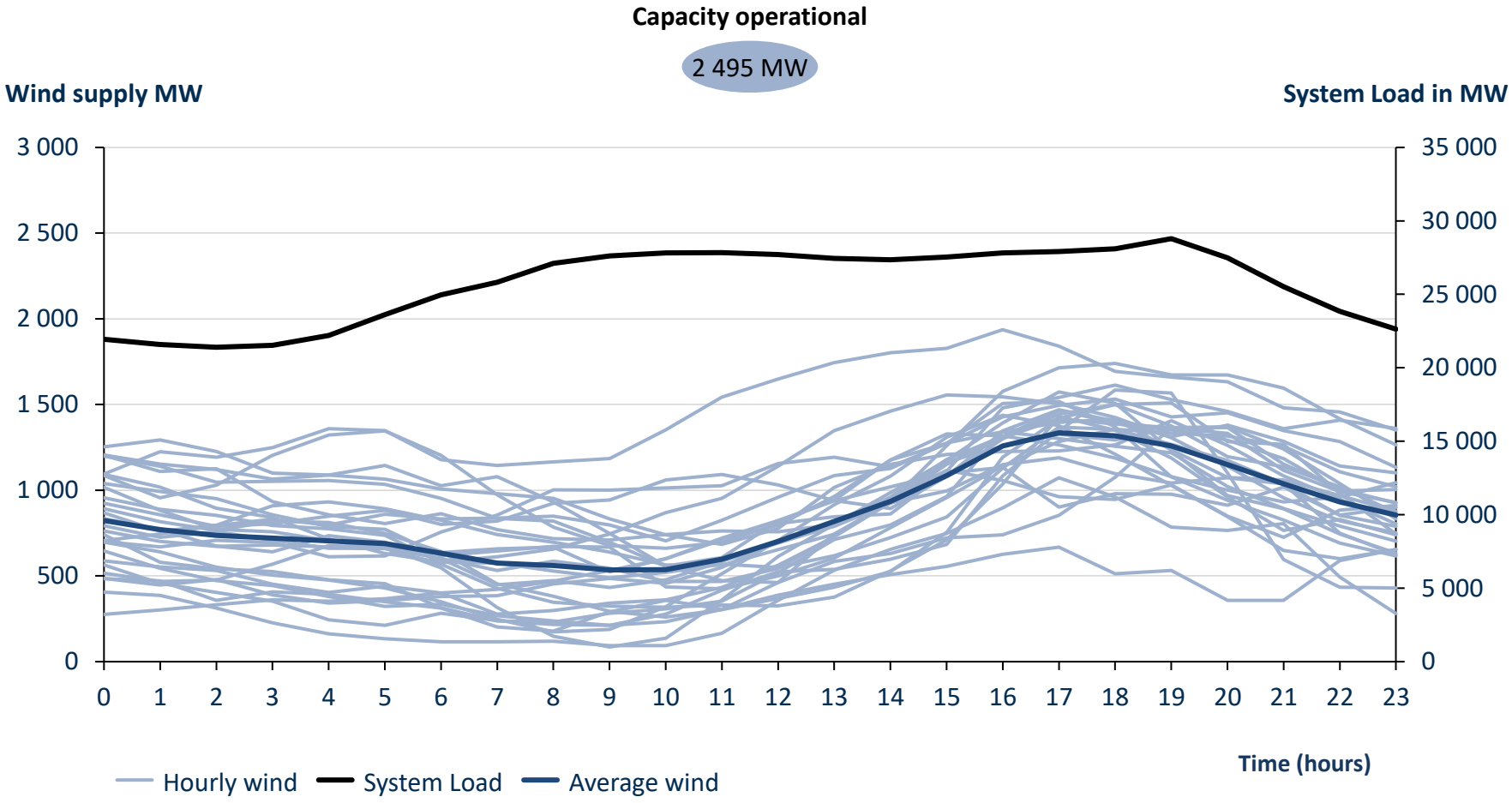
In Feb 2021, wind supply increased during the evening peak

Hourly wind production for all 28 days of February 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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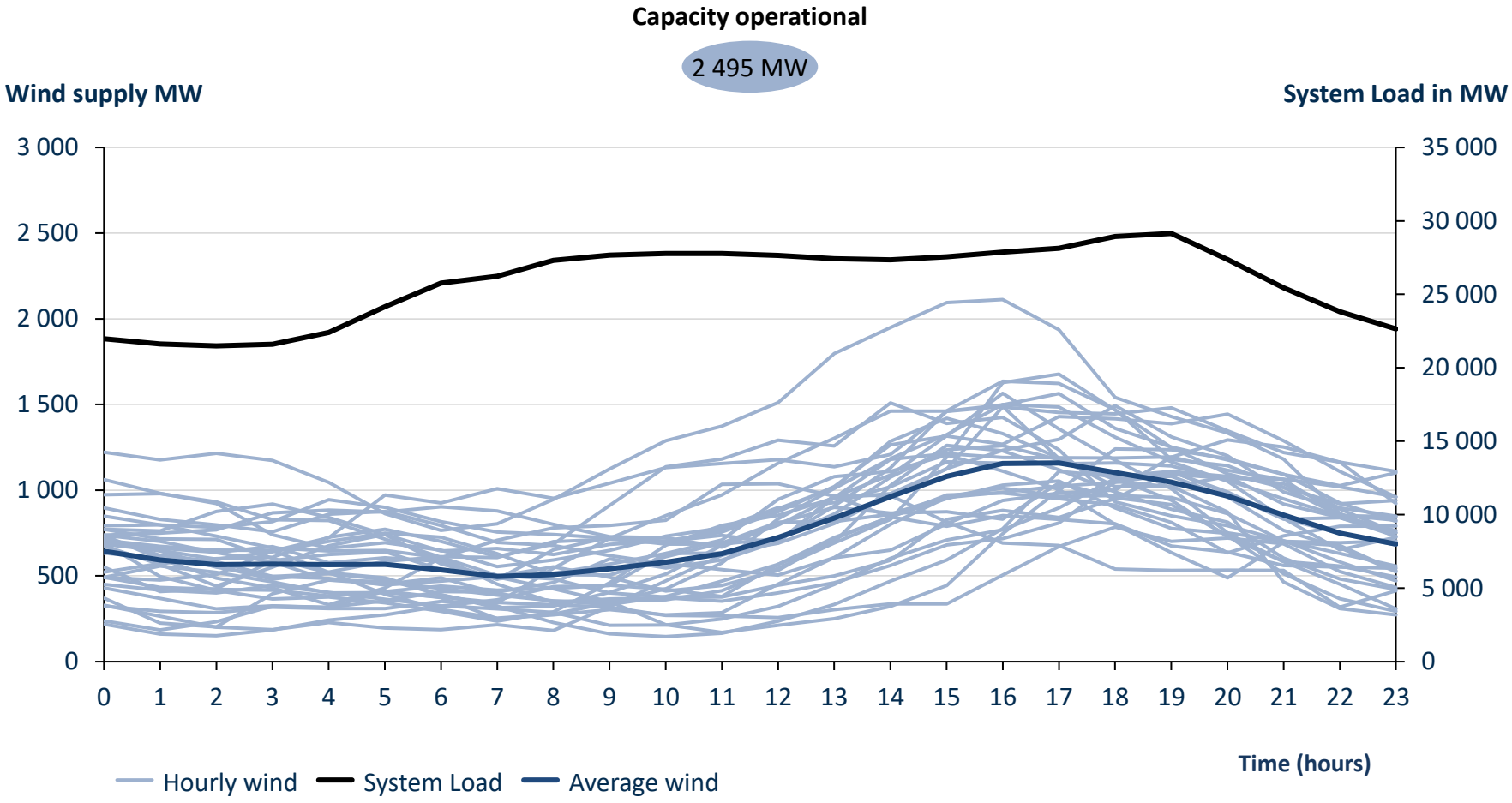
In Mar 2021, wind supply increased during the evening peak

Hourly wind production for all 31 days of March 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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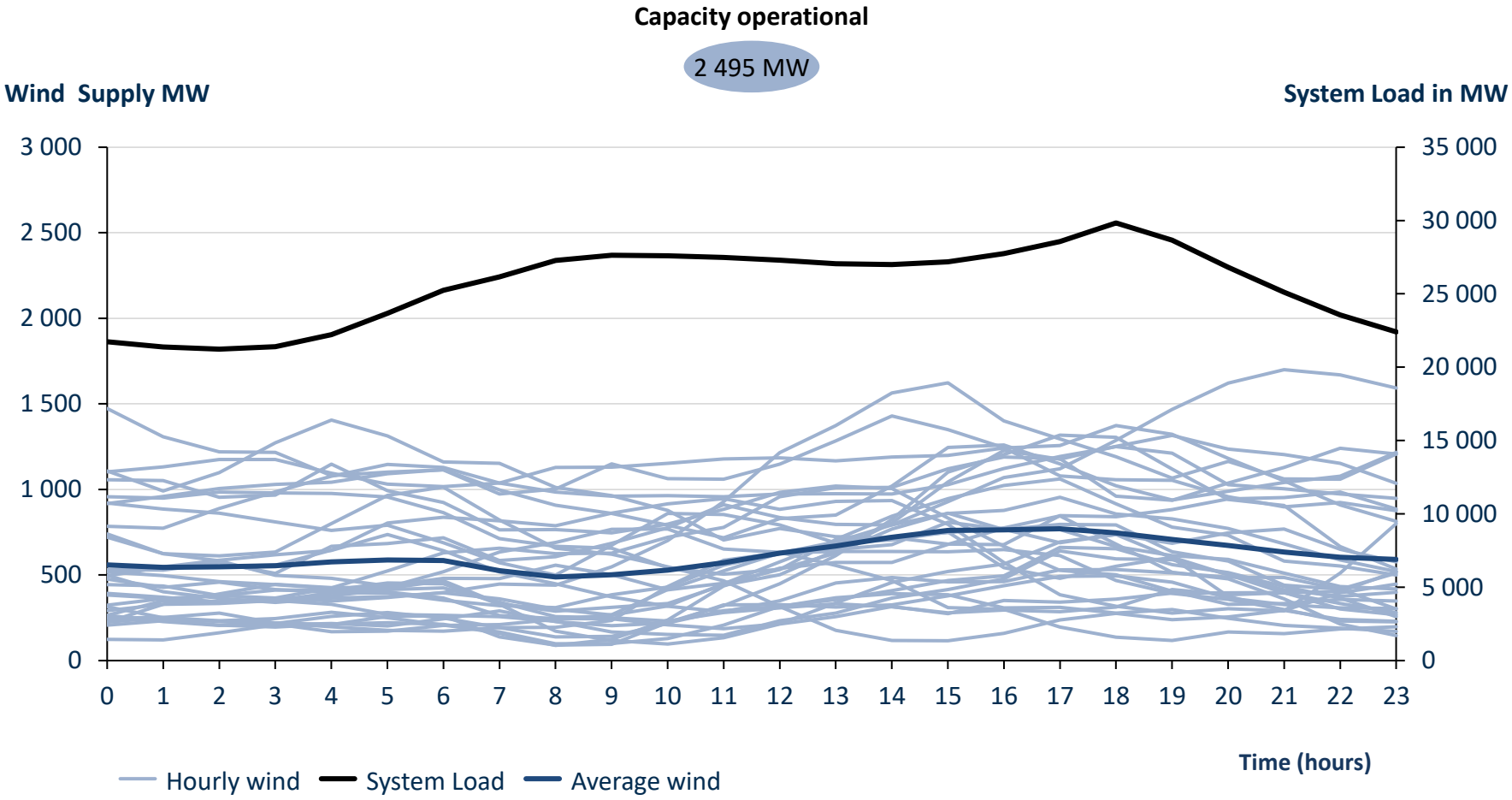
In Apr 2021, wind supply fluctuated day-to-day

Hourly wind production for all 30 days of April 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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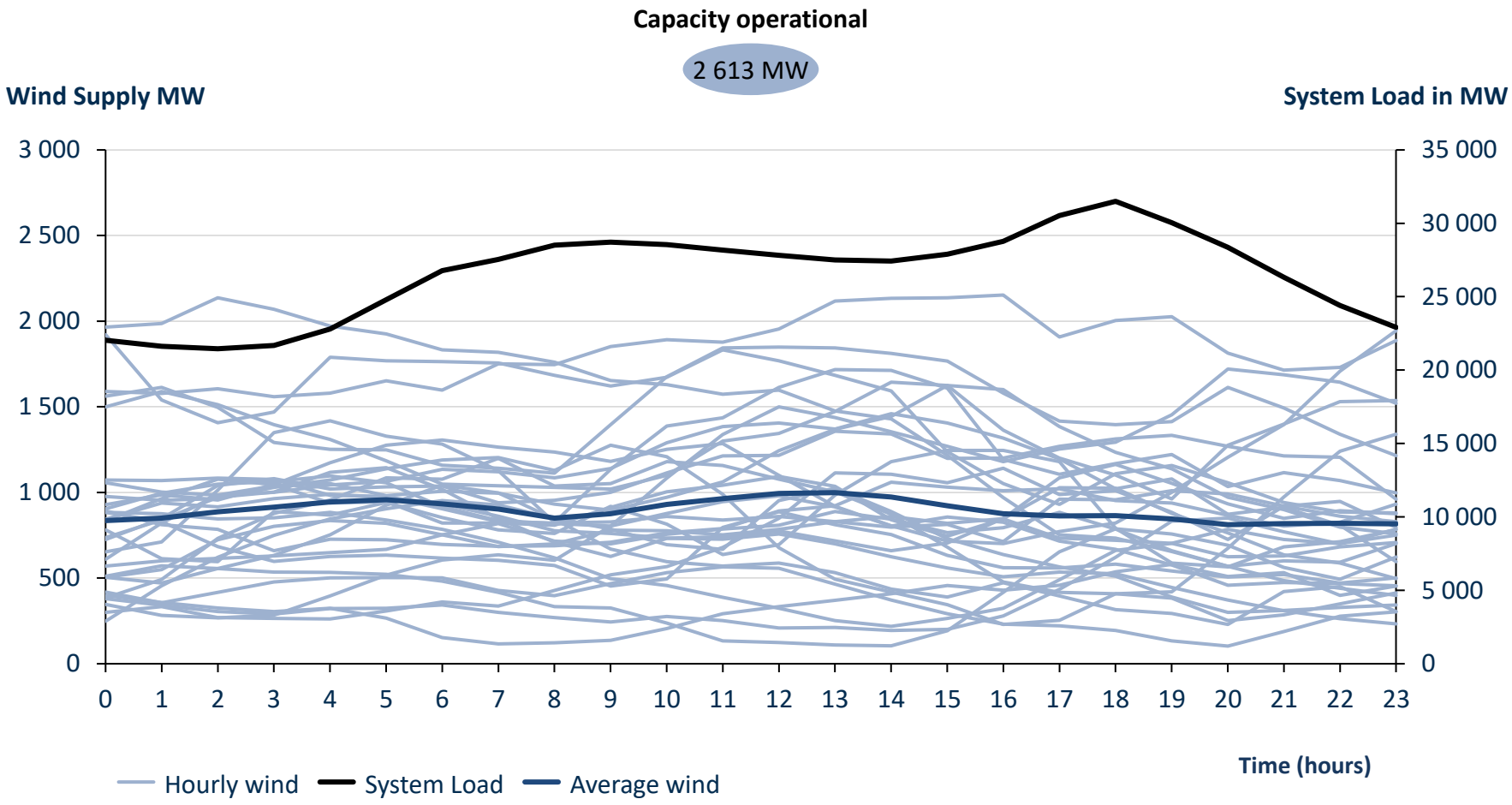
In May 2021, wind supply fluctuated day-to-day

Hourly wind production for all 31 days of May 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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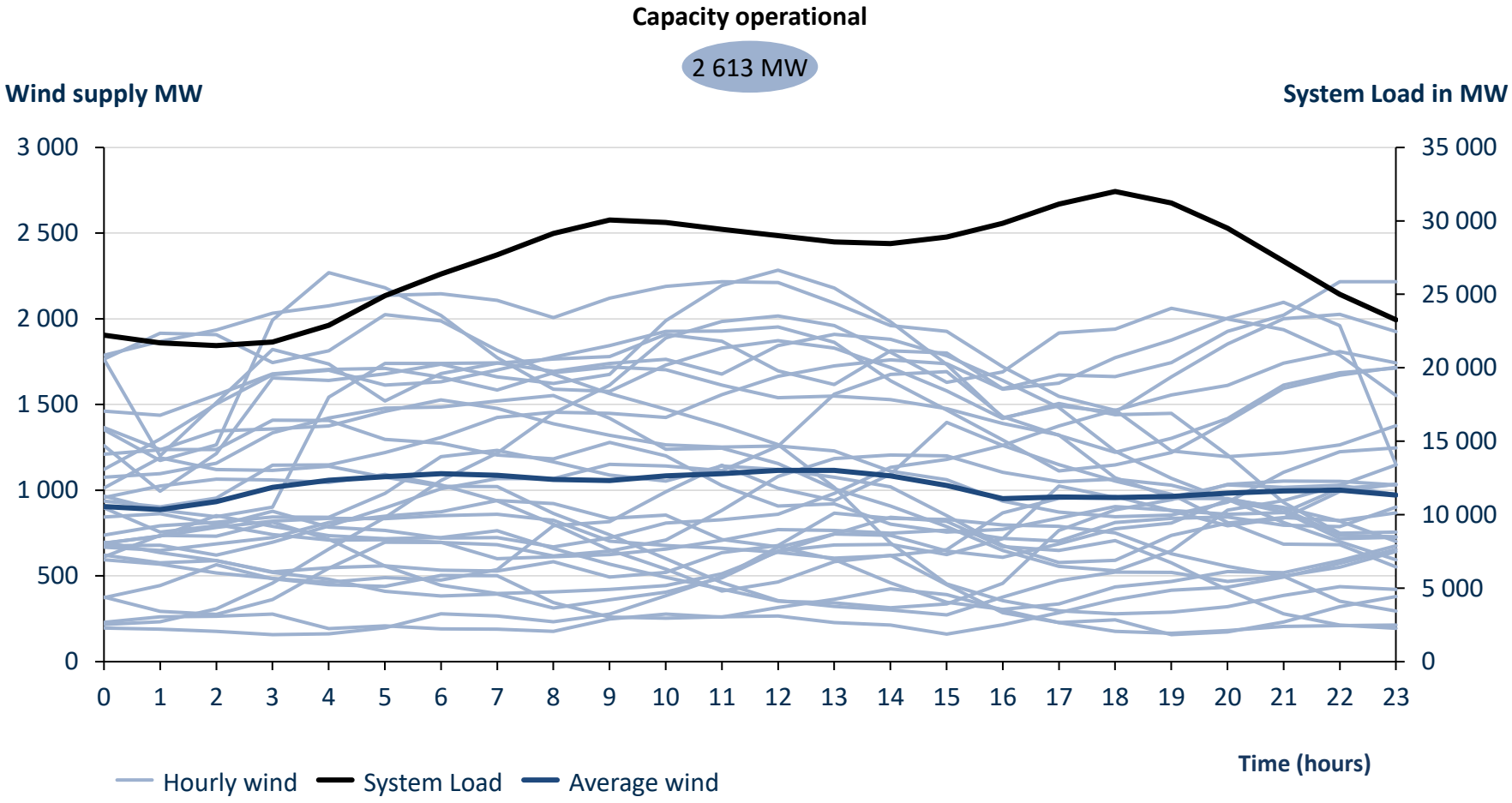
In Jun 2021, wind supply fluctuated day-to-day

Hourly wind production for all 30 days of June 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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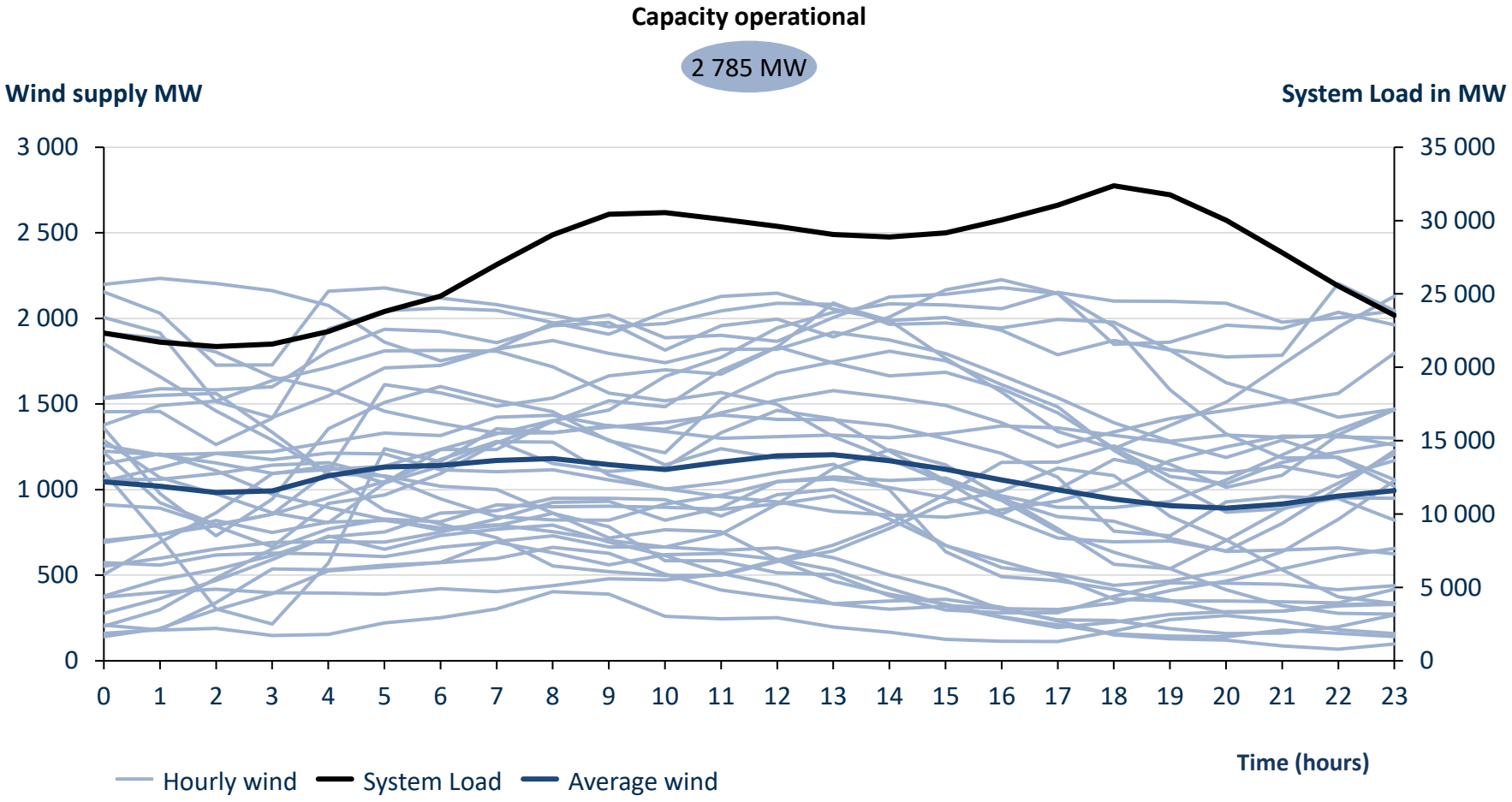
In Jul 2021, wind supply fluctuated day-to-day

Hourly wind production for all 31 days of July 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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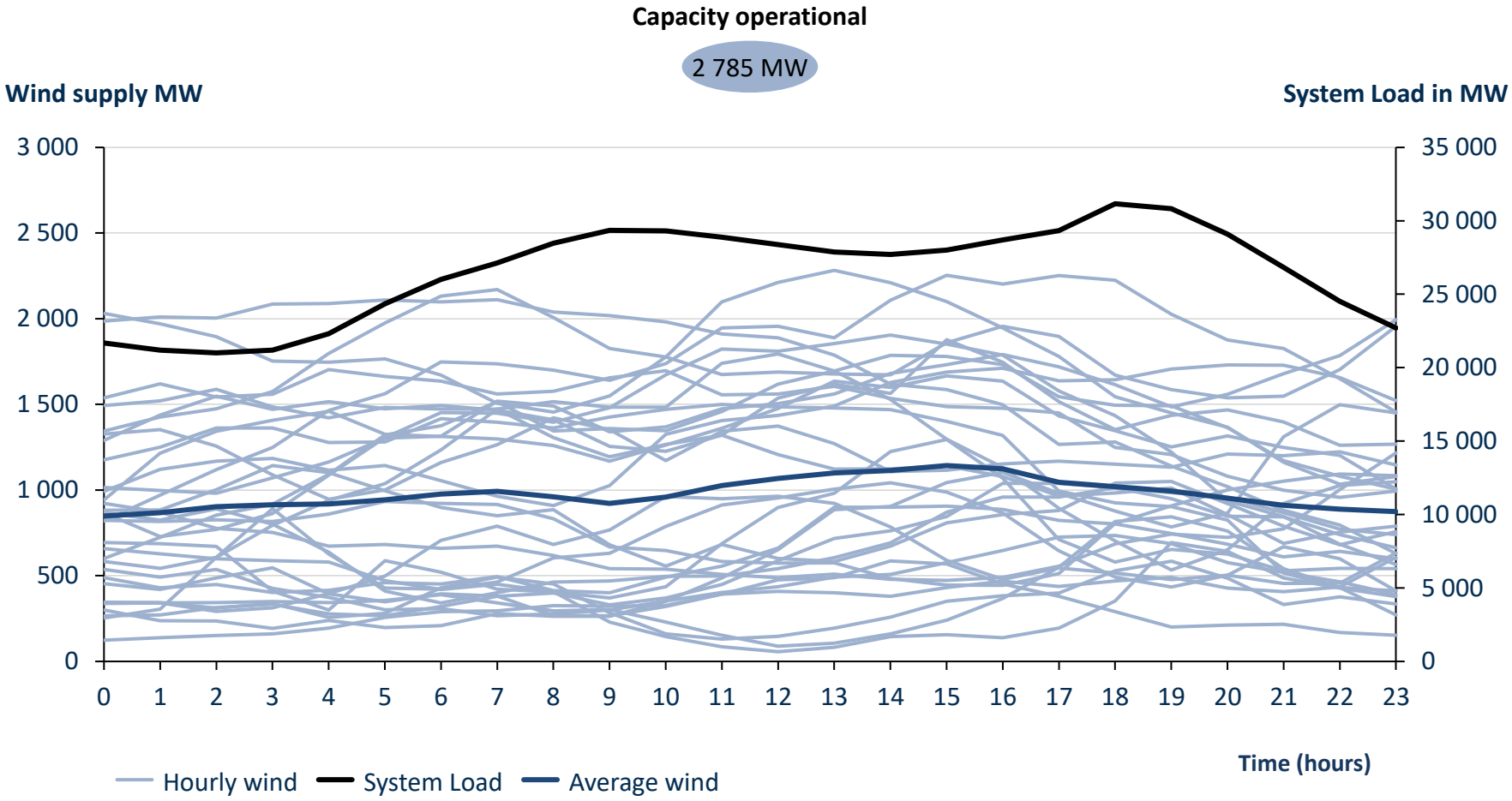
In Aug 2021, wind supply fluctuated day-to-day

Hourly wind production for all 31 days of August 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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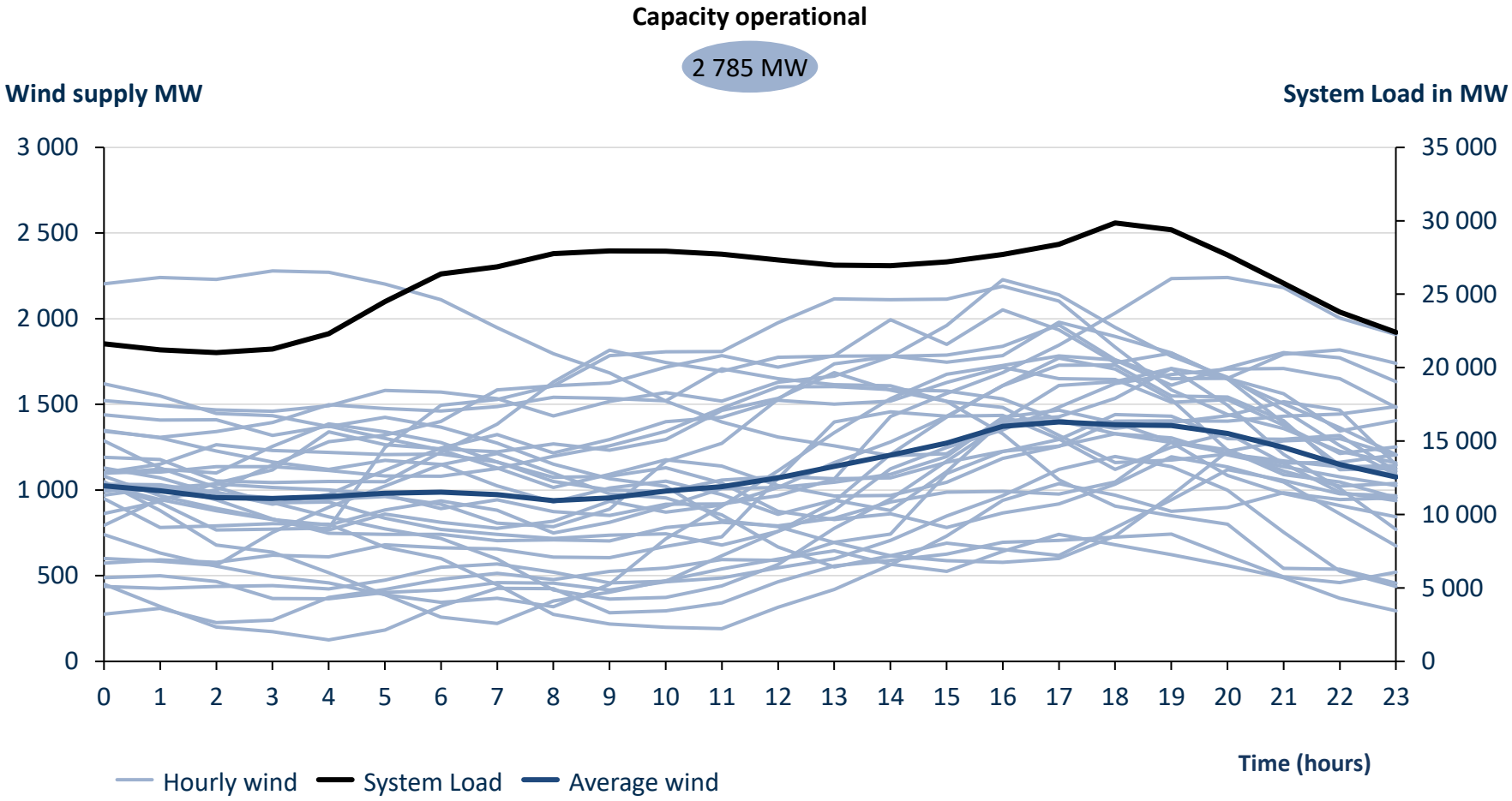
In Sep 2021, wind supply fluctuated day-to-day

Hourly wind production for all 30 days of September 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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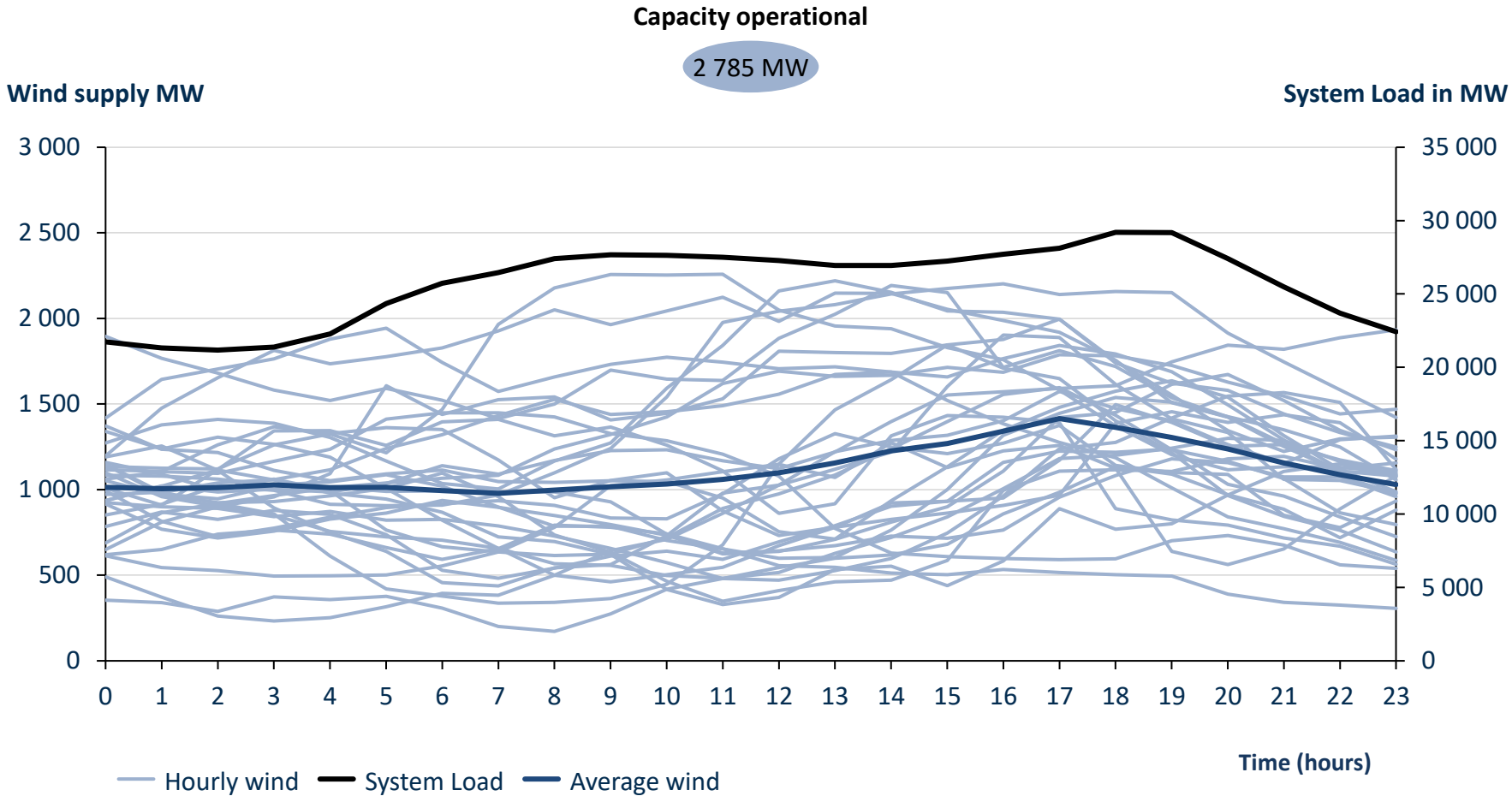
In Oct 2021, wind supply fluctuated day-to-day

Hourly wind production for all 31 days of October 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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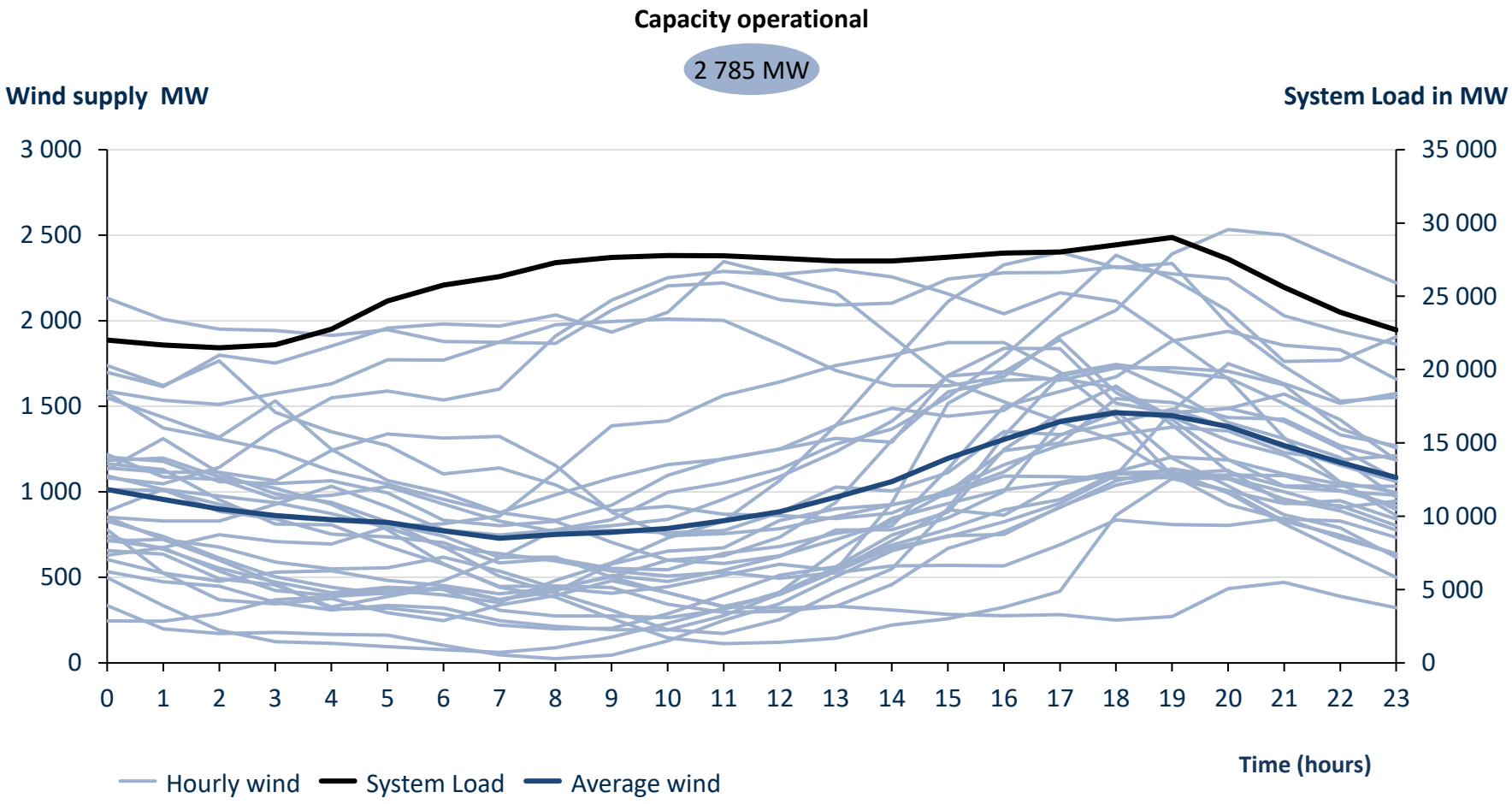
In Nov 2021, wind supply fluctuated day-to-day

Hourly wind production for all 30 days of November 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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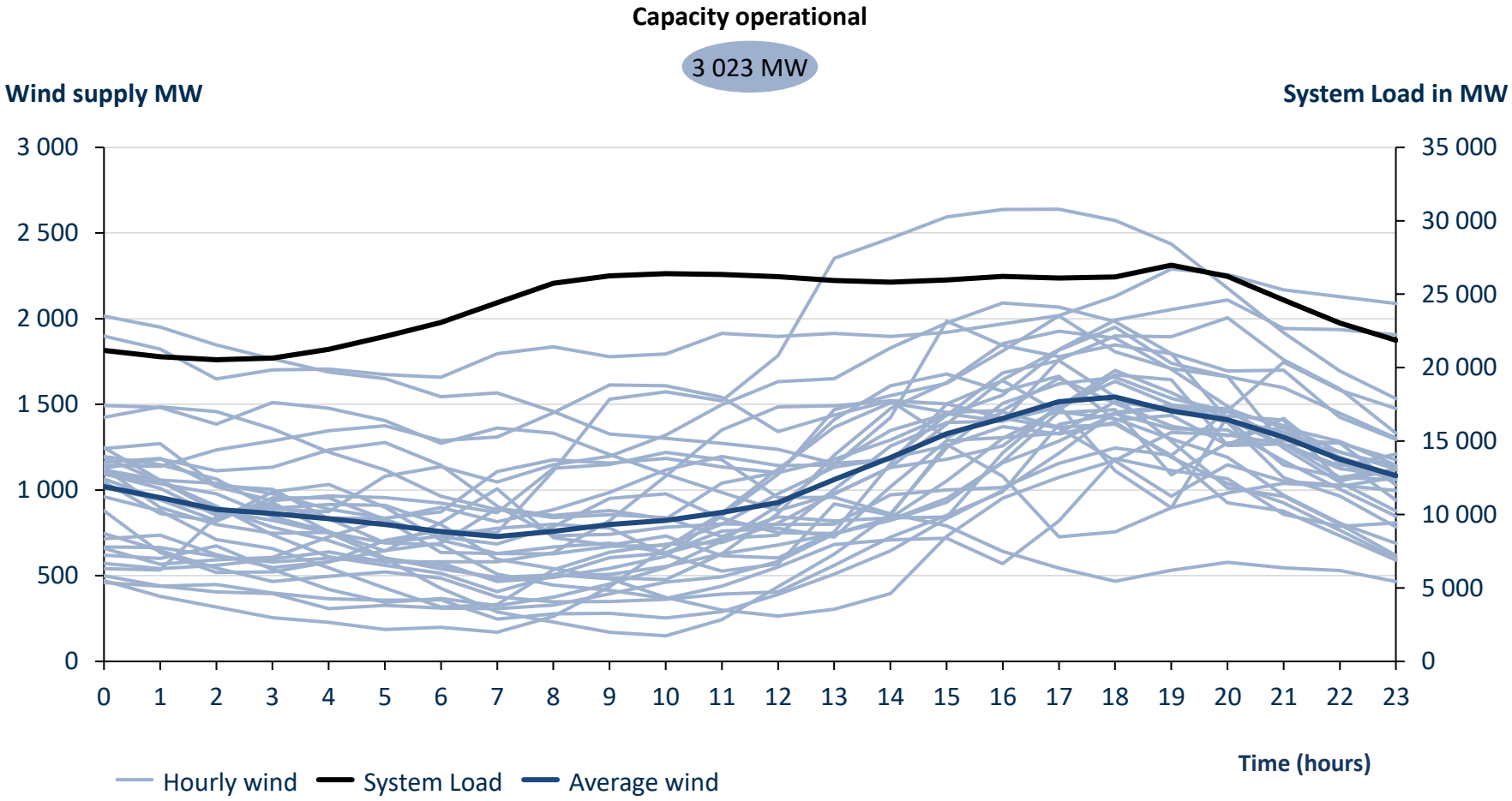
In Dec 2021, wind supply fluctuated day-to-day

Hourly wind production for all 31 days of December 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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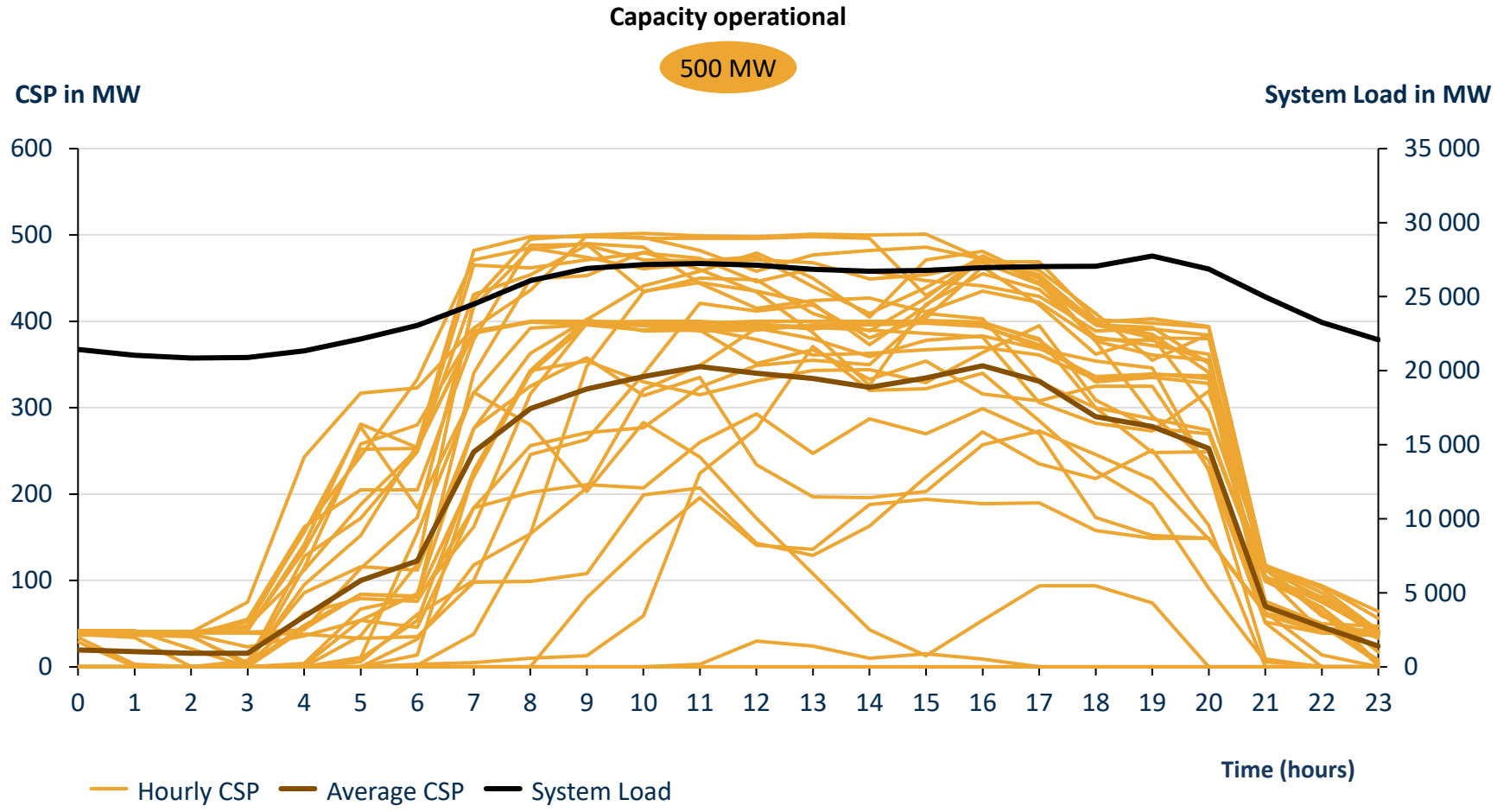
In Jan 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of January 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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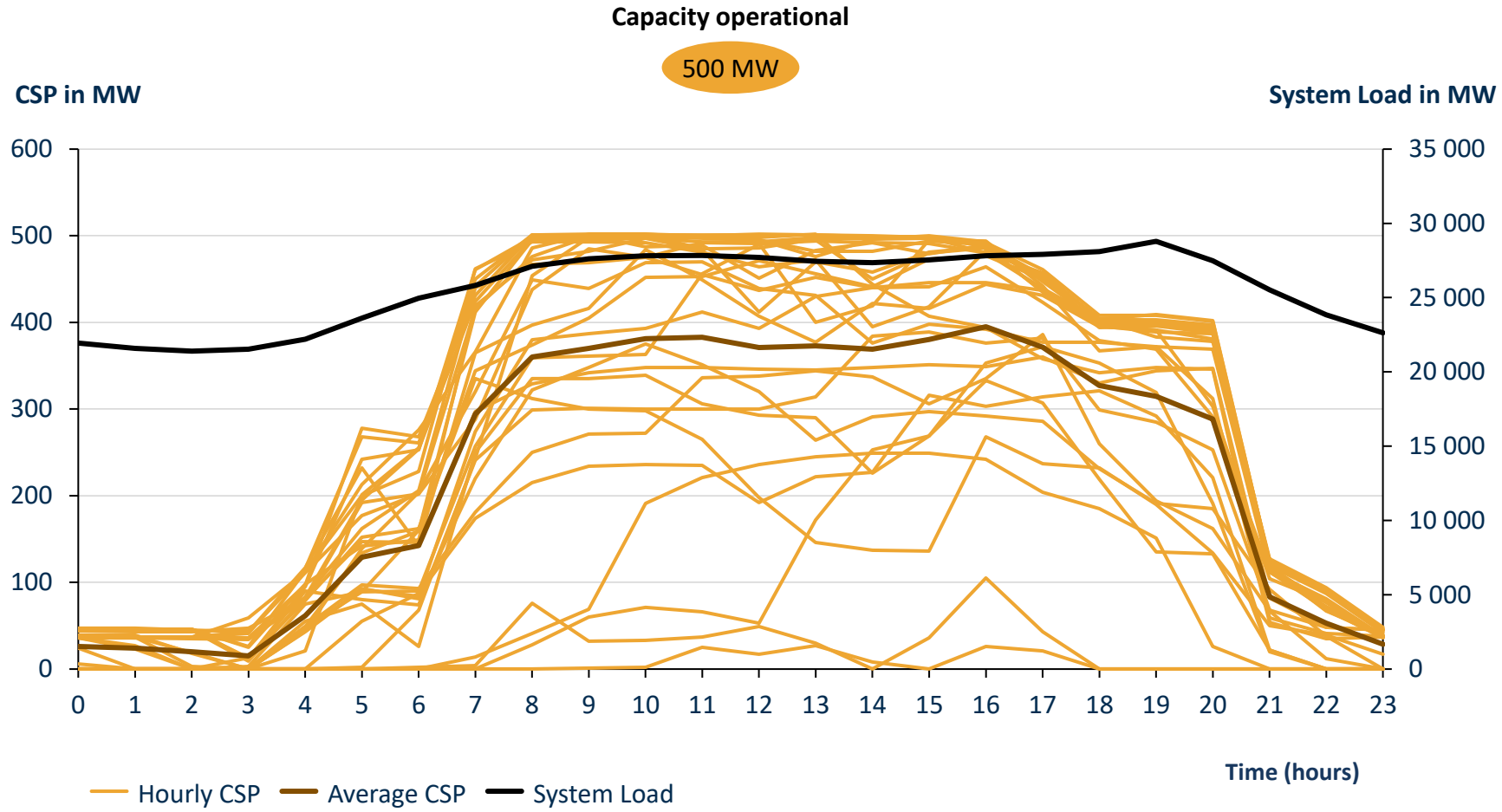
In Feb 2021, CSP storage used in evenings

Hourly CSP production for all 28 days of February 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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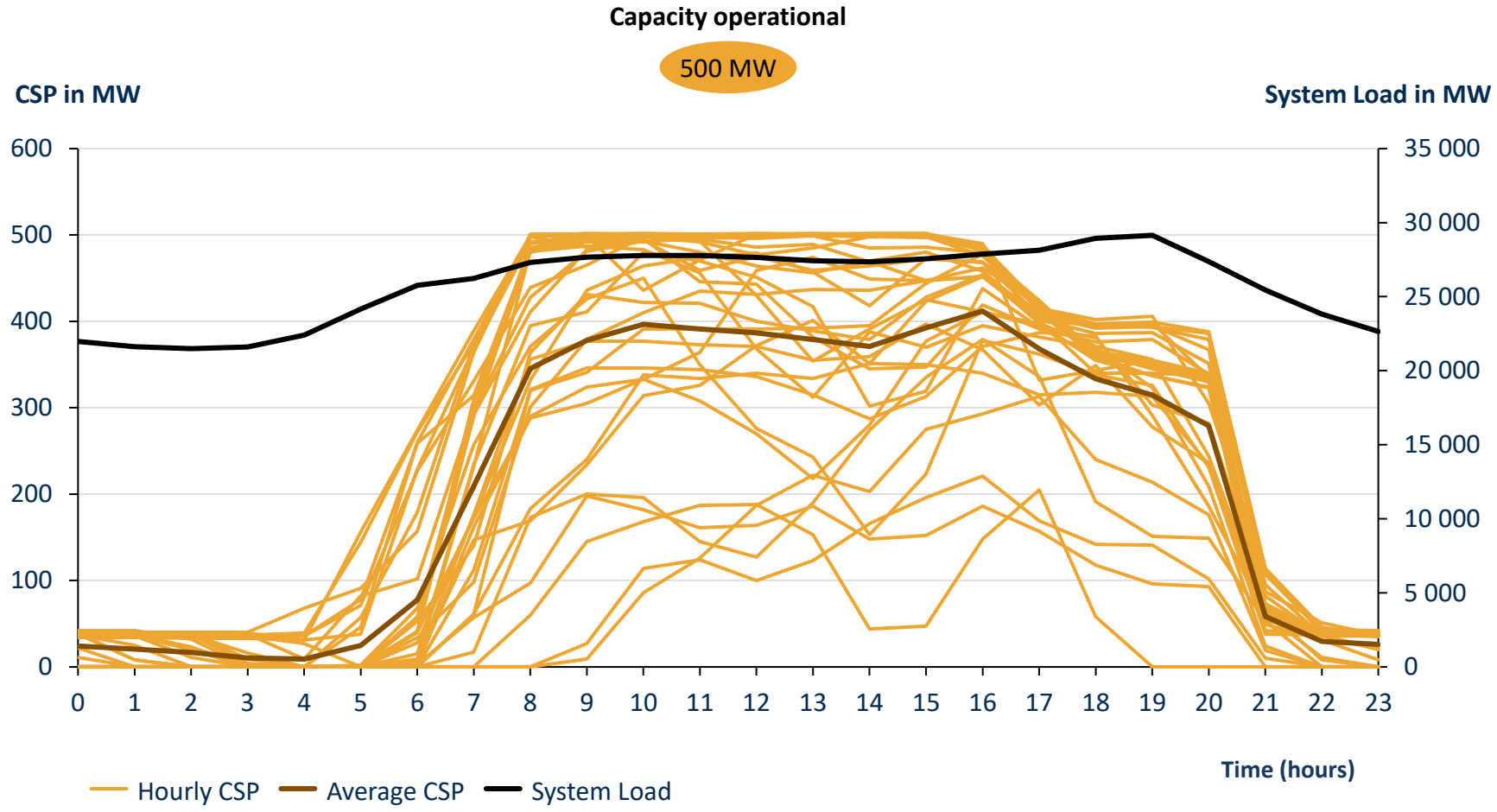
In Mar 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of March 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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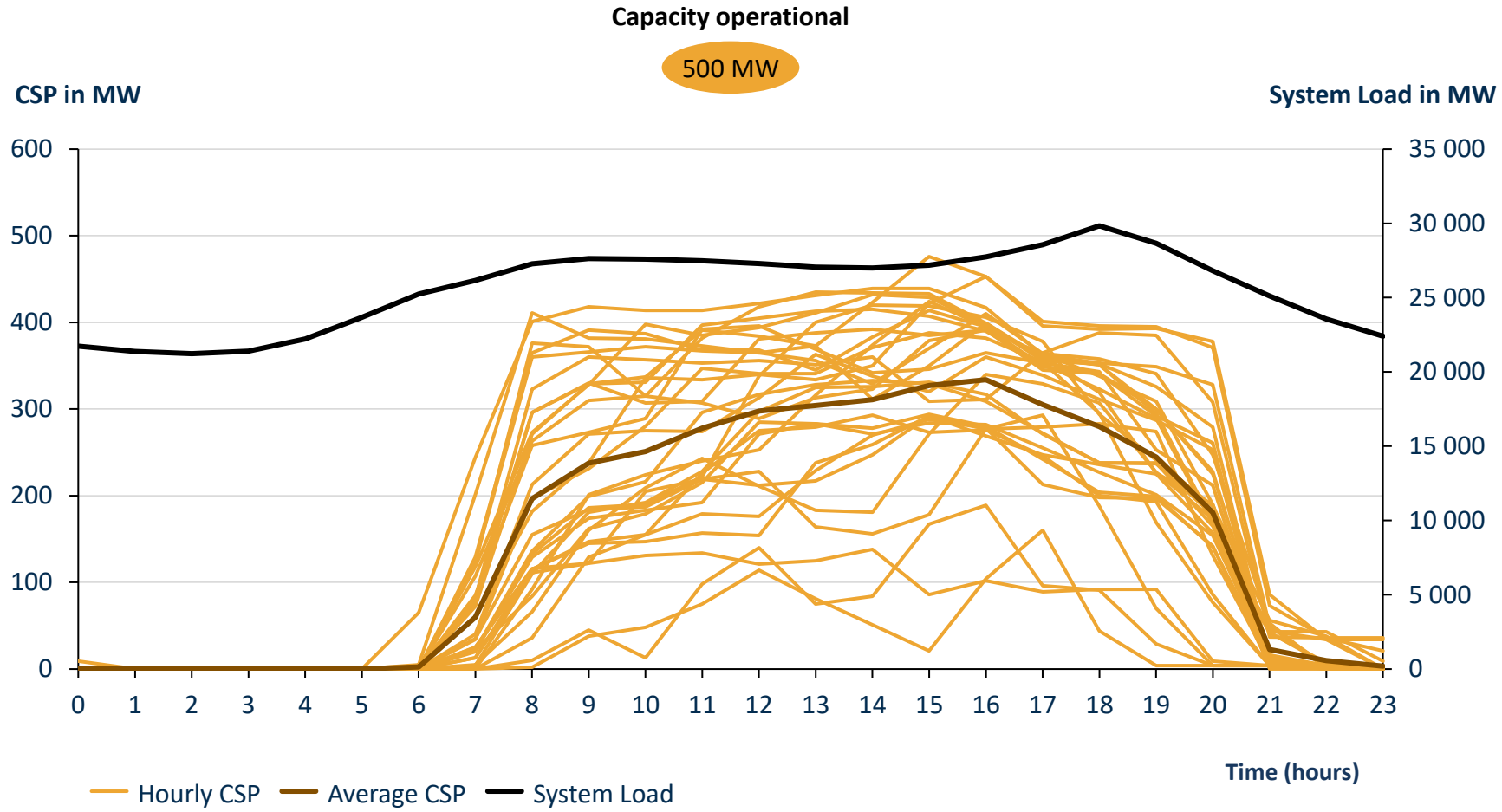
In Apr 2021, CSP storage used in evenings

Hourly CSP production for all 30 days of April 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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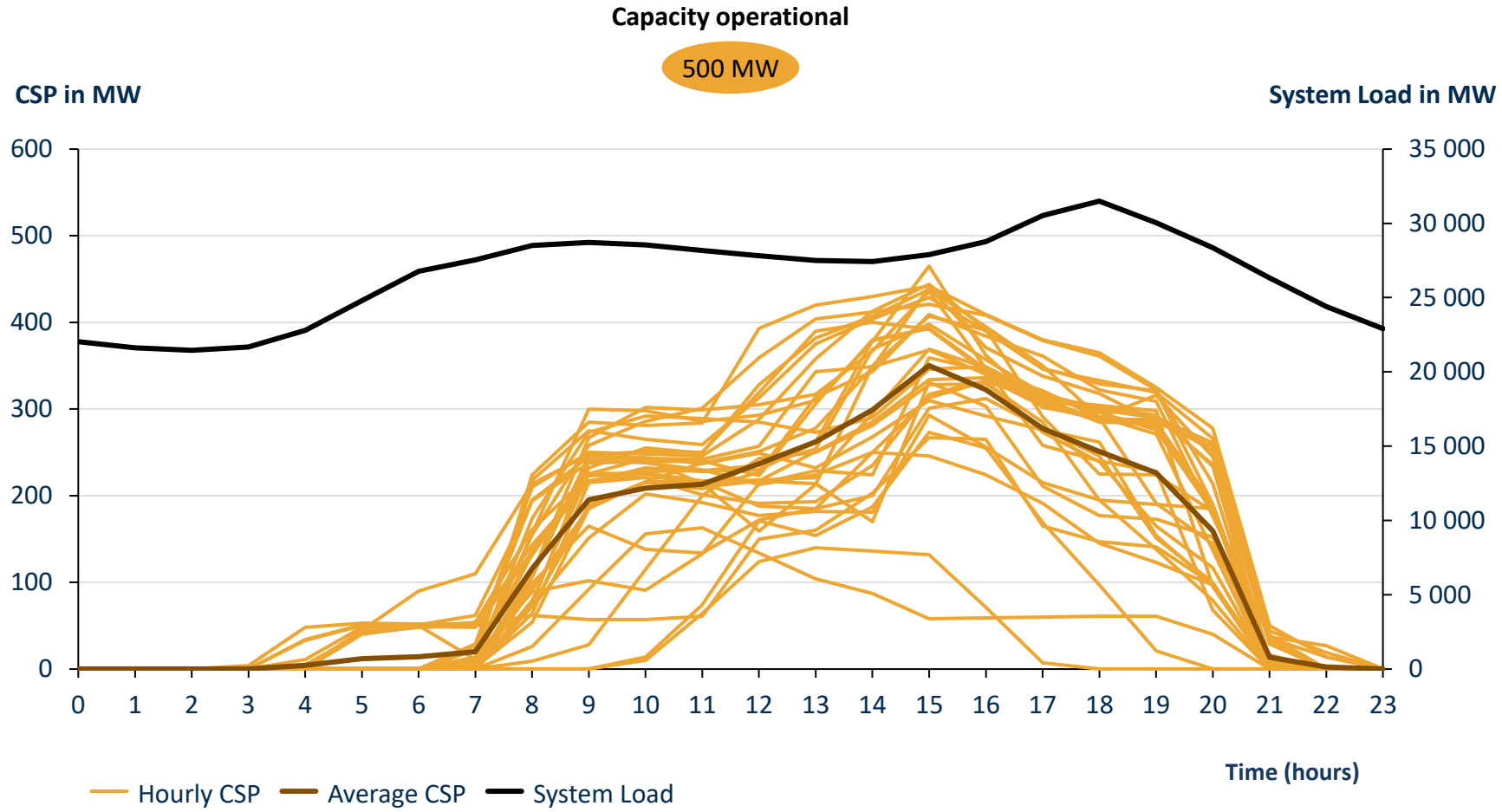
In May 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of May 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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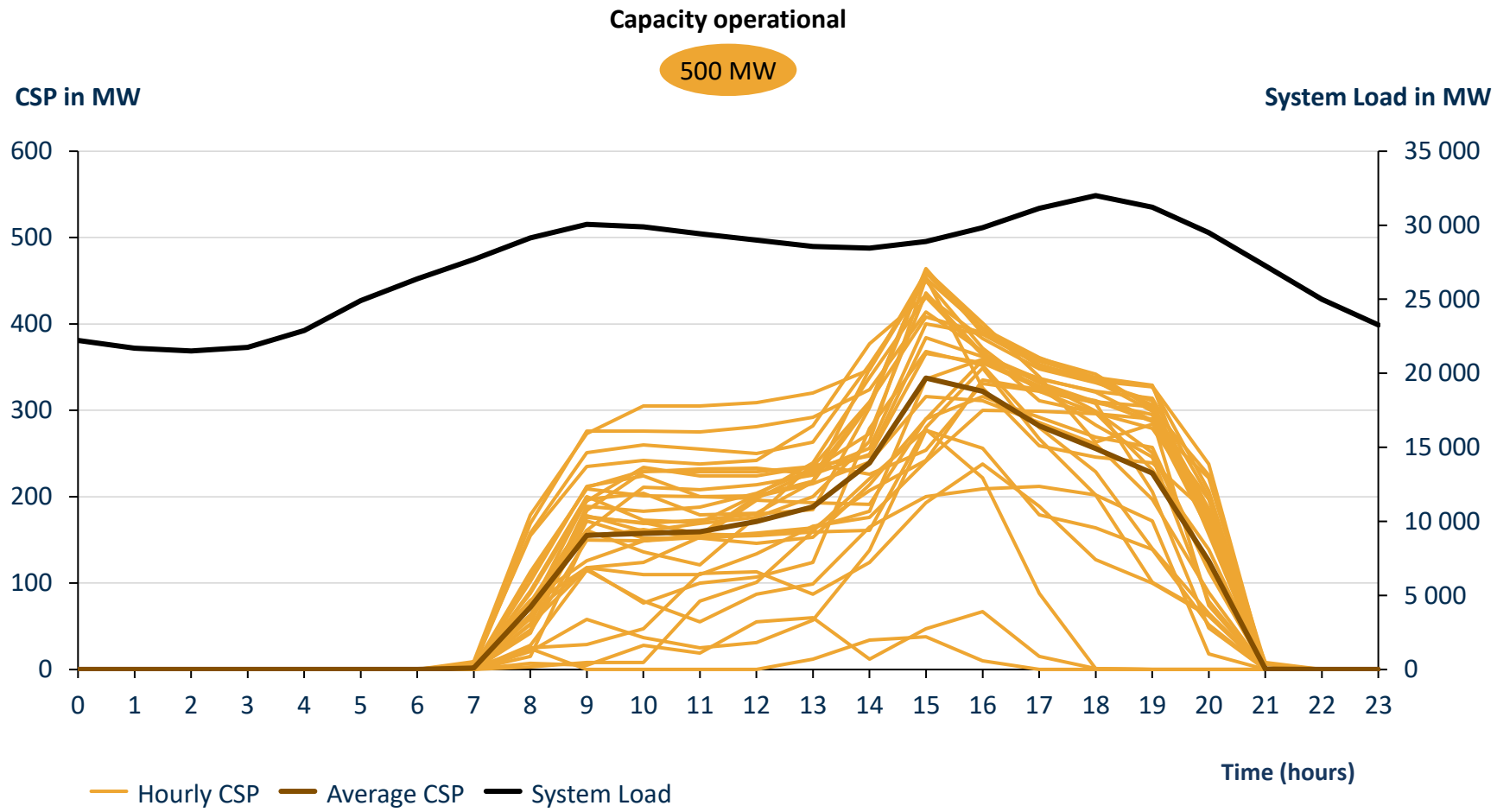
In Jun 2021, CSP storage used in evenings

Hourly CSP production for all 30 days of June 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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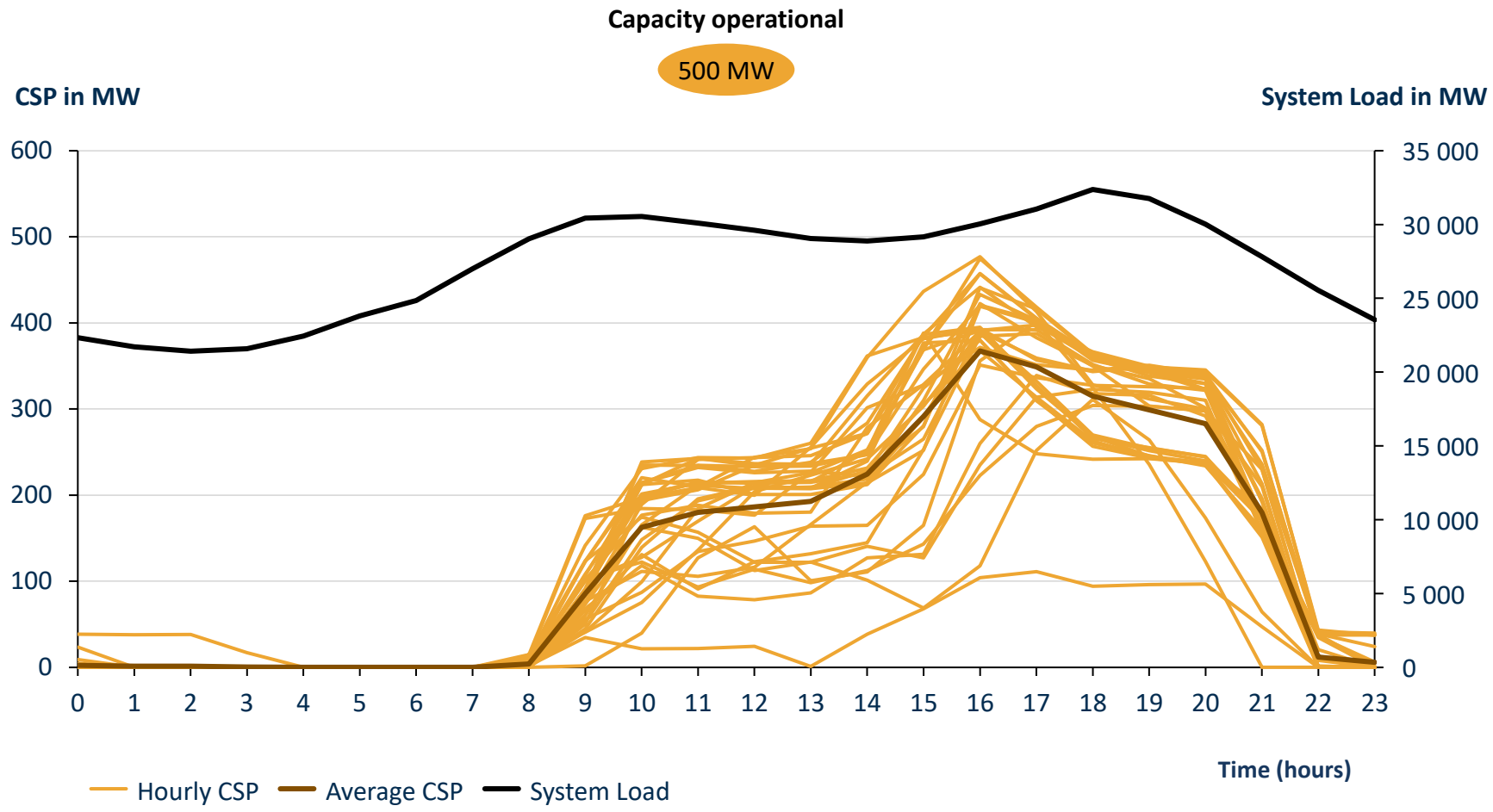
In Jul 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of July 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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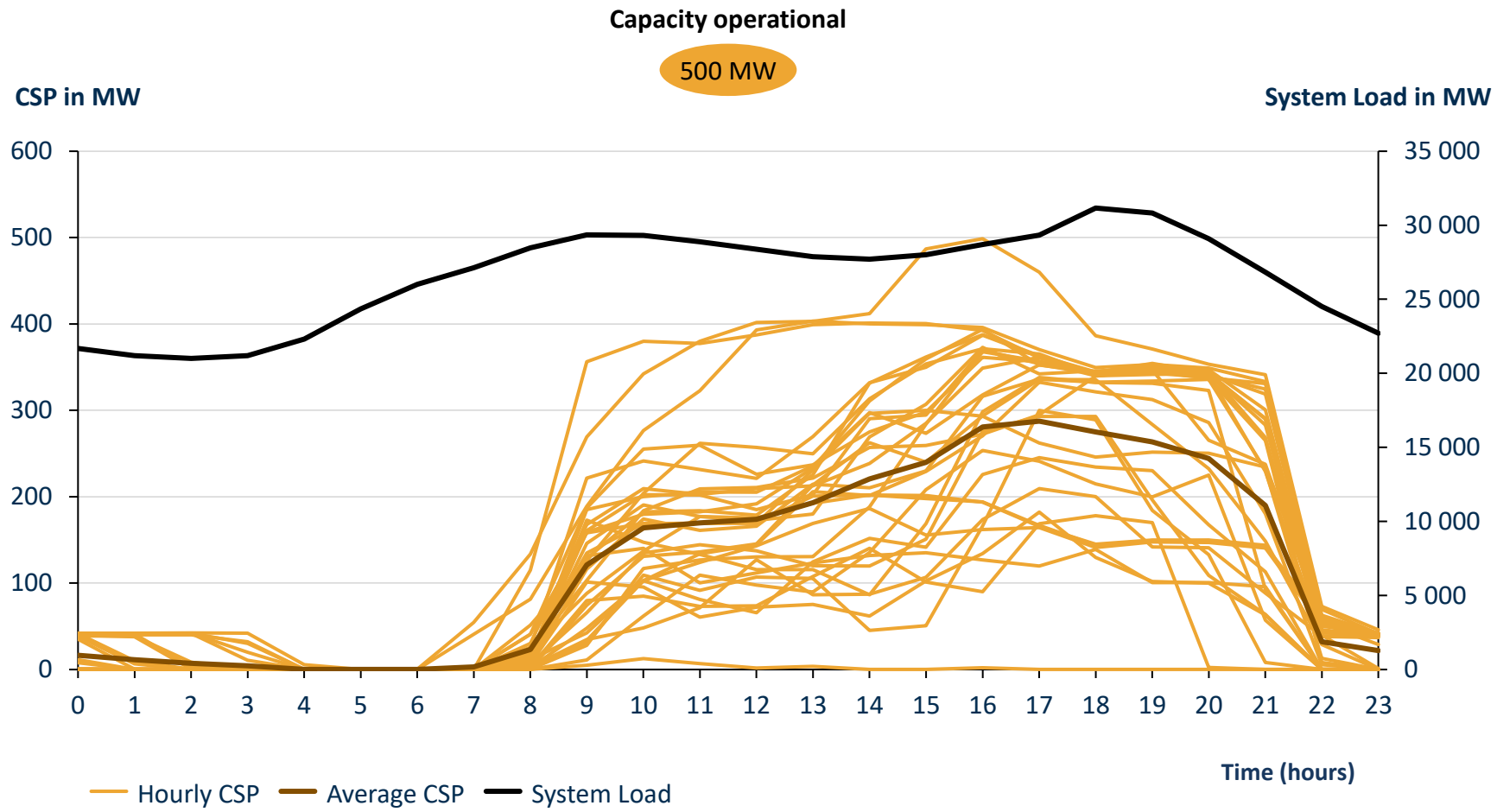
In Aug 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of August 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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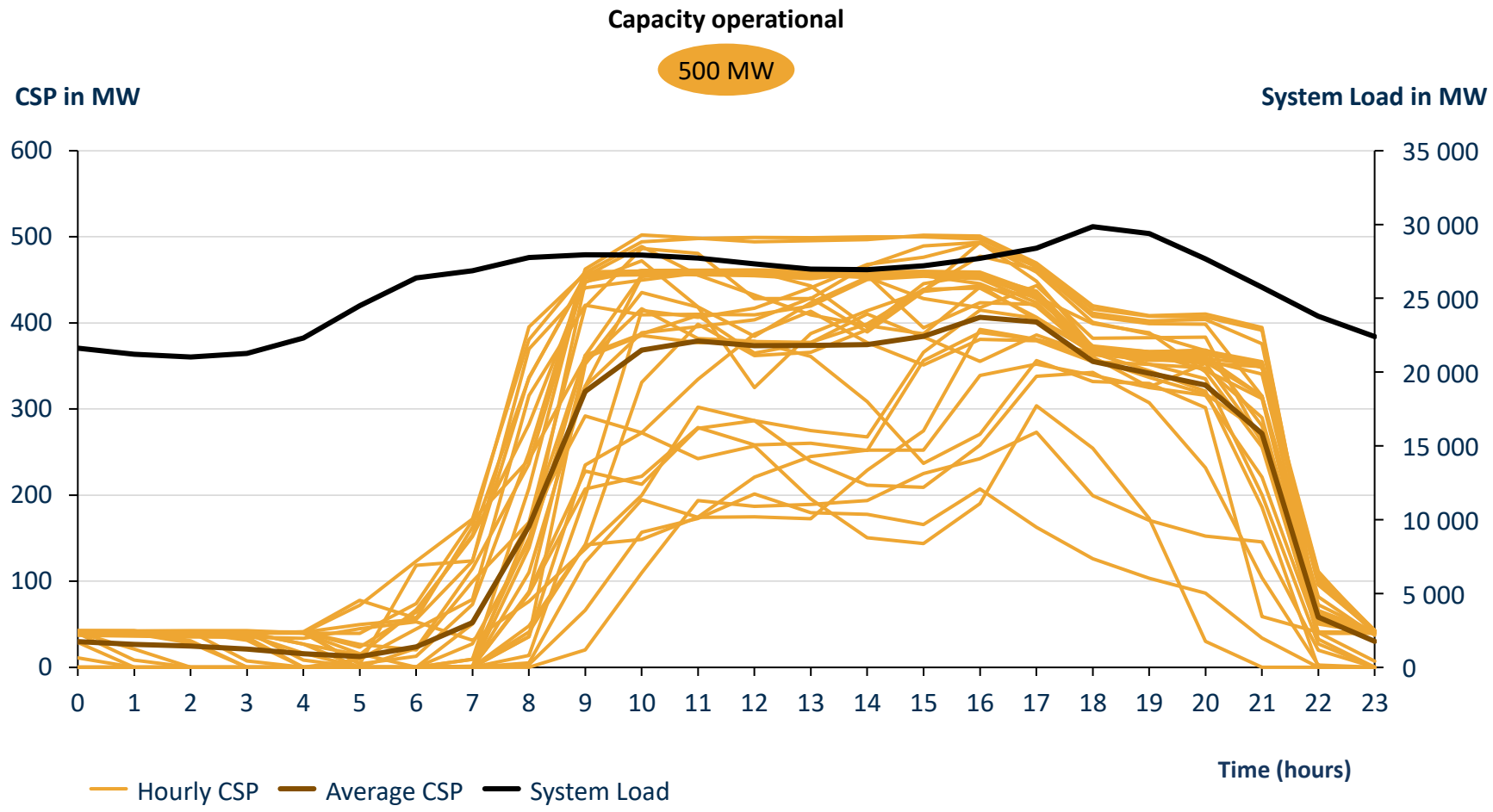
In Sep 2021, CSP storage used in evenings

Hourly CSP production for all 30 days of September 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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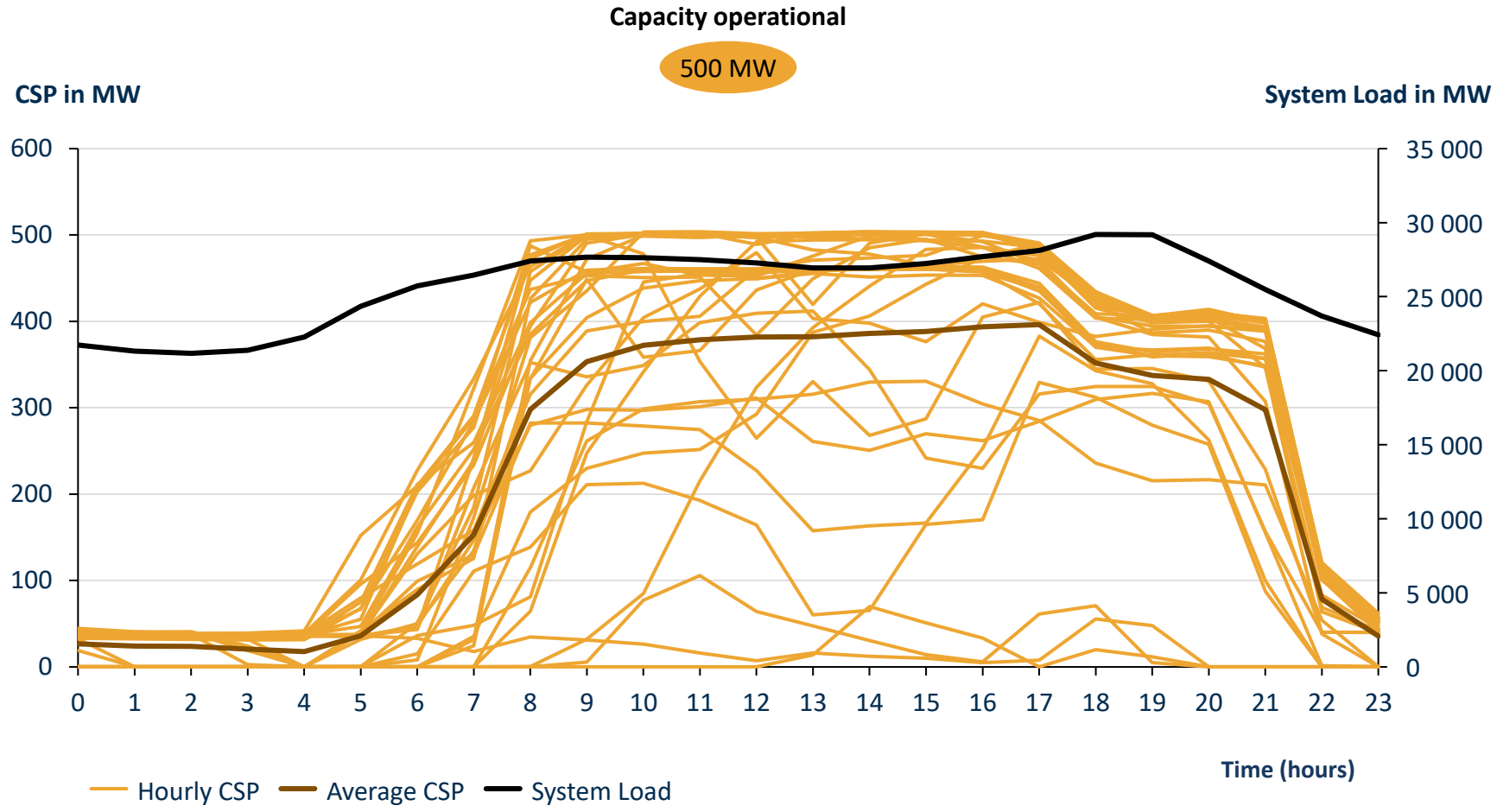
In Oct 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of October 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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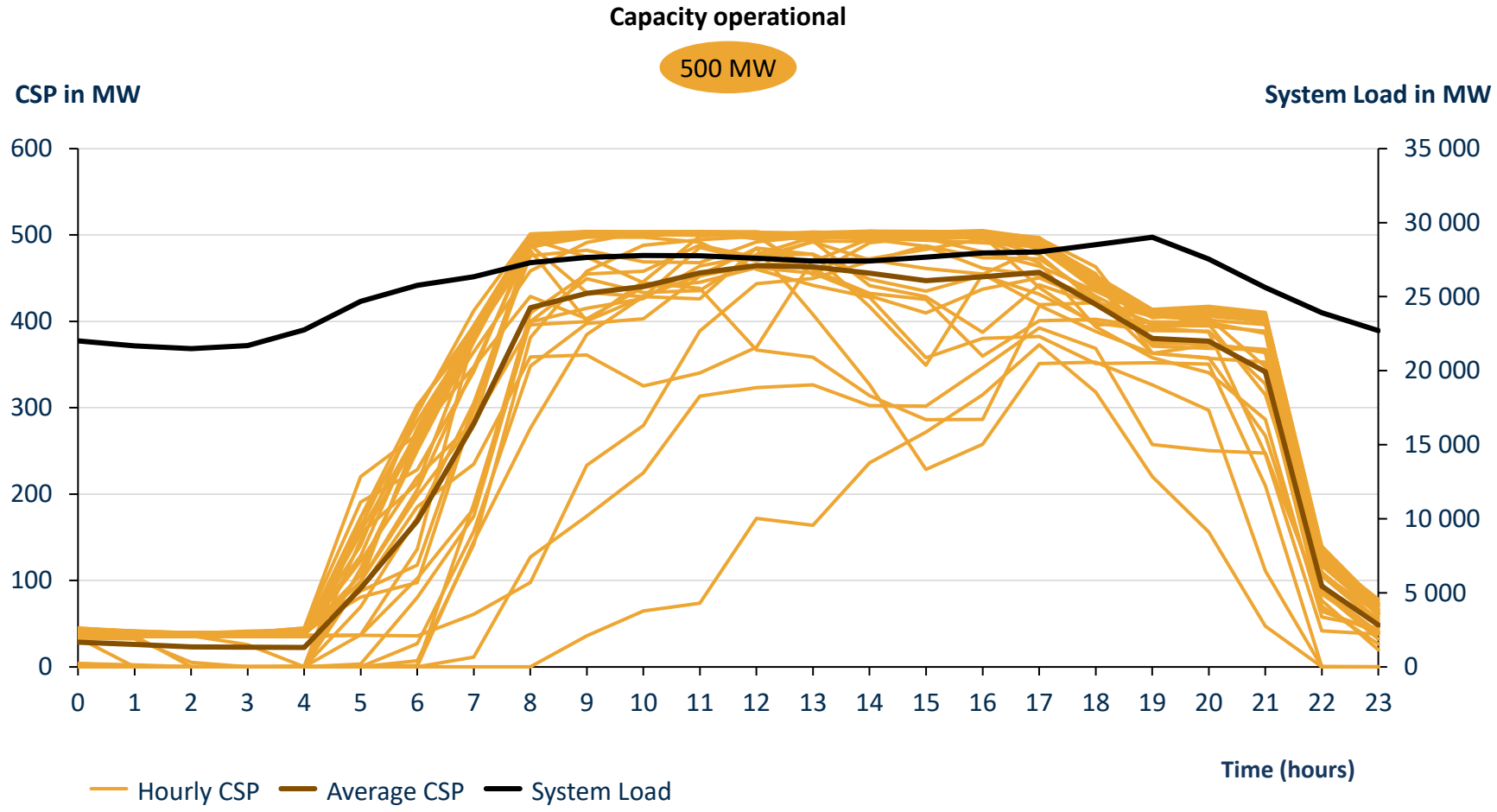
In Nov 2021, CSP storage used in evenings

Hourly CSP production for all 30 days of November 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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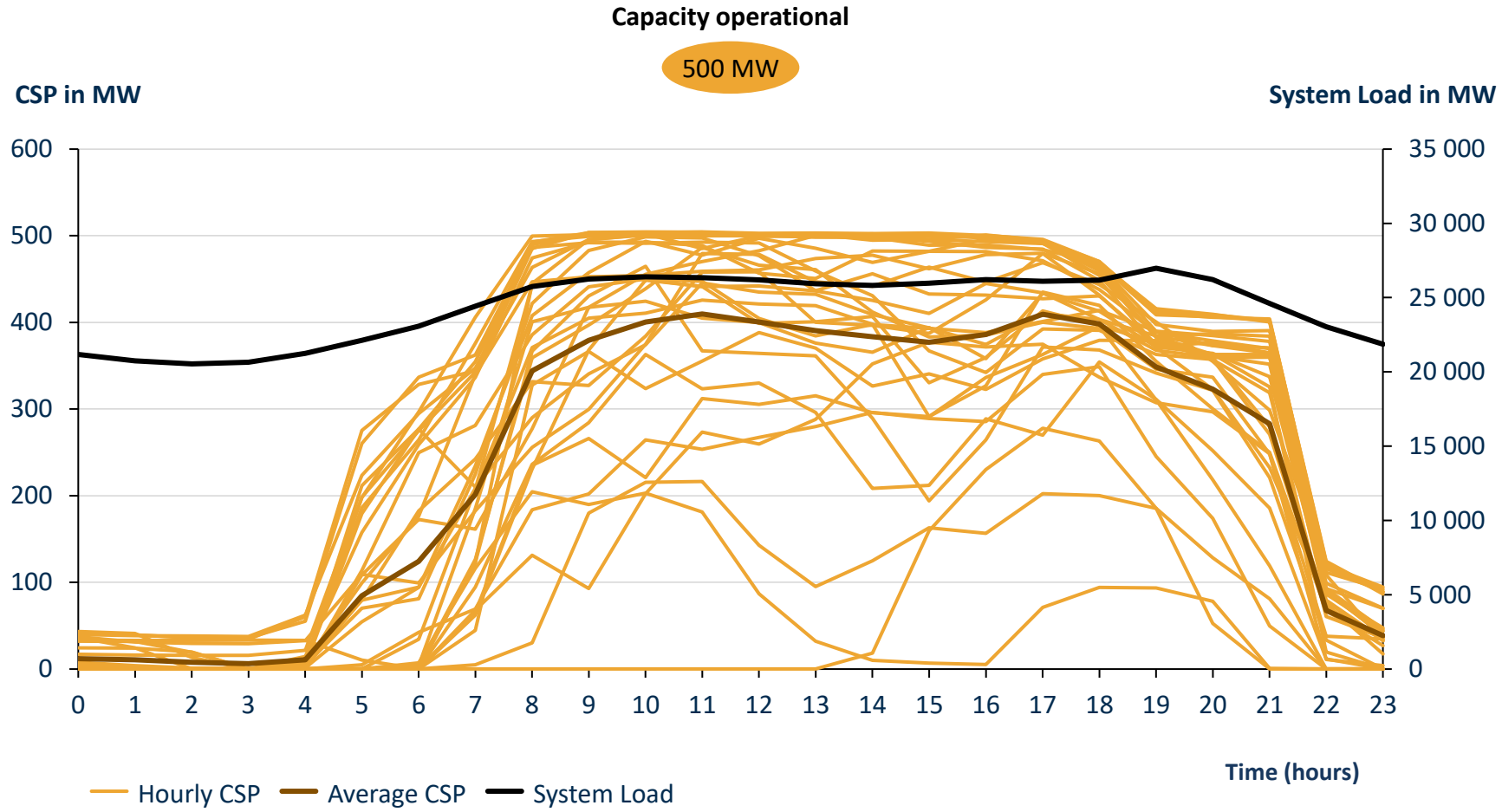
In Dec 2021, CSP storage used in evenings

Hourly CSP production for all 31 days of December 2021 & average system load diurnal course



Note: System load excludes hydro pumping load (represented as the average for the month)
Sources: Eskom; CSIR Energy Centre analysis

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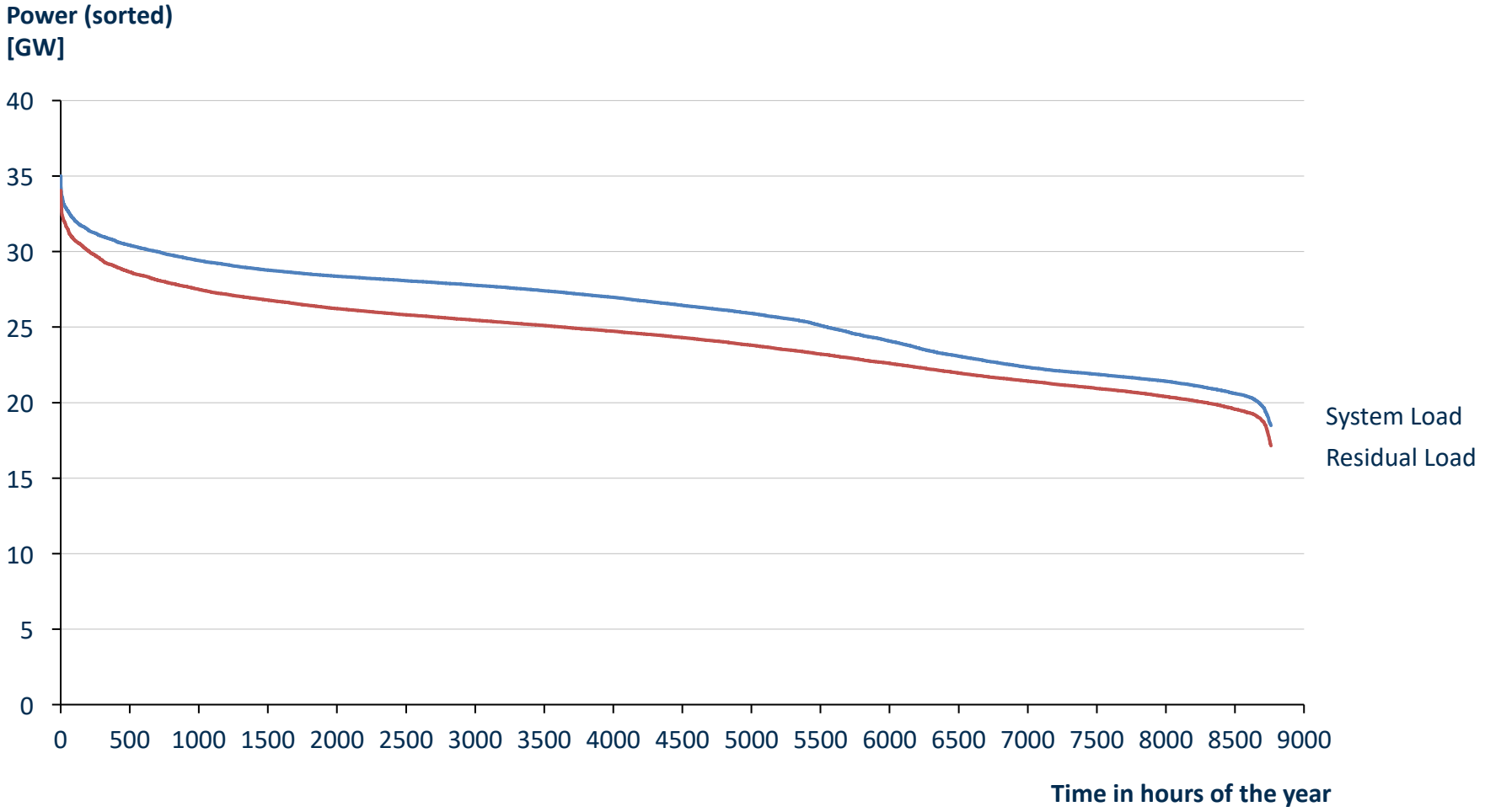
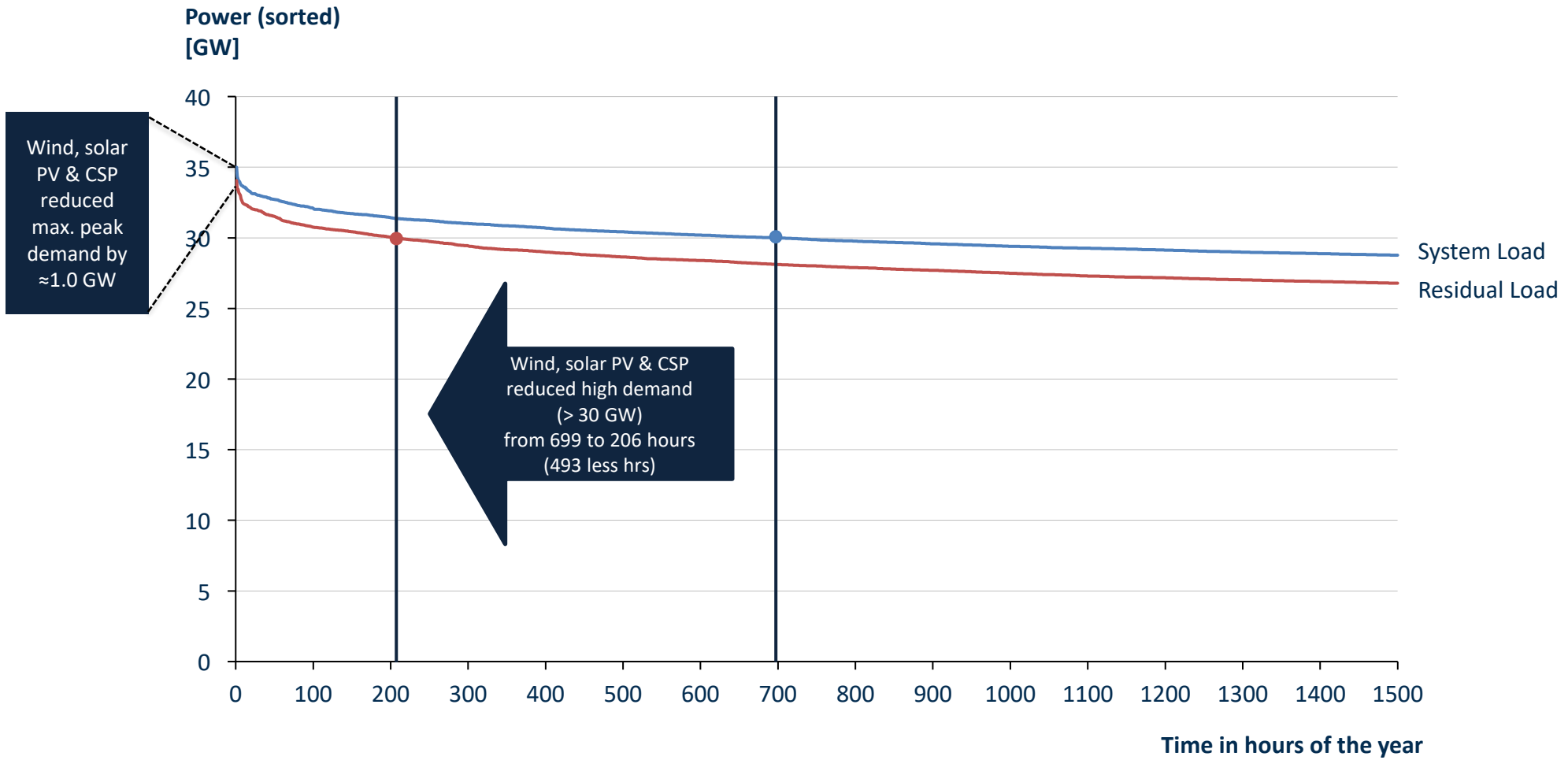
Jan-Dec 2021 system load and residual load duration curves



Notes: Residual Load = System Load - wind - Solar PV - CSP
Sources: Eskom; CSIR Energy Centre analysis

From Jan-Dec 2021 – wind, solar PV & CSP reduced the number of hours with >30 GW total load by 70.5% (~493 less hours)



Sources: Eskom; CSIR Energy Centre analysis

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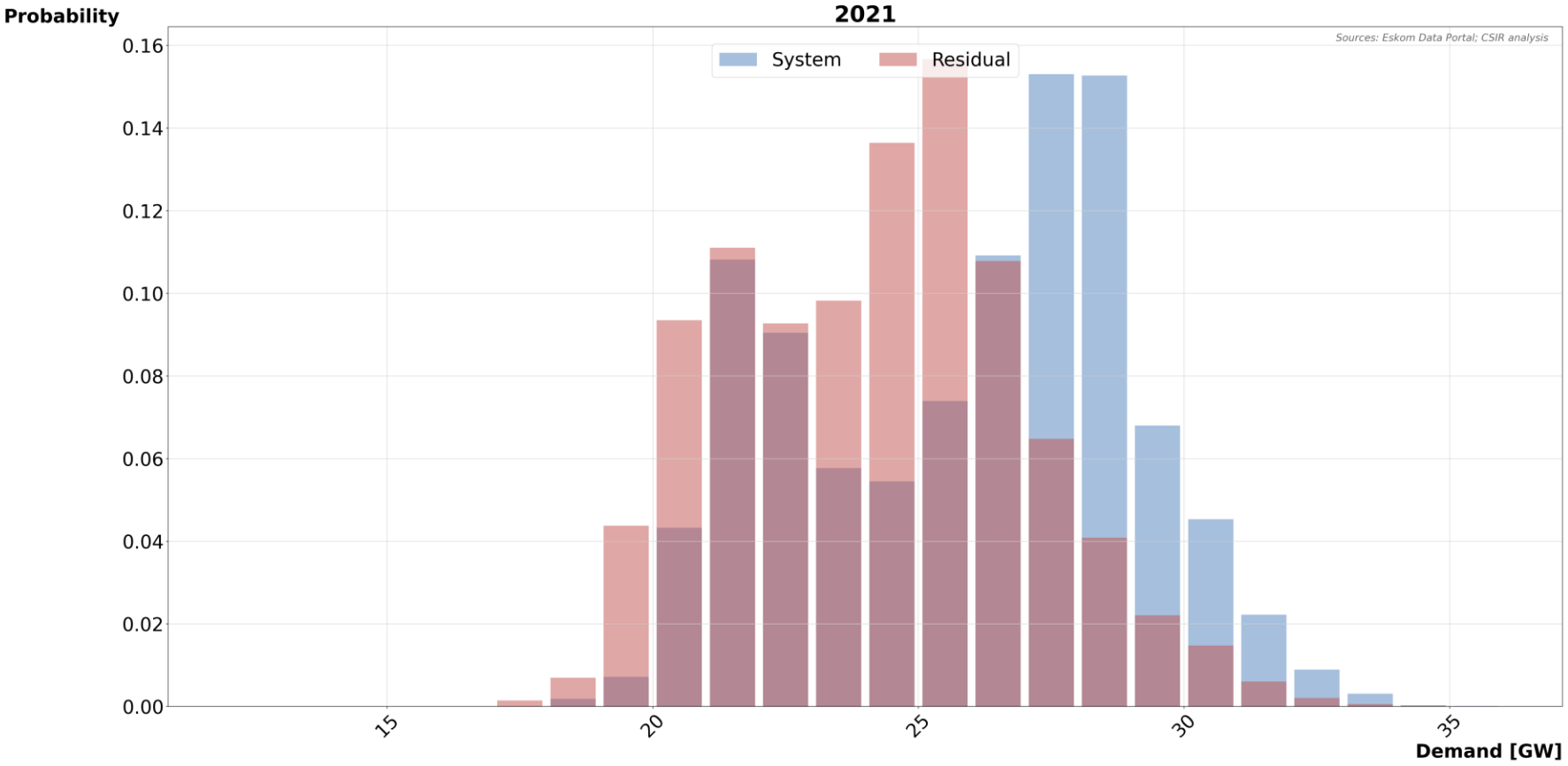
VRE contribution continues to be demonstrated - distinct shift of residual demand to lower demand levels as VRE contributes during most demand periods



Sources: Eskom; CSIR Energy Centre analysis

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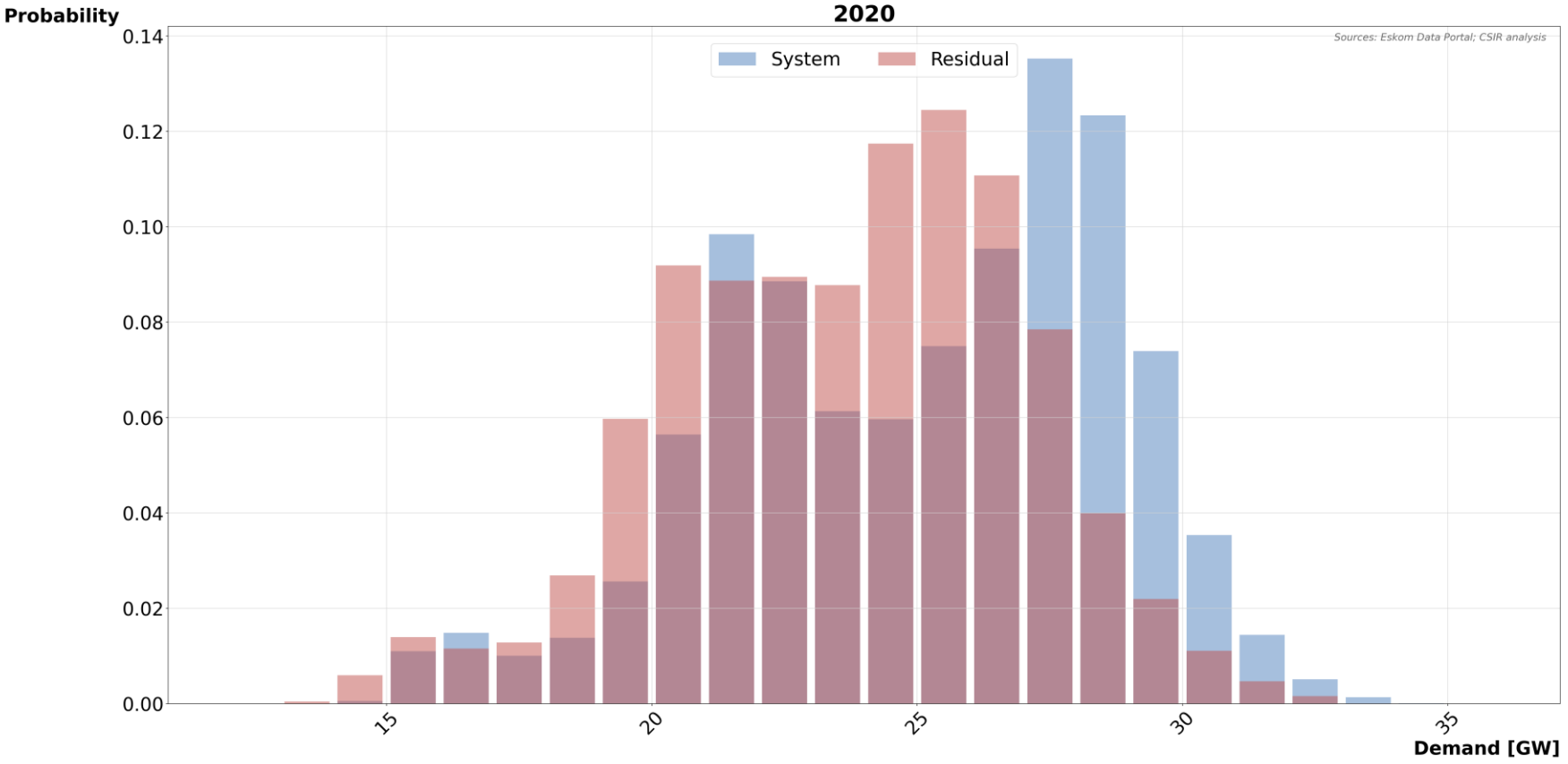
Unique nature of 2020 demand meant unprecedented low demand levels but for very brief periods of time with similar effect of VRE



Sources: Eskom; CSIR Energy Centre analysis

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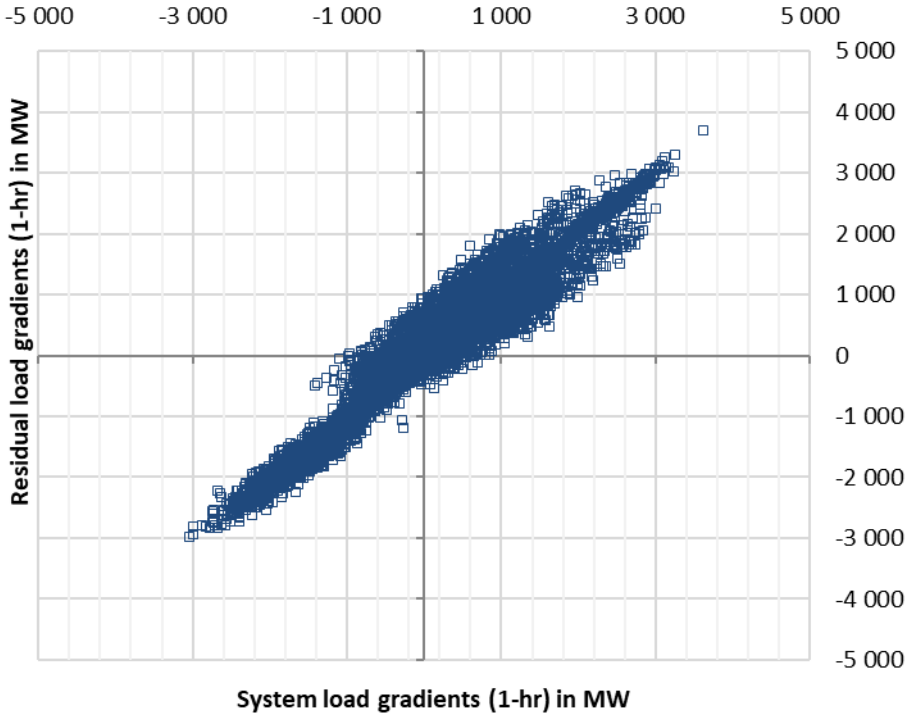
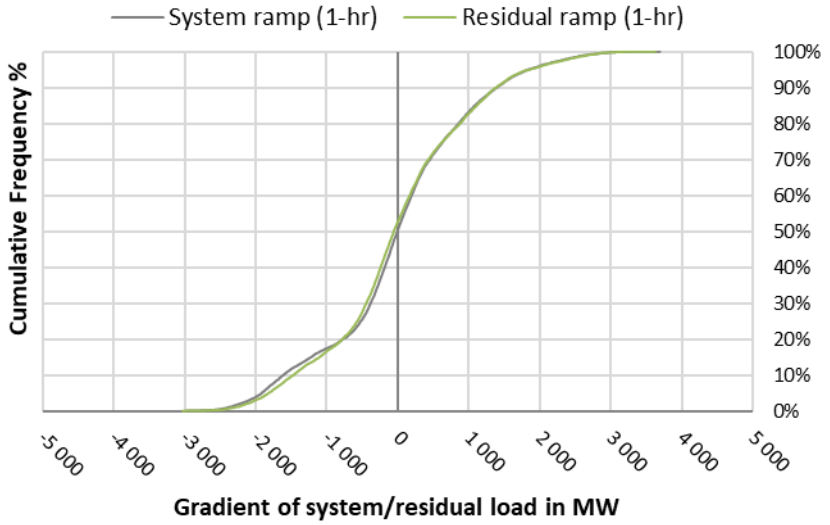
1-hour gradients did not significantly increase due to collective 5.9 GW of wind, solar PV & CSP

System load 1-hour gradients vs. residual load 1-hour gradients for all hours from Jan-Dec 2021



Cumulative frequency distribution of 1-hour gradients for all hours from Jan-Dec 2021



Notes: System and Residual load excludes pumping load for all data points throughout the year
Sources: Eskom; CSIR Energy Centre analysis

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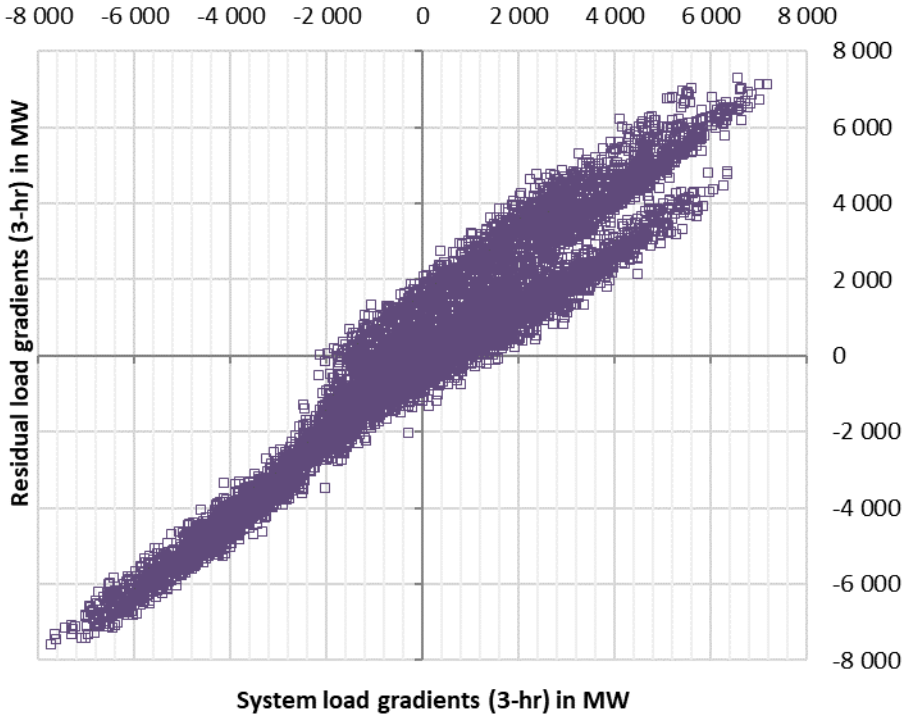
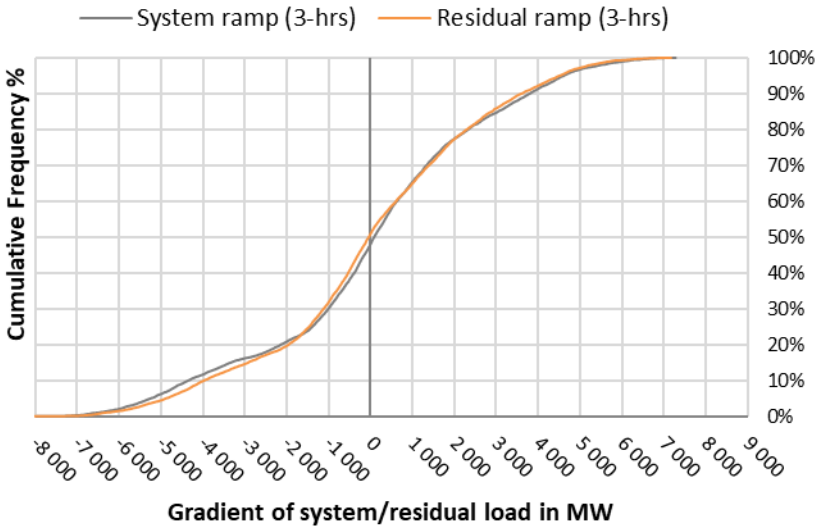
Similarly - 3-hour gradients did not significantly increase due to 5.9 GW of wind, solar PV & CSP

System load 3-hour gradients vs. residual load 3-hour gradients for all hours from Jan-Dec 2021



Cumulative frequency distribution of 3-hour gradients for all hours from Jan-Dec 2021



Notes: System and Residual load excludes pumping load for all data points throughout the year
Sources: Eskom; CSIR Energy Centre analysis

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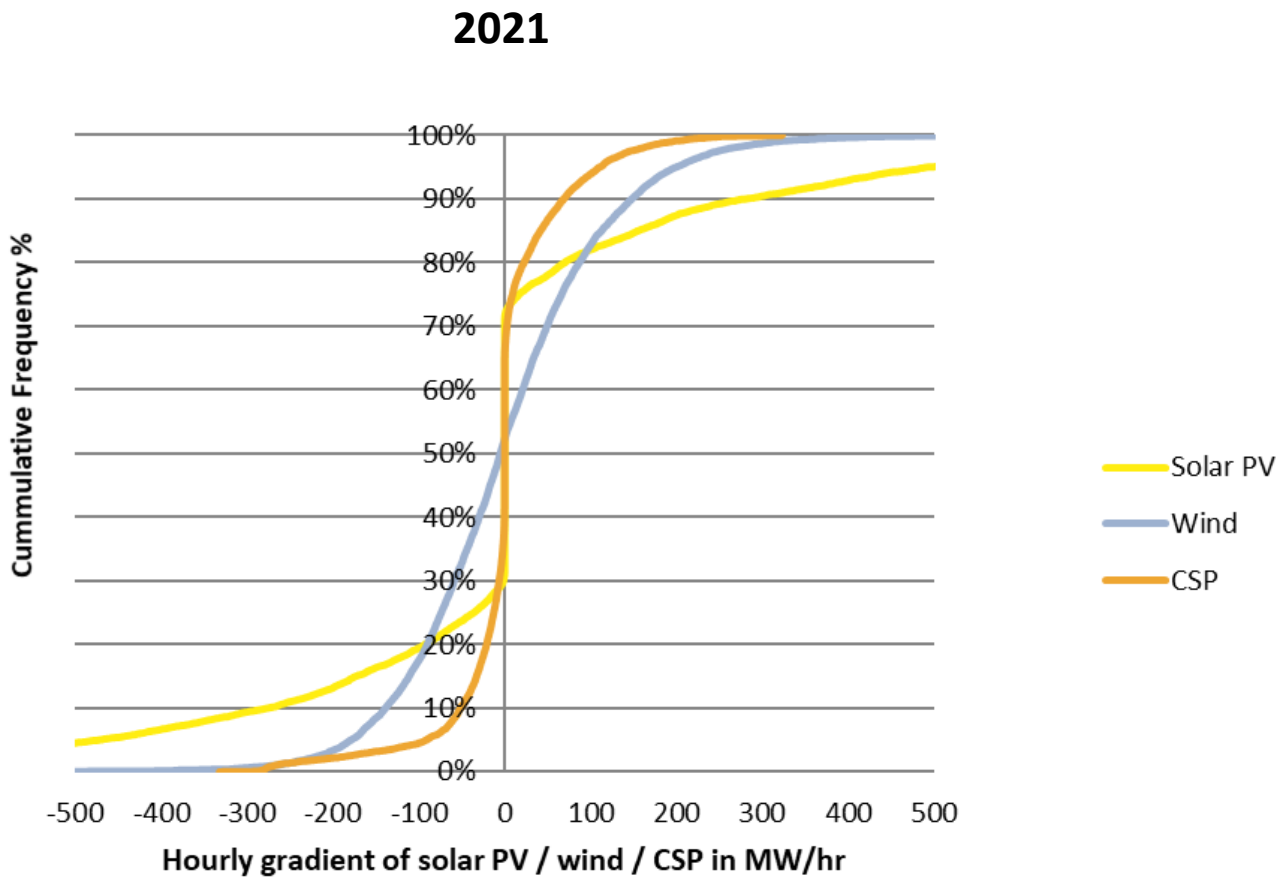
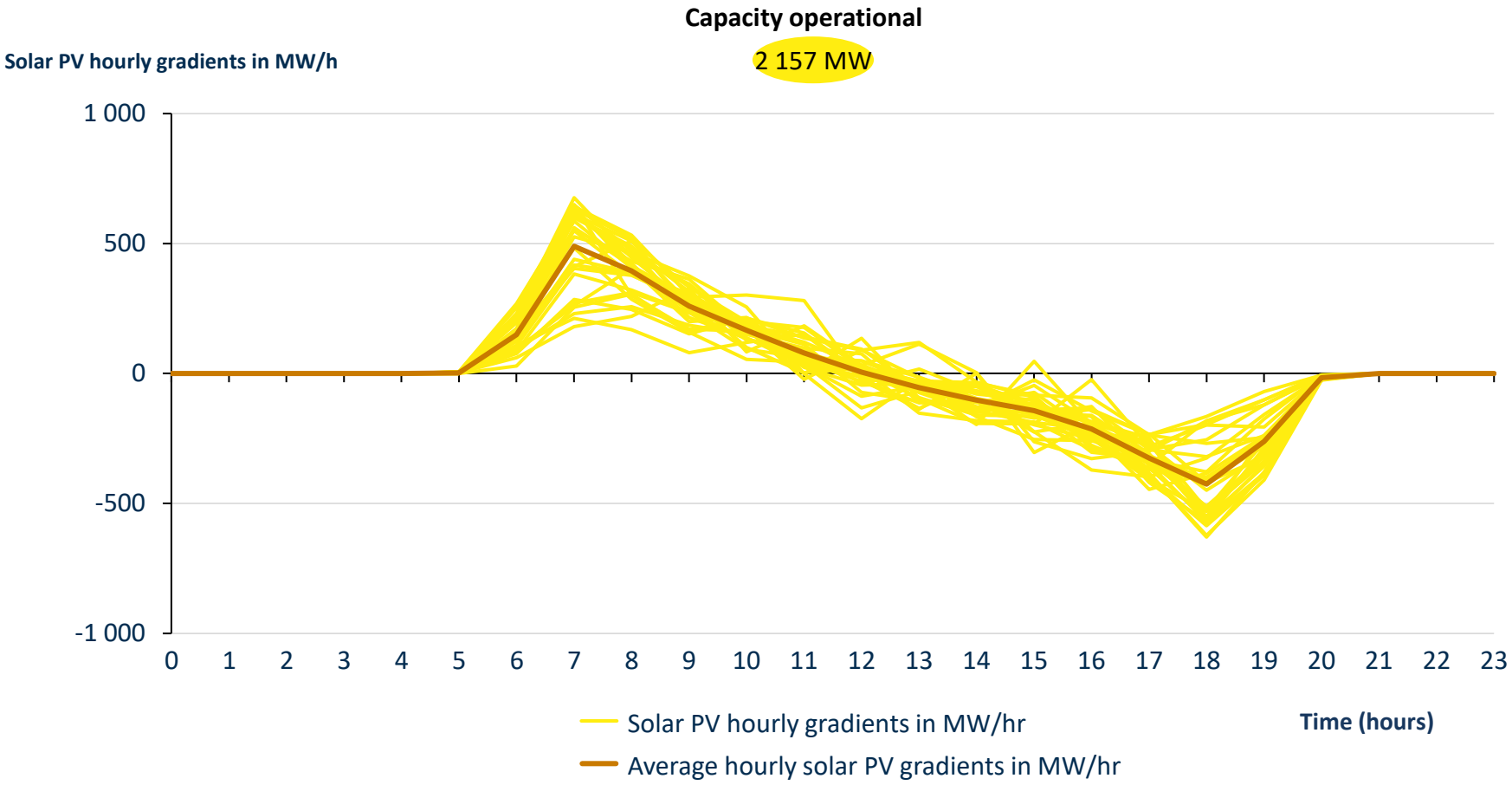
Wind, solar PV & CSP frequency distribution of 1-hour gradients in 2021



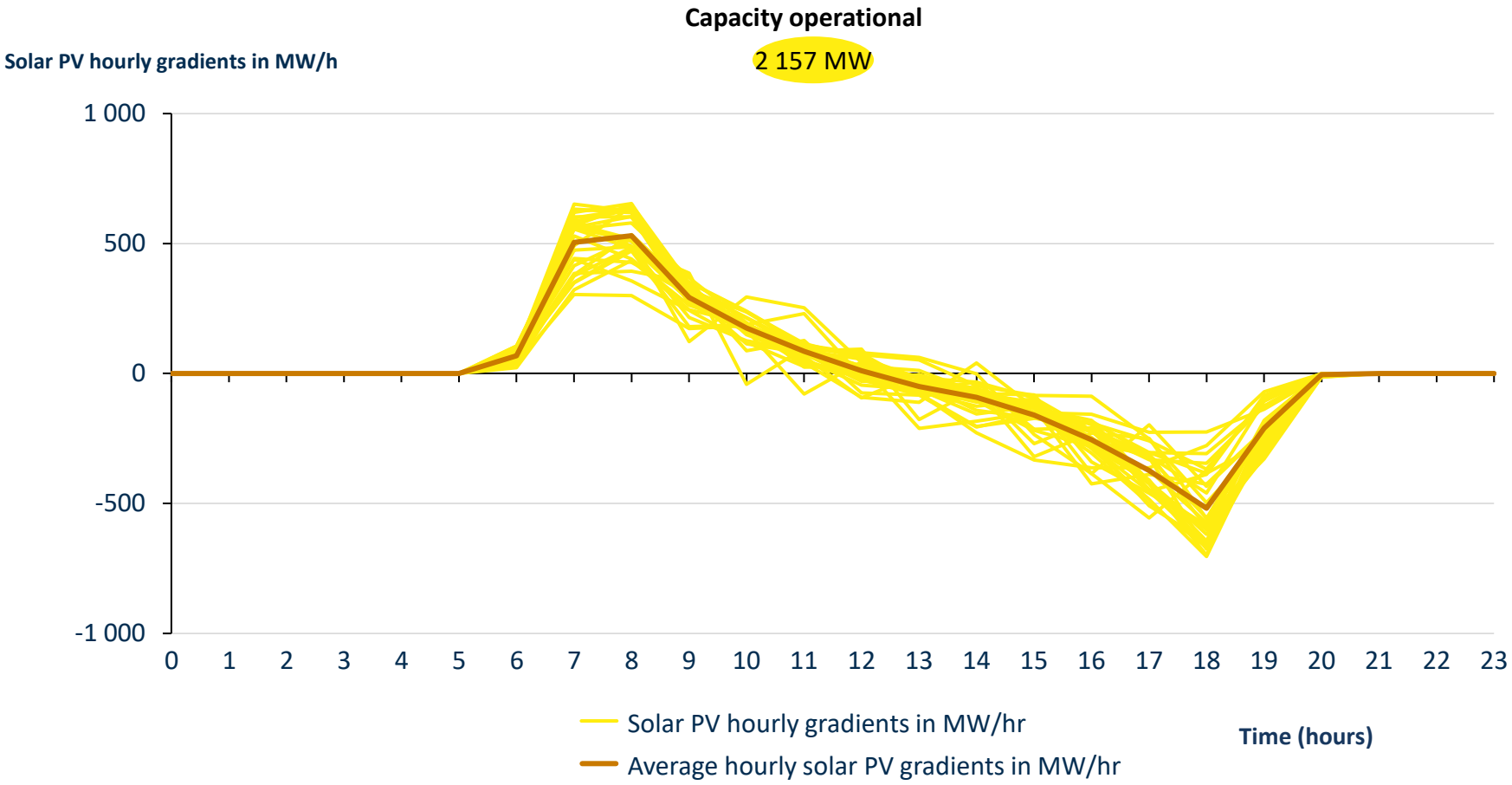
Sources: Eskom; CSIR Energy Centre analysis

Solar PV 1-hour gradients in January 2021



Sources: Eskom; CSIR Energy Centre analysis

Solar PV 1-hour gradients in February 2021



Sources: Eskom; CSIR Energy Centre analysis

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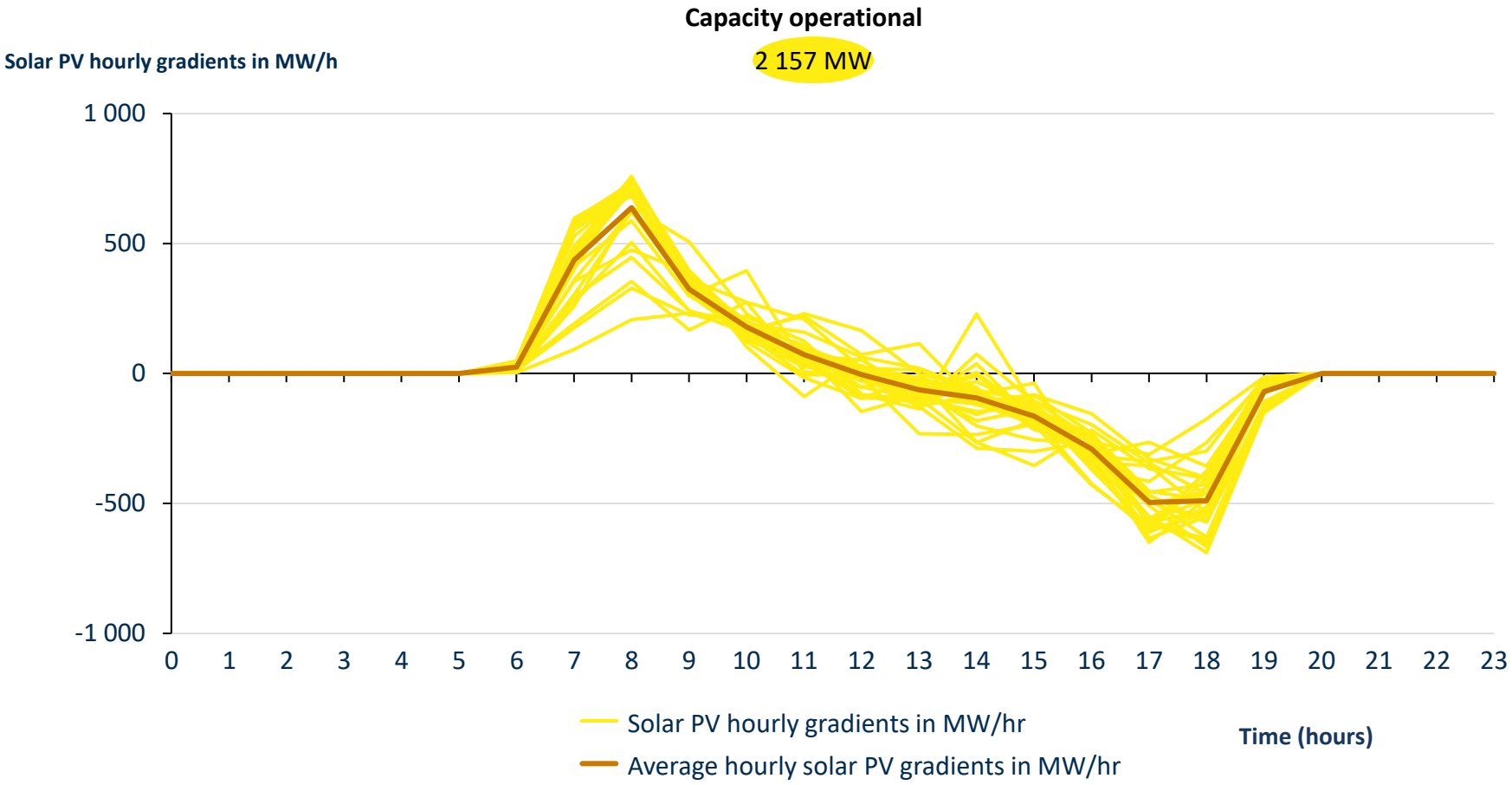
Solar PV 1-hour gradients in March 2021



Sources: Eskom; CSIR Energy Centre analysis

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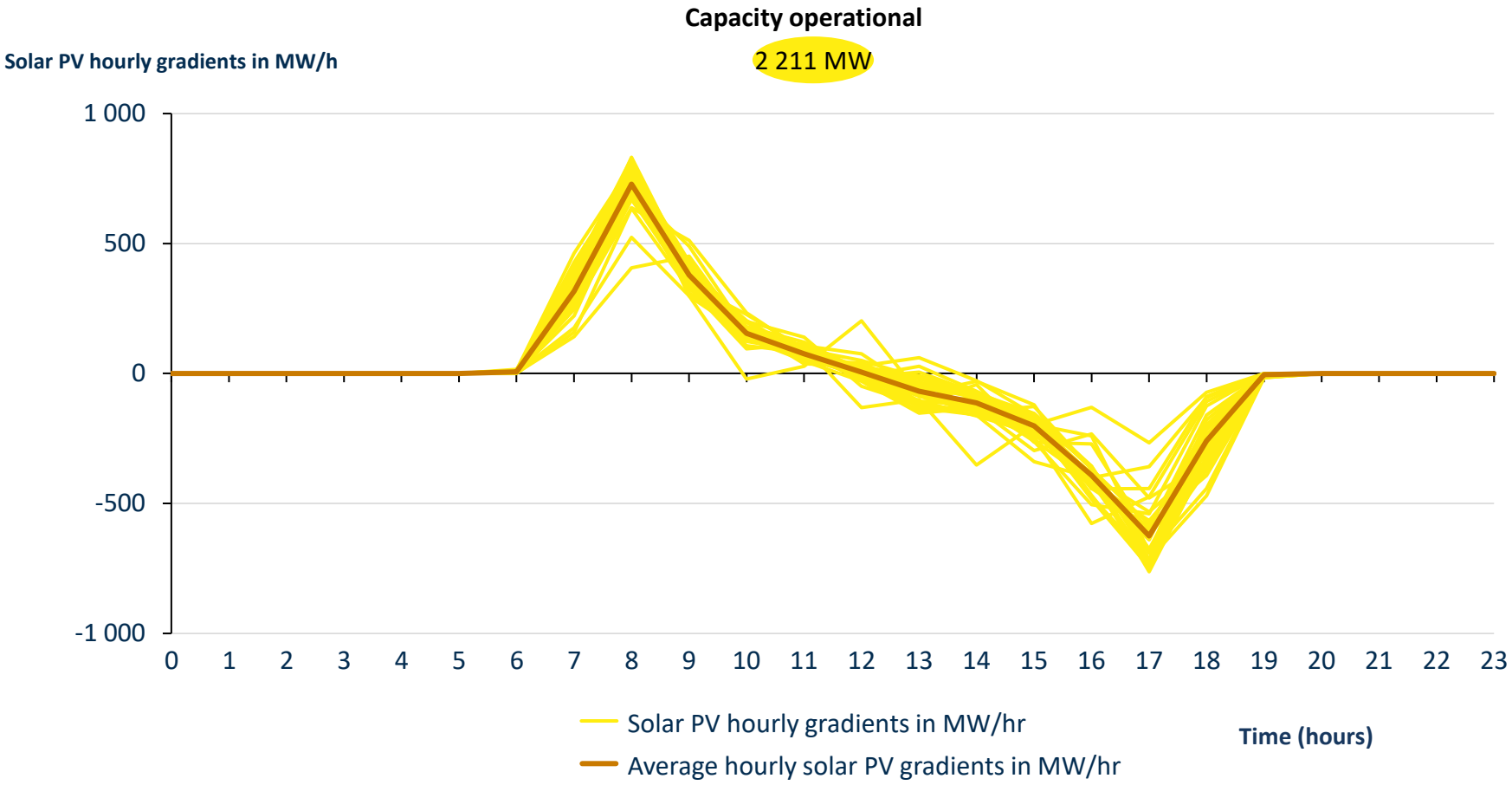
Solar PV 1-hour gradients in April 2021



Sources: Eskom; CSIR Energy Centre analysis

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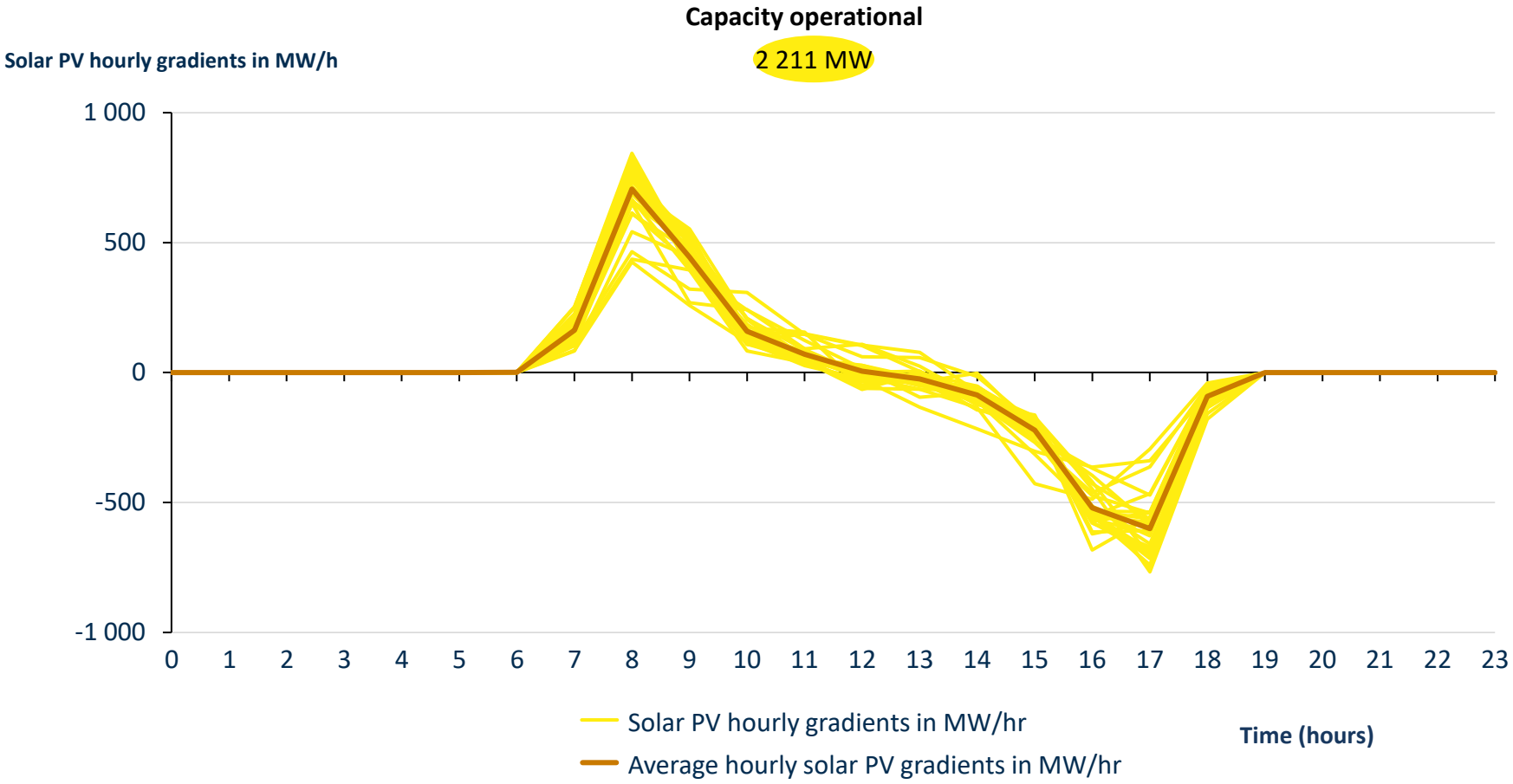
Solar PV 1-hour gradients in May 2021



Sources: Eskom; CSIR Energy Centre analysis

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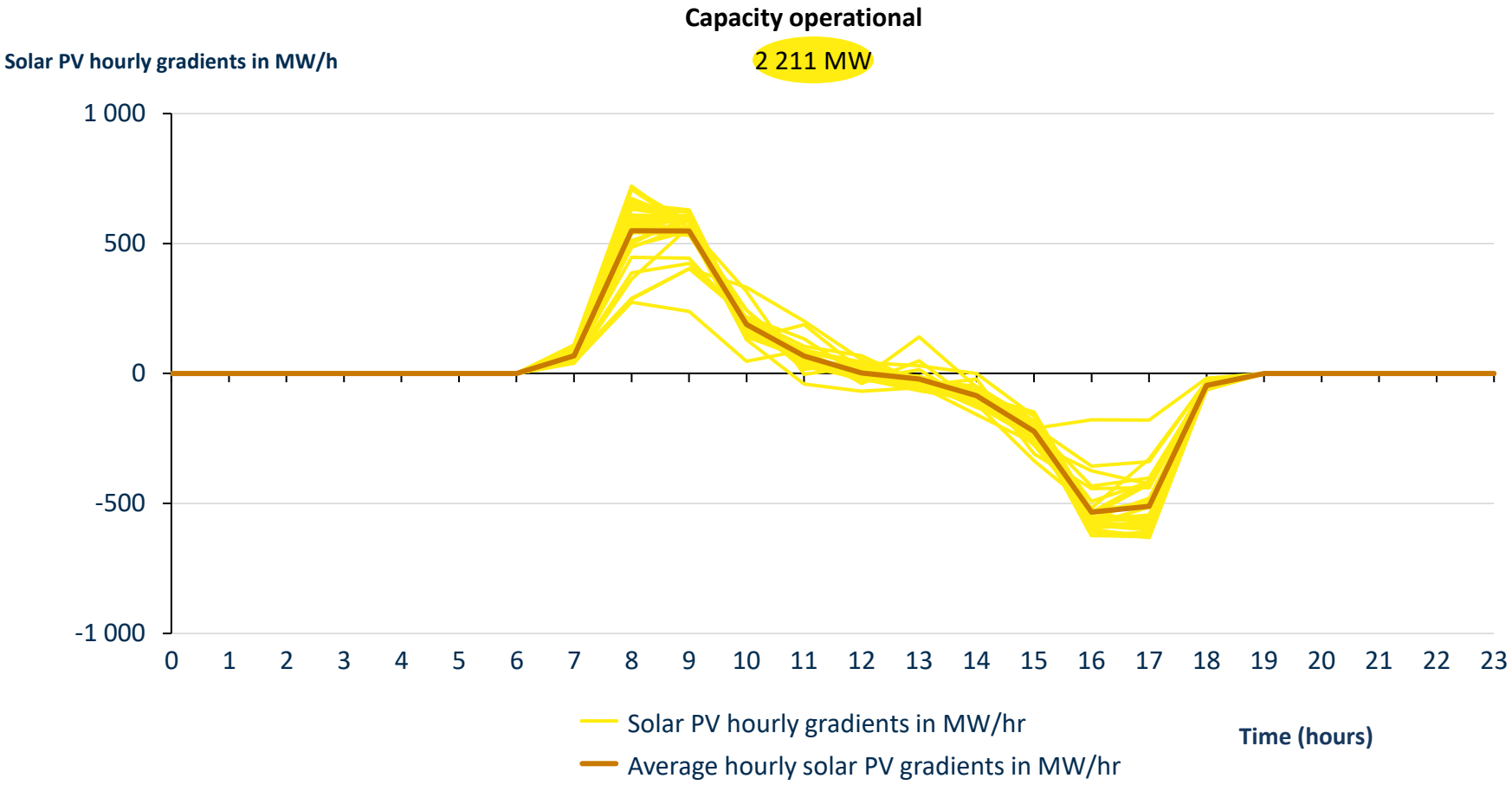
Solar PV 1-hour gradients in June 2021



Sources: Eskom; CSIR Energy Centre analysis

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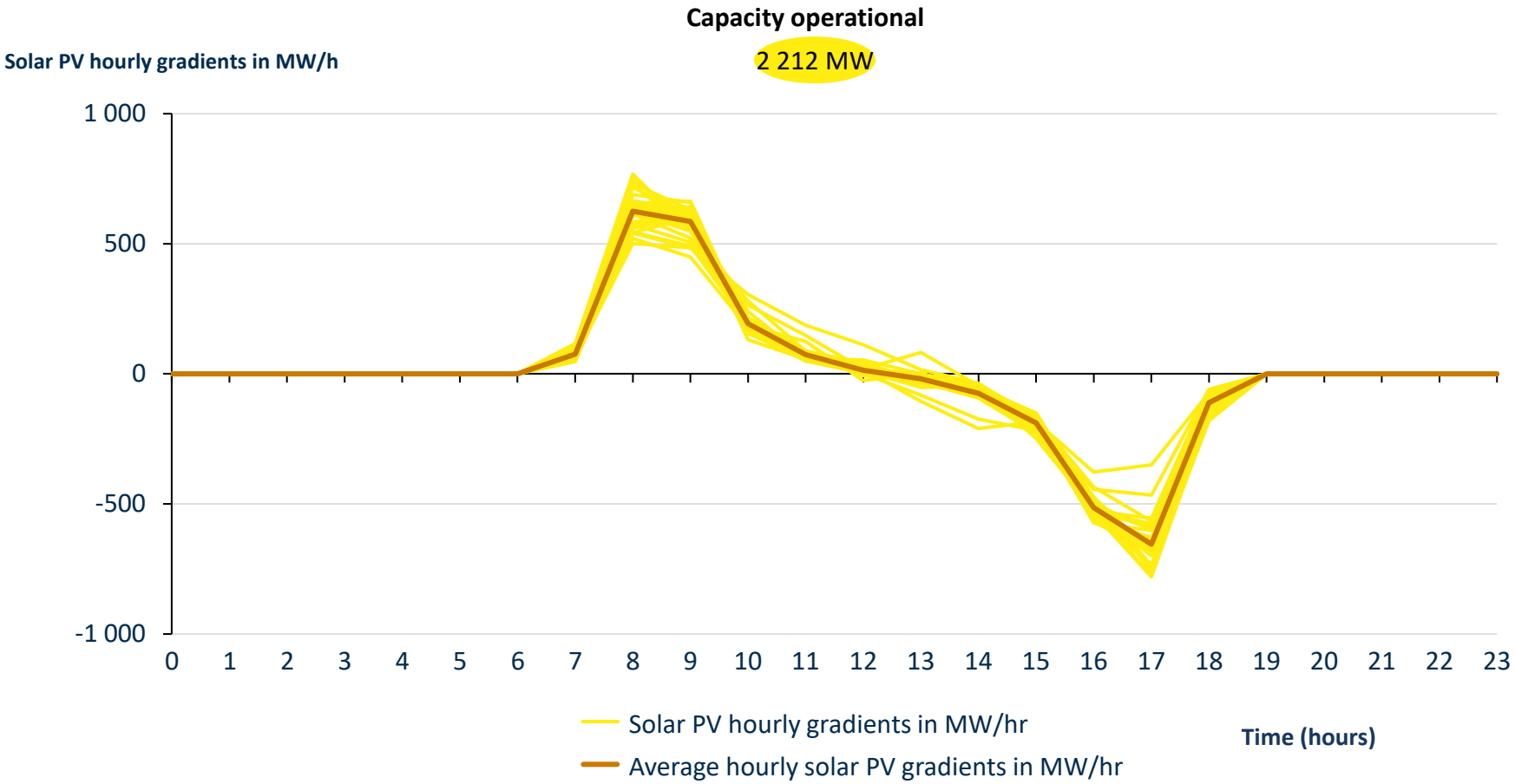
Solar PV 1-hour gradients in July 2021



Sources: Eskom; CSIR Energy Centre analysis

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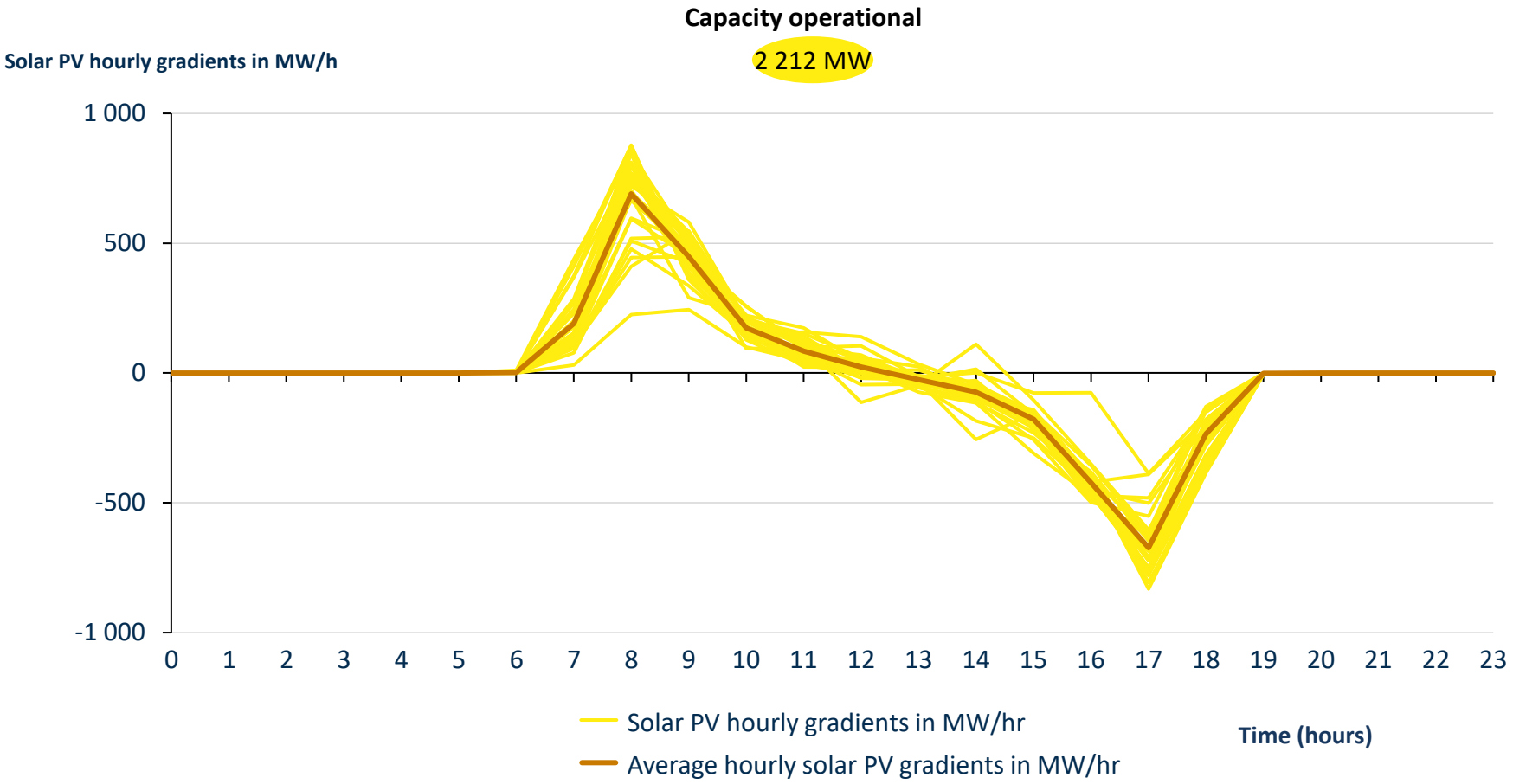
Solar PV 1-hour gradients in August 2021



Sources: Eskom; CSIR Energy Centre analysis

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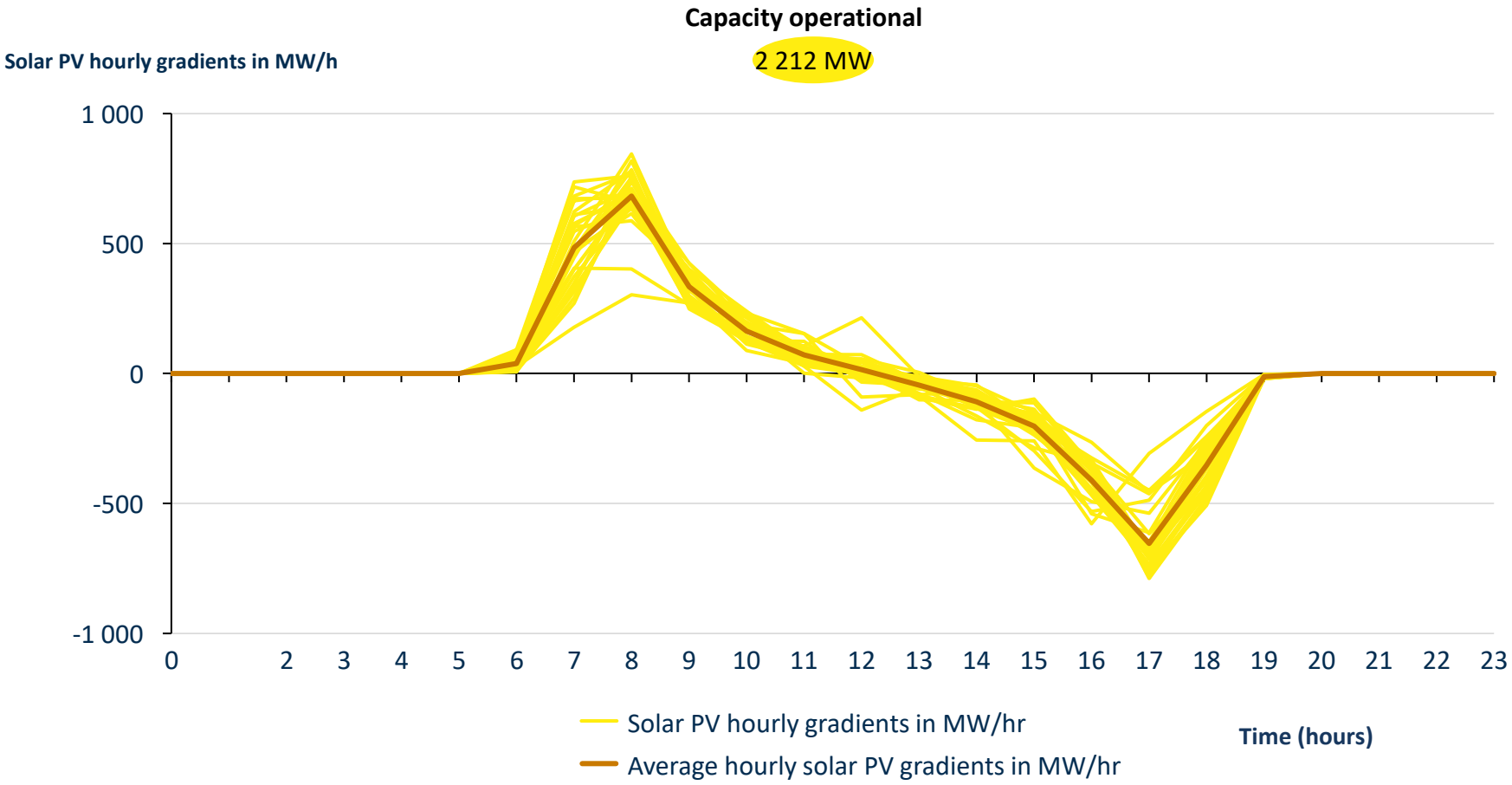
Solar PV 1-hour gradients in September 2021



Sources: Eskom; CSIR Energy Centre analysis

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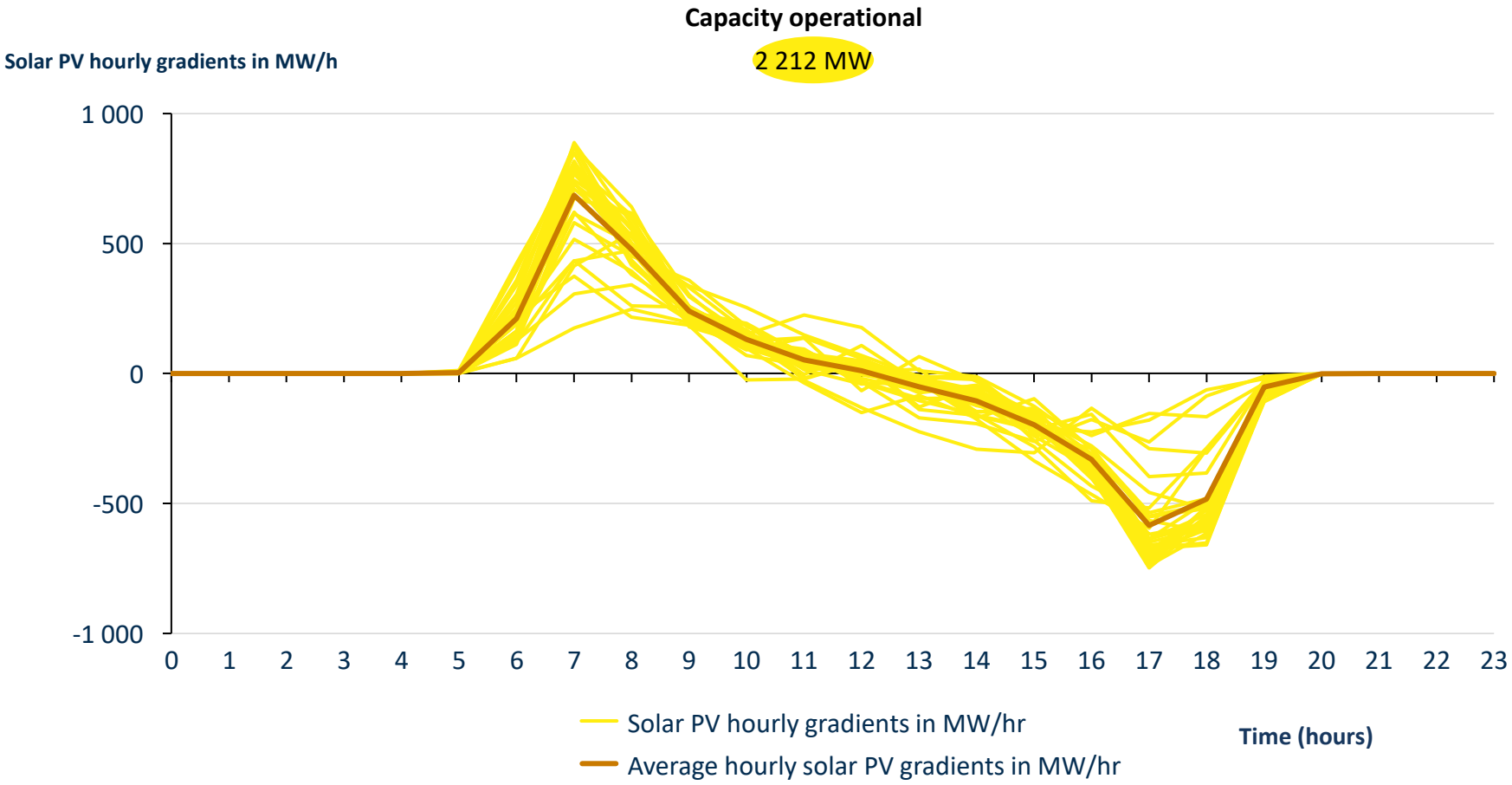
Solar PV 1-hour gradients in October 2021



Sources: Eskom; CSIR Energy Centre analysis

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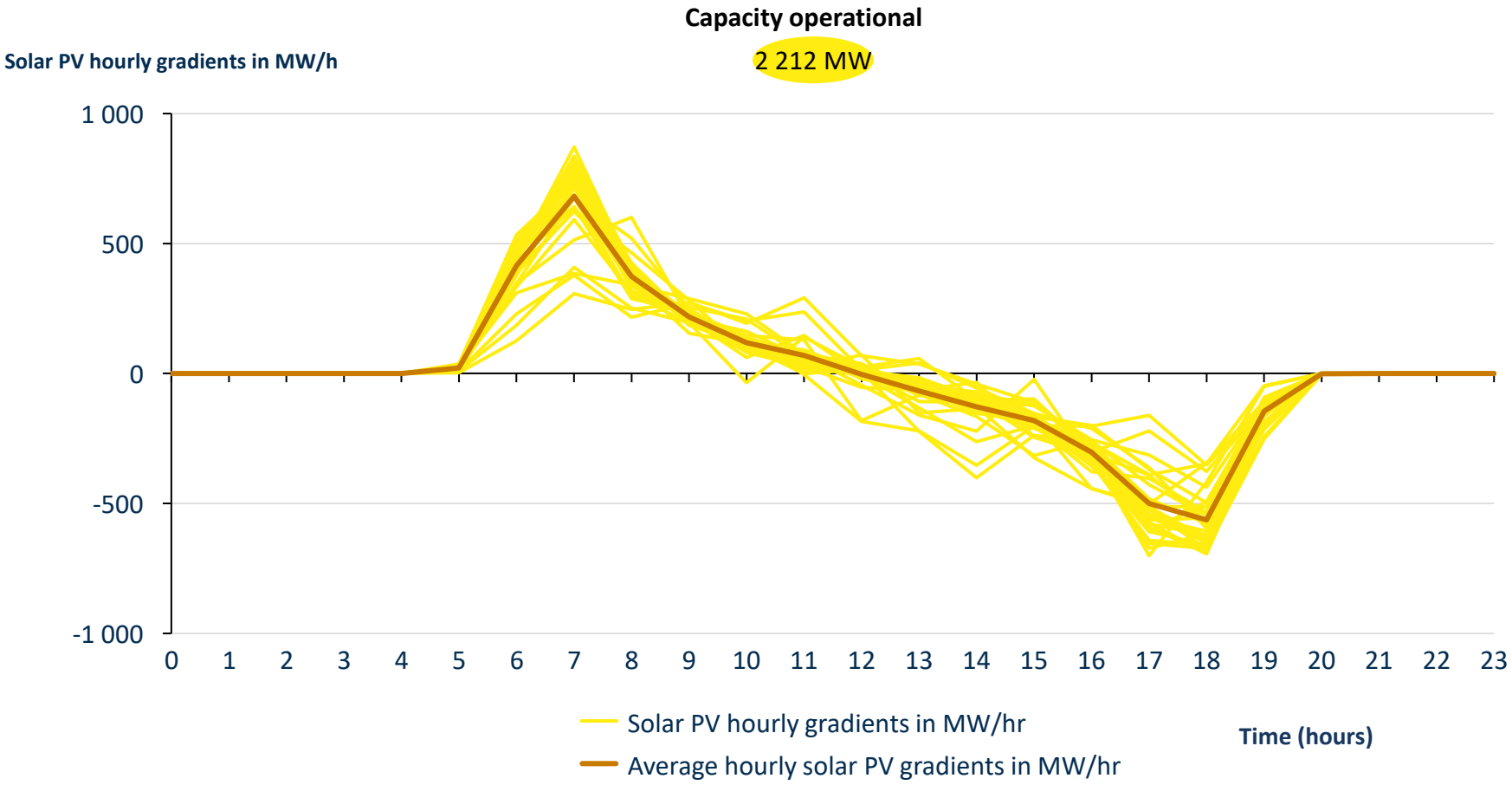
Solar PV 1-hour gradients in November 2021



Sources: Eskom; CSIR Energy Centre analysis

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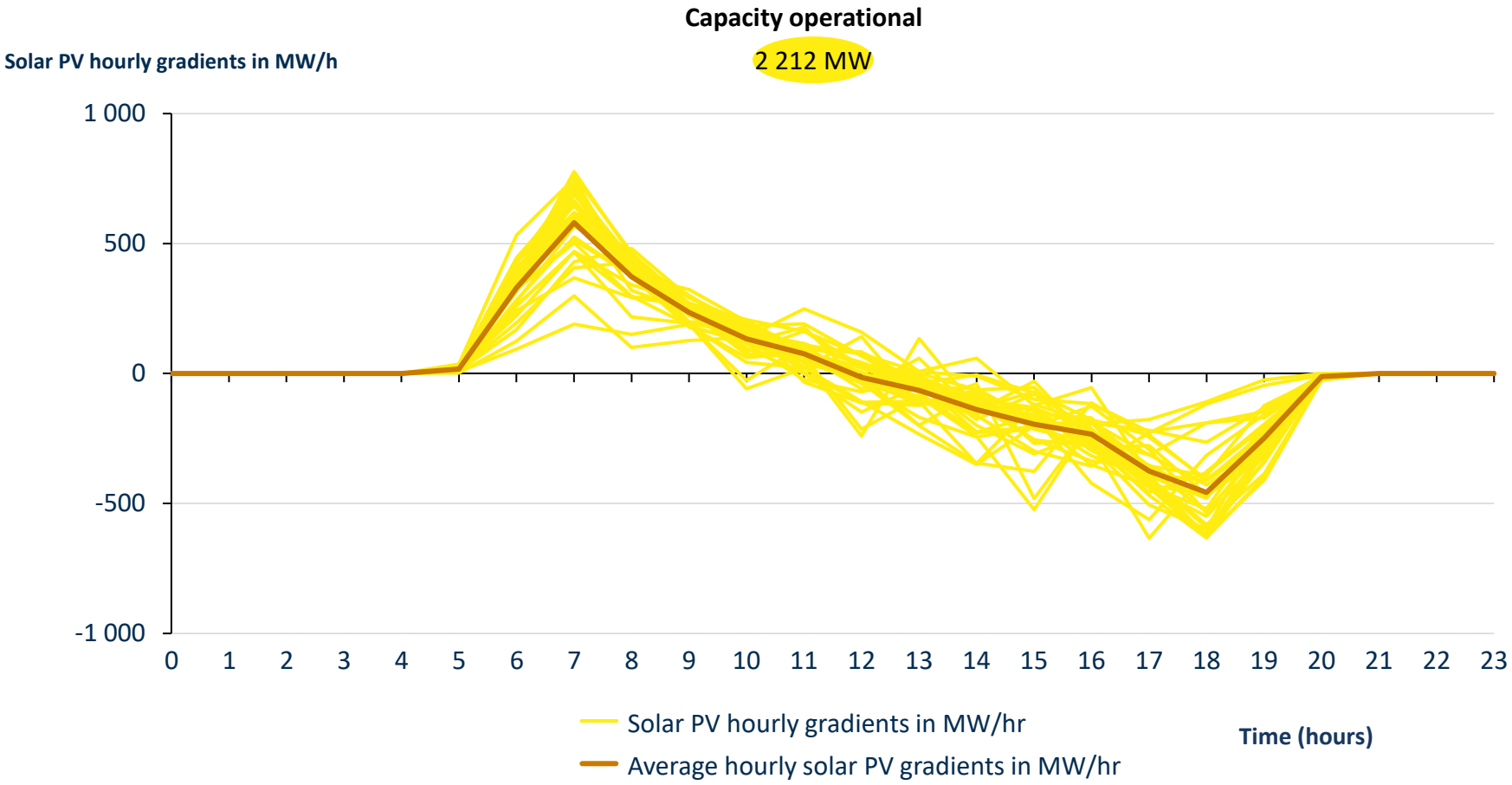
Solar PV 1-hour gradients in December 2021



Sources: Eskom; CSIR Energy Centre analysis

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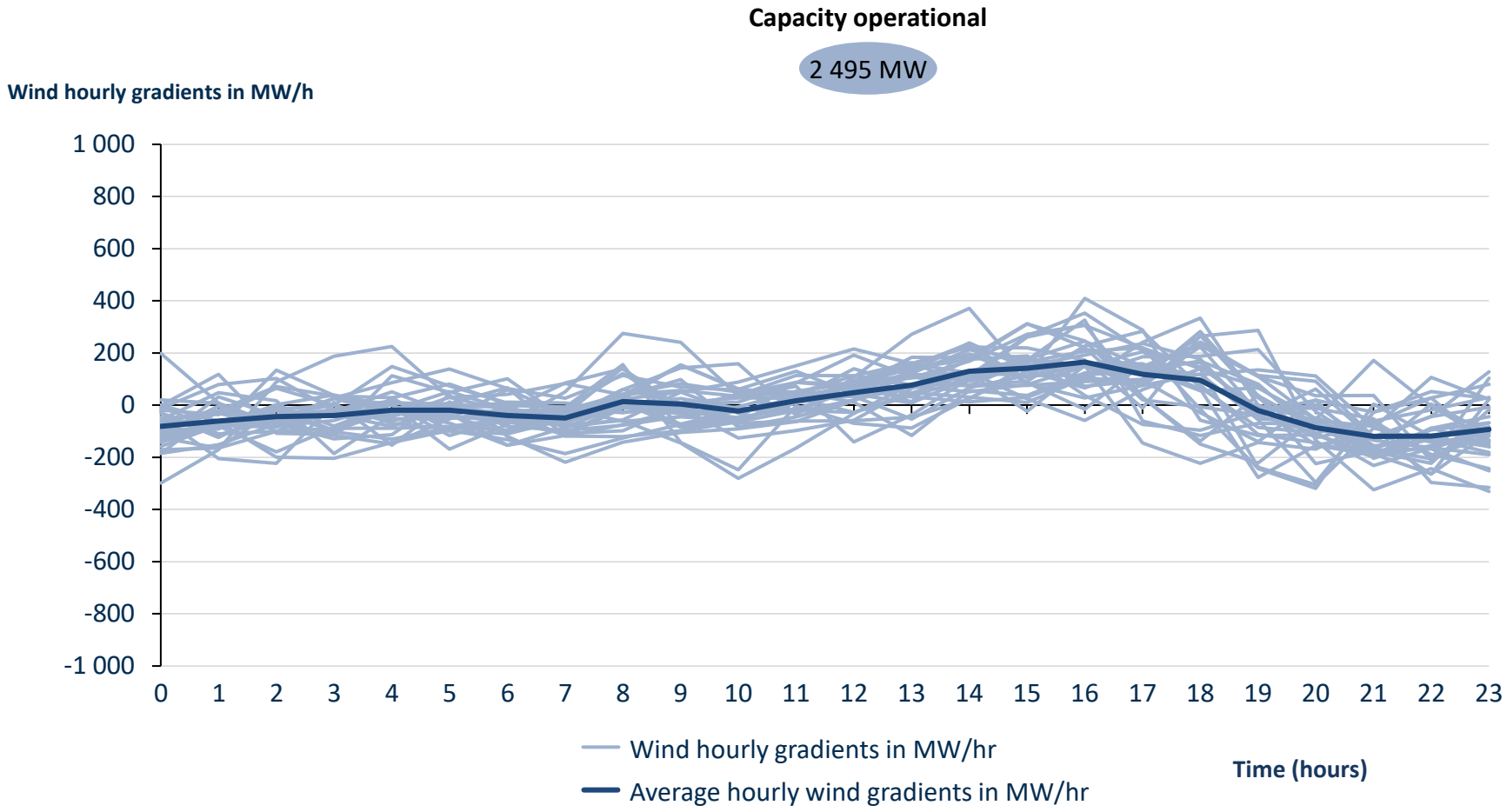
Wind 1-hour gradients in January 2021



Sources: Eskom; CSIR Energy Centre analysis

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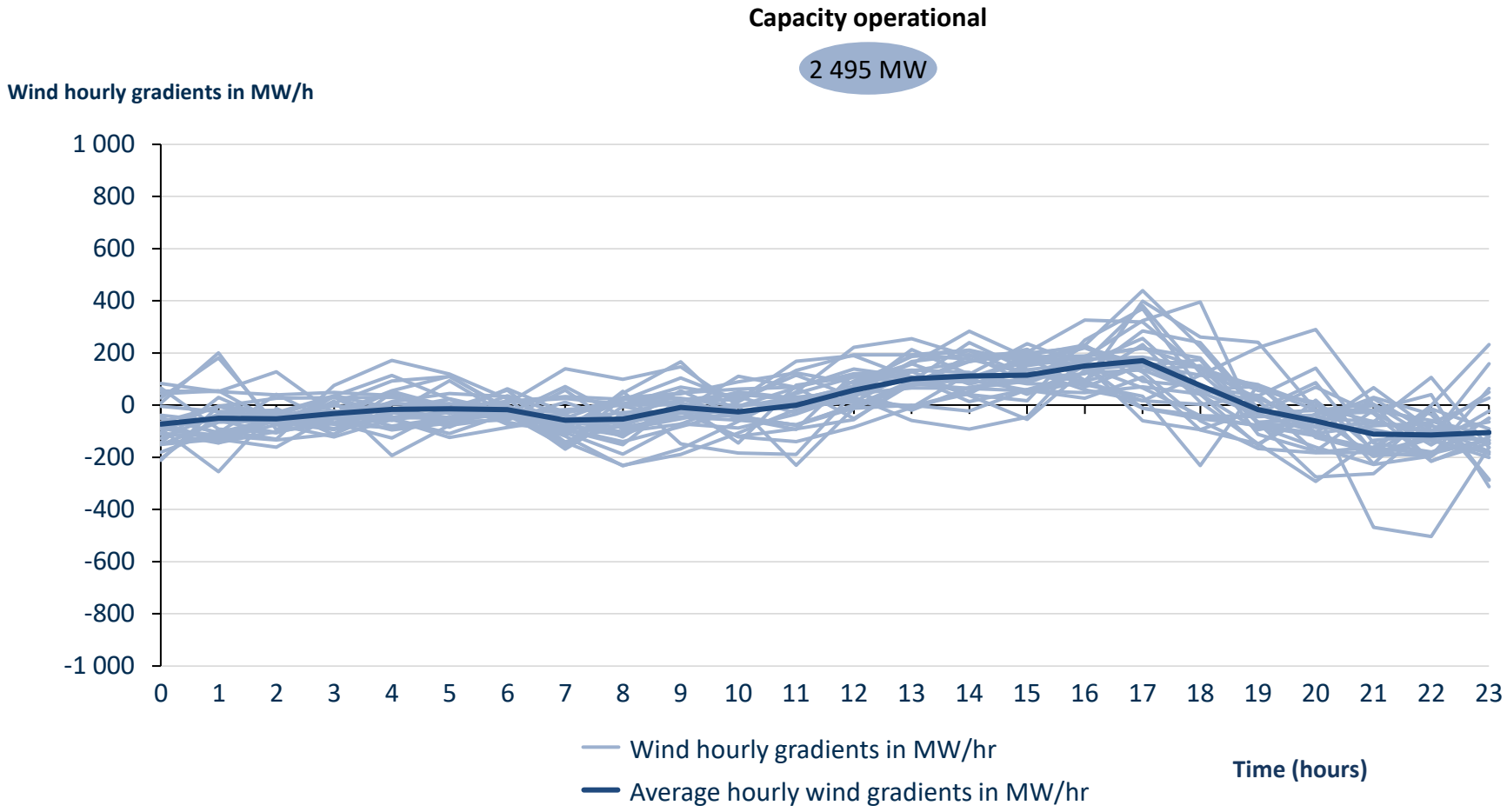
Wind 1-hour gradients in February 2021



Sources: Eskom; CSIR Energy Centre analysis

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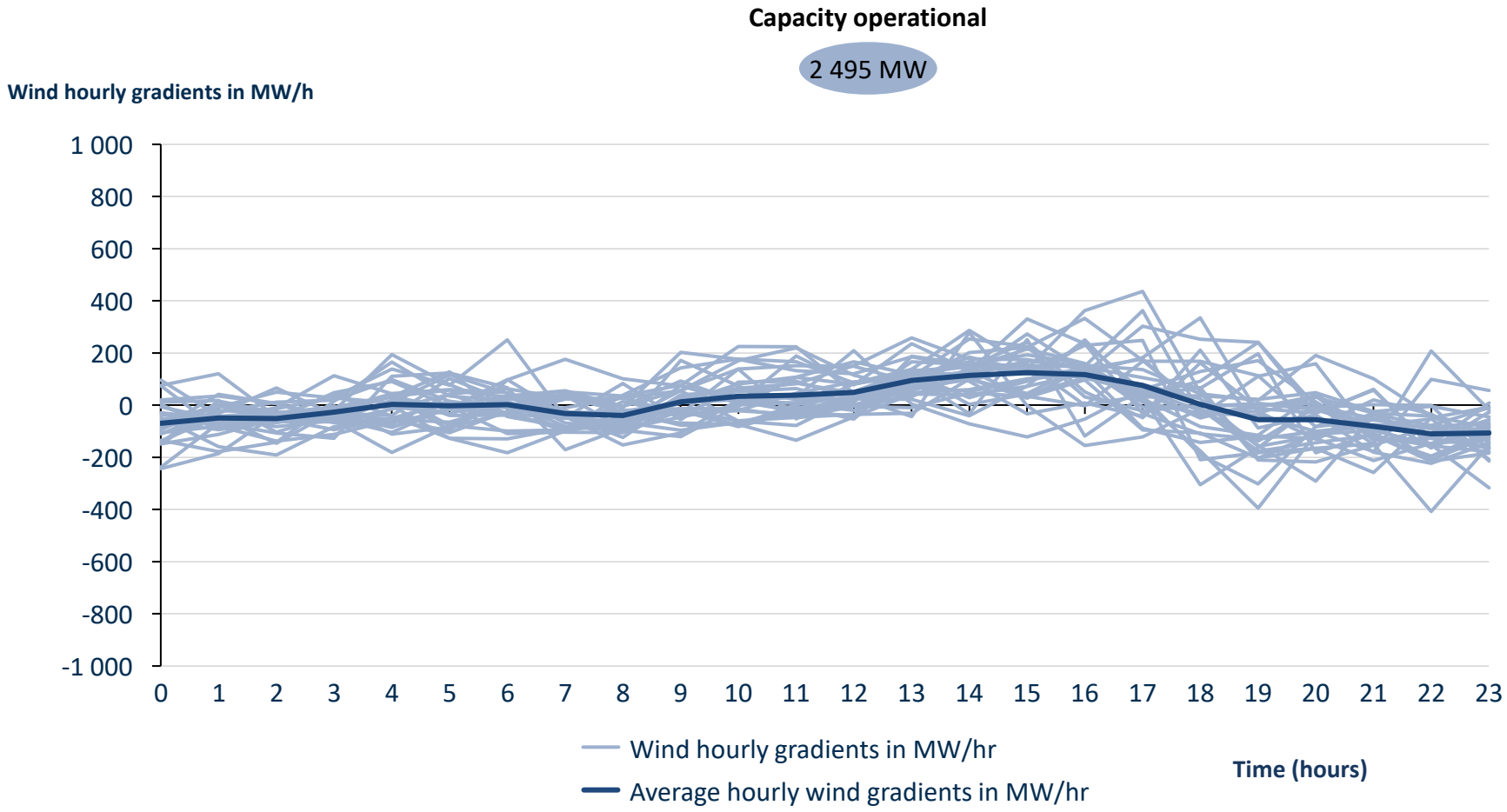
Wind 1-hour gradients in March 2021



Sources: Eskom; CSIR Energy Centre analysis

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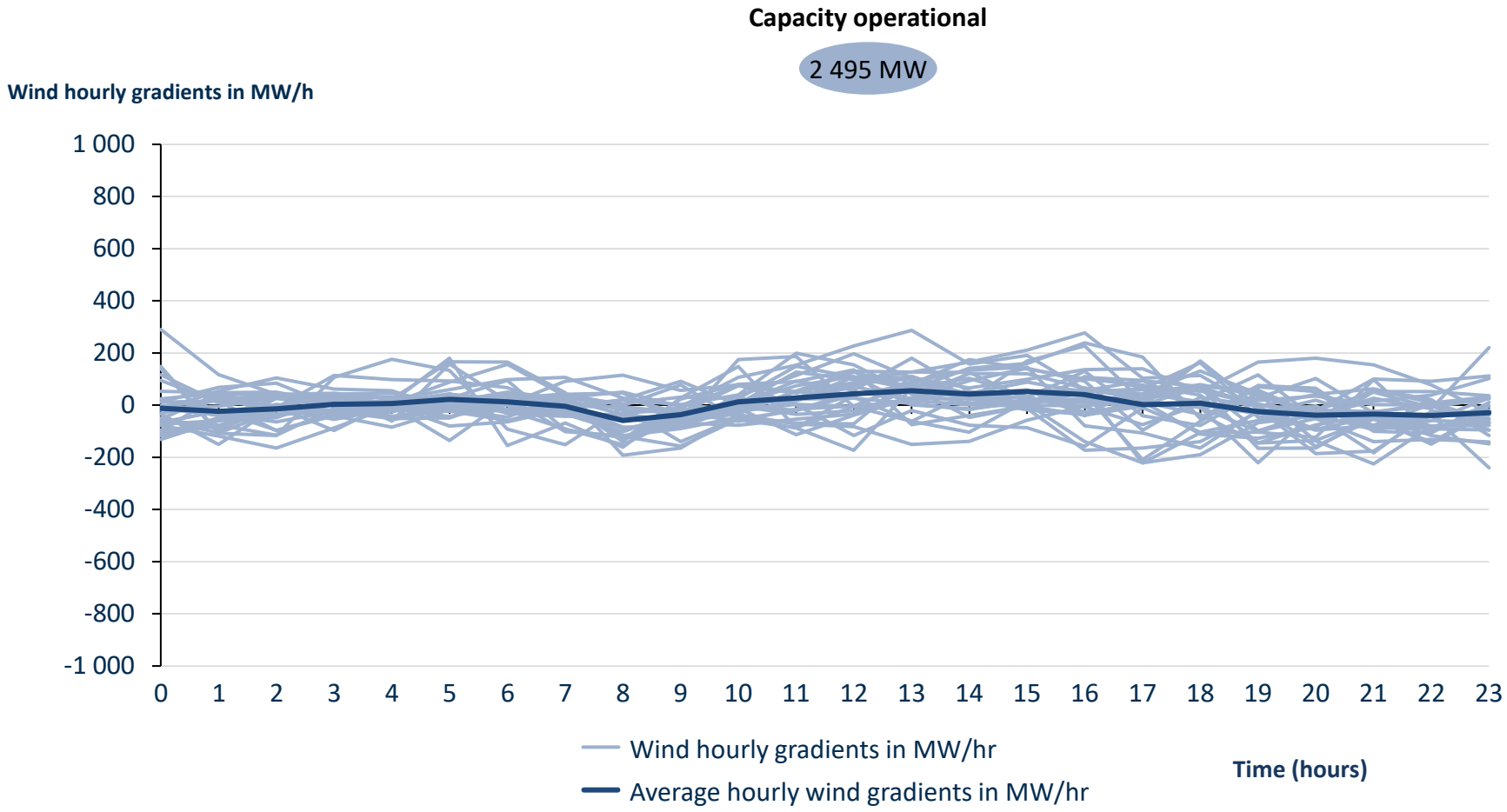
Wind 1-hour gradients in April 2021



Sources: Eskom; CSIR Energy Centre analysis

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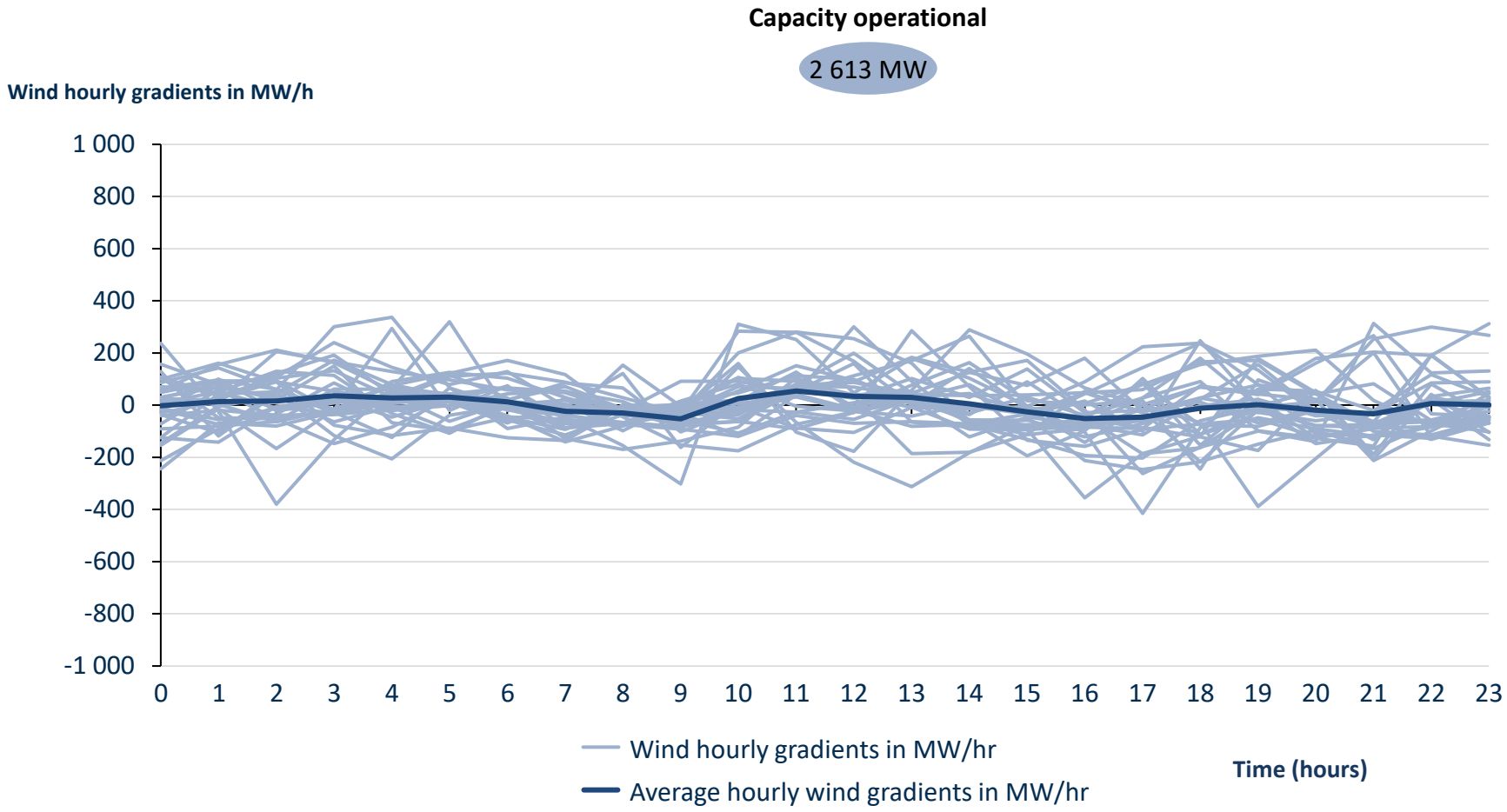
Wind 1-hour gradients in May 2021



Sources: Eskom; CSIR Energy Centre analysis

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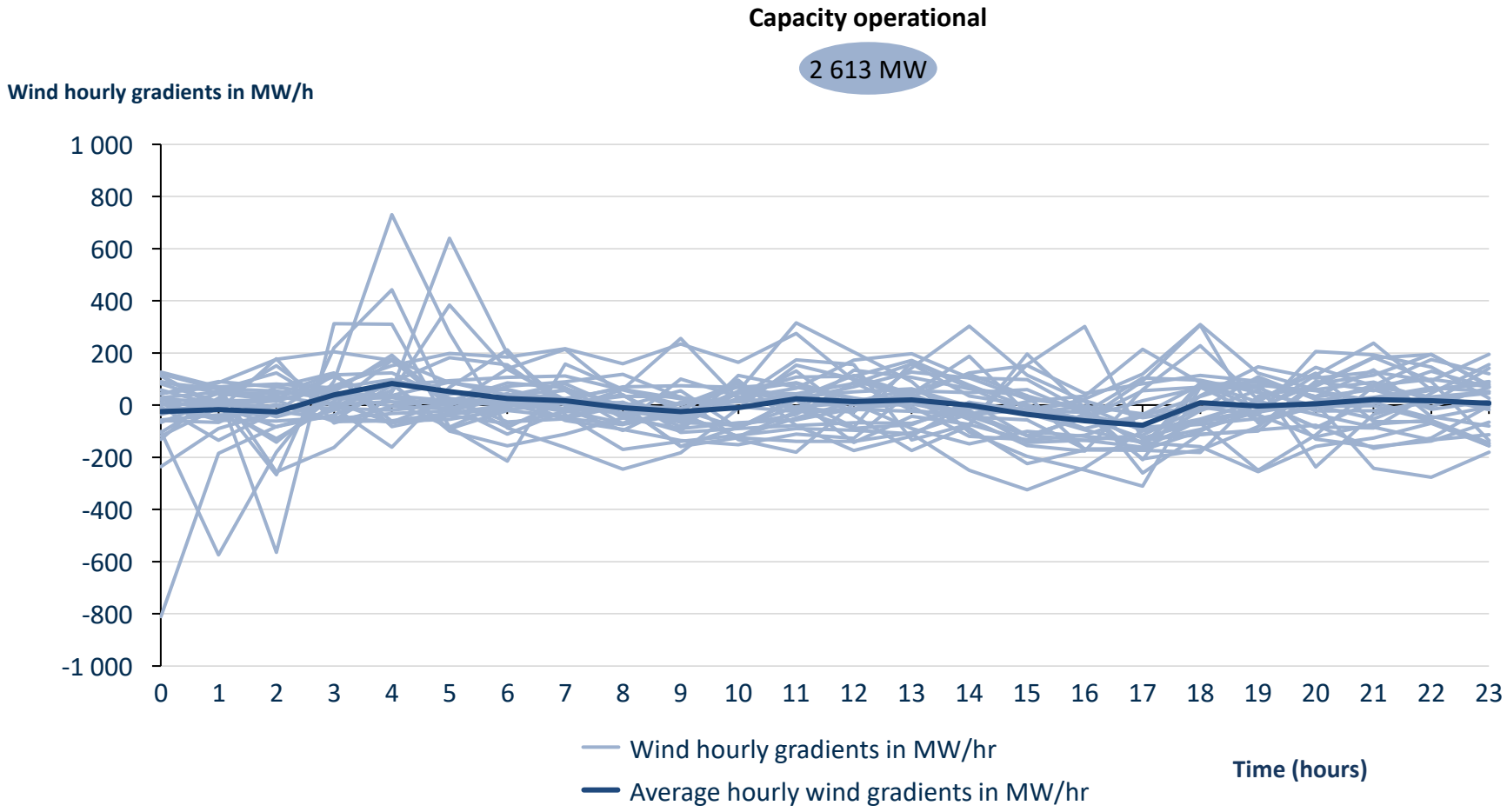
Wind 1-hour gradients in June 2021



Sources: Eskom; CSIR Energy Centre analysis

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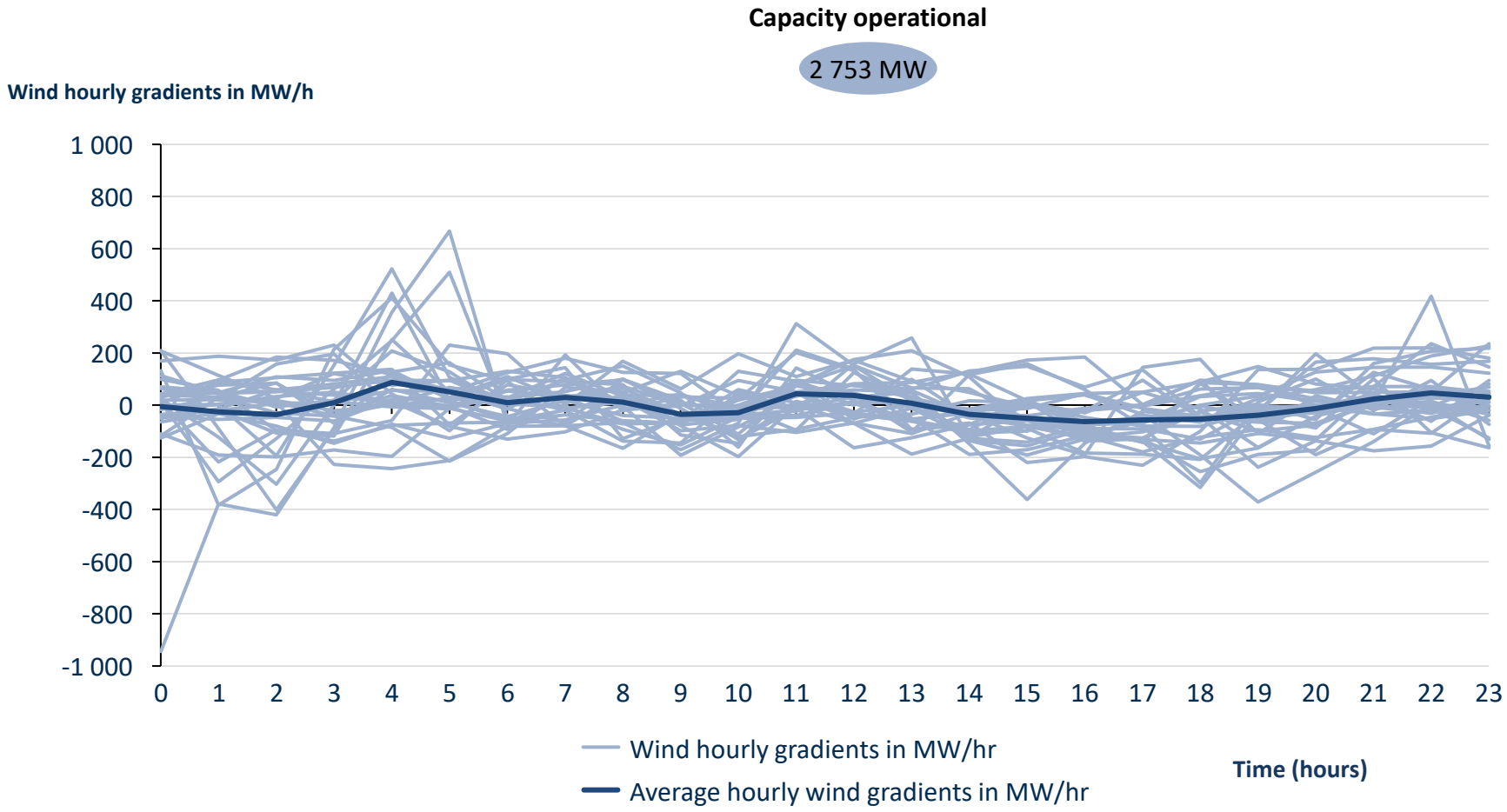
Wind 1-hour gradients in July 2021



Sources: Eskom; CSIR Energy Centre analysis

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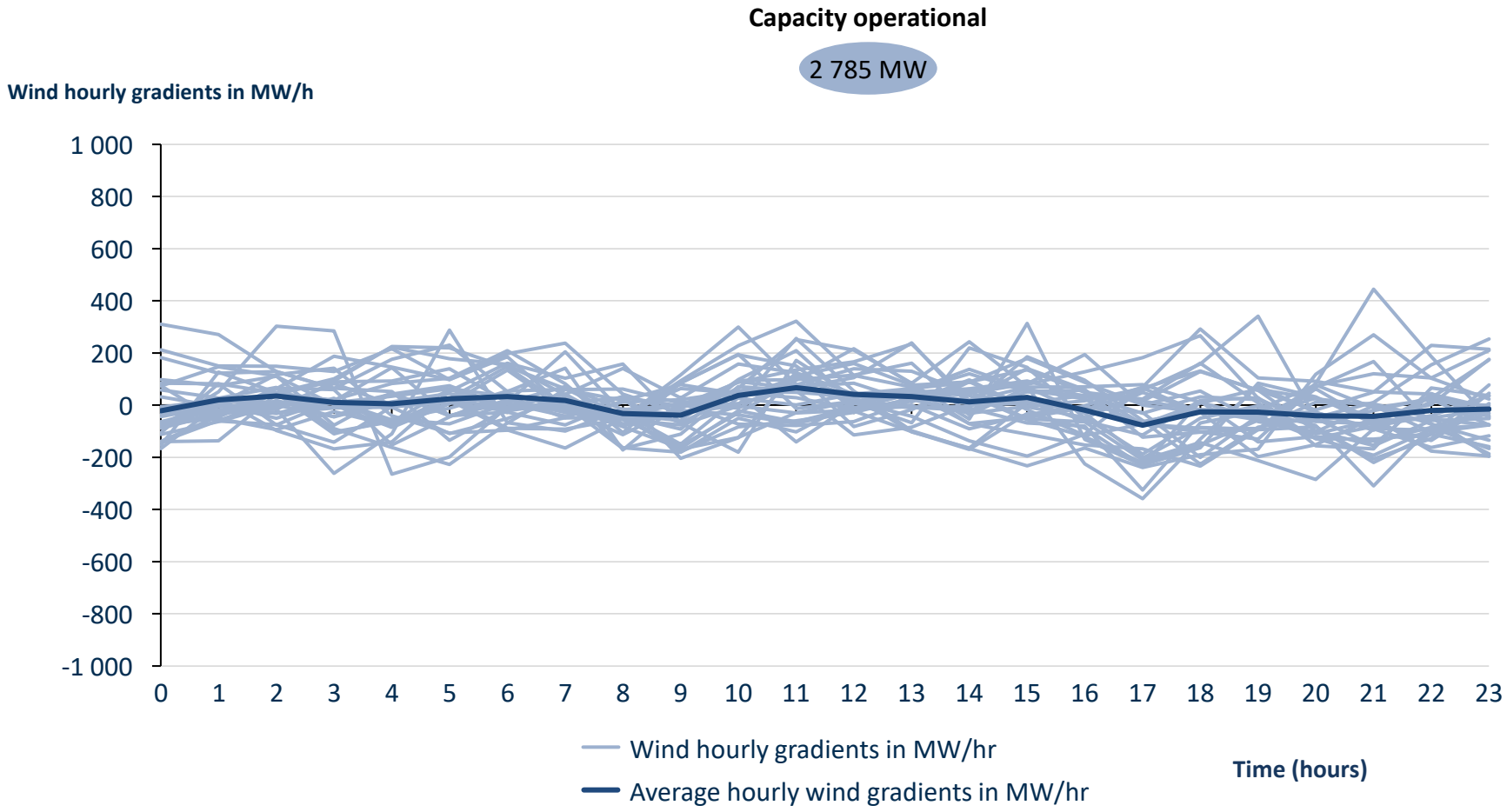
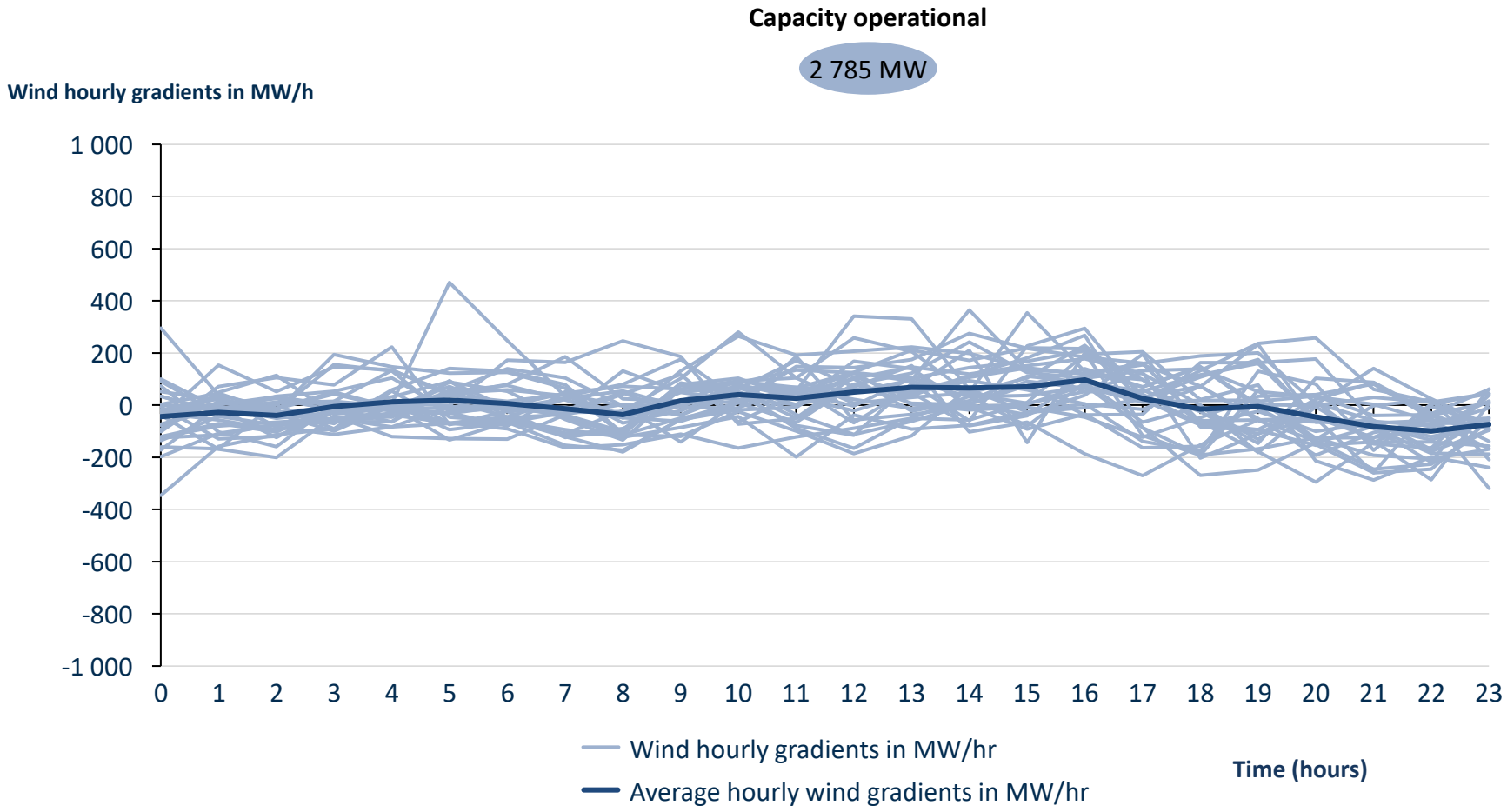
Wind 1-hour gradients in August 2021



Sources: Eskom; CSIR Energy Centre analysis

Wind 1-hour gradients in September 2021



Sources: Eskom; CSIR Energy Centre analysis

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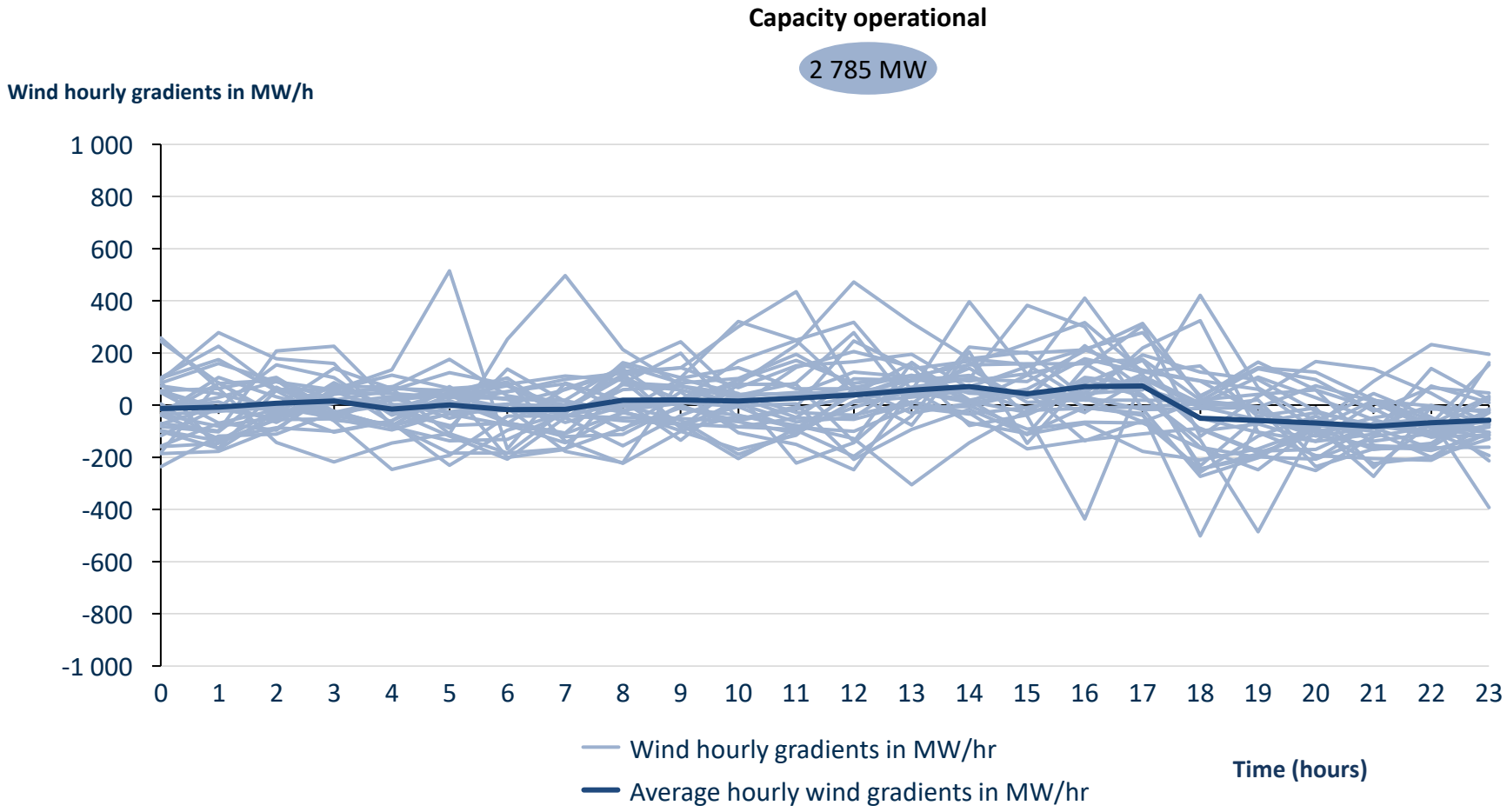
Wind 1-hour gradients in October 2021



Sources: Eskom; CSIR Energy Centre analysis

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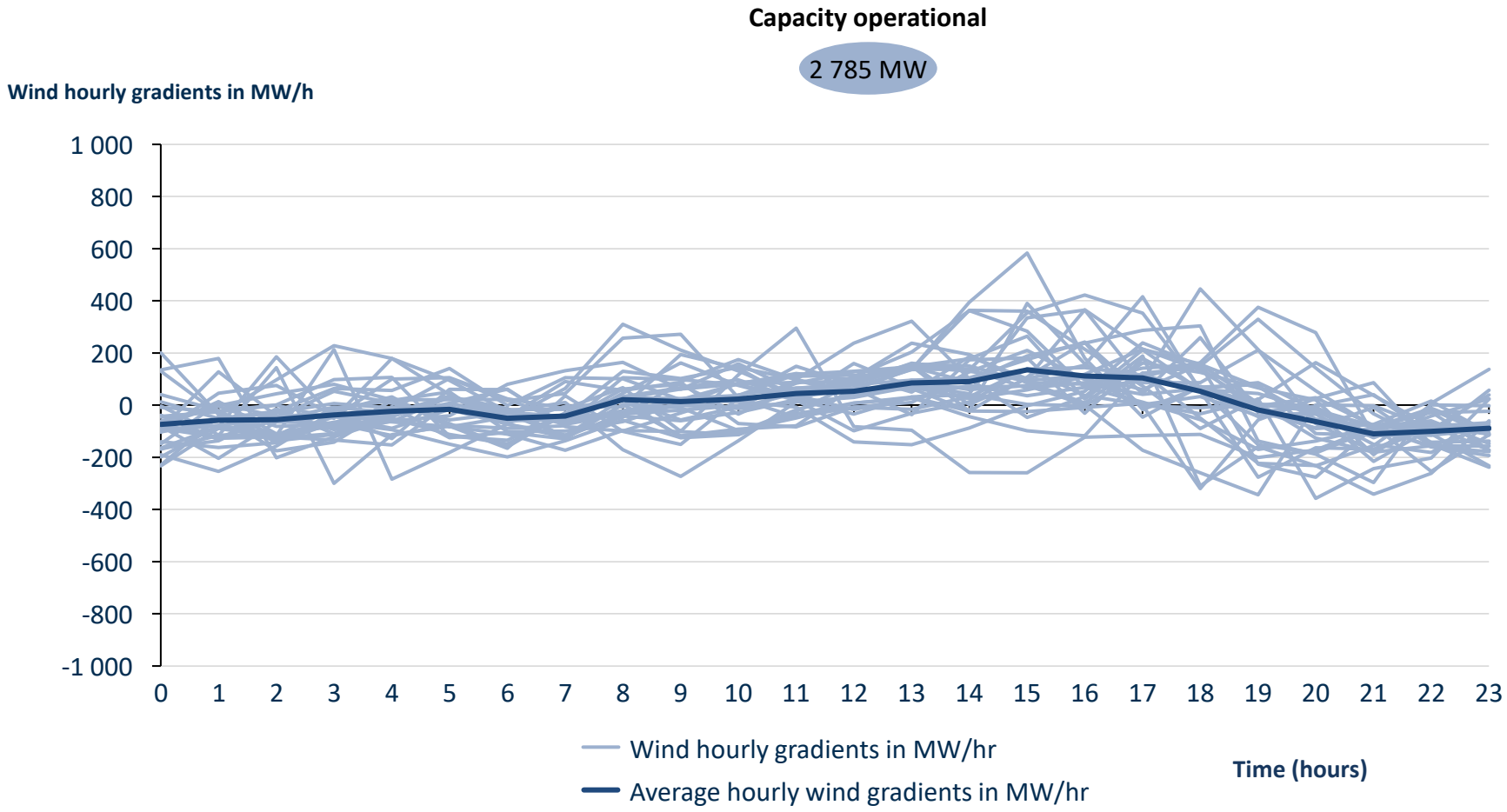
Wind 1-hour gradients in November 2021



Sources: Eskom; CSIR Energy Centre analysis

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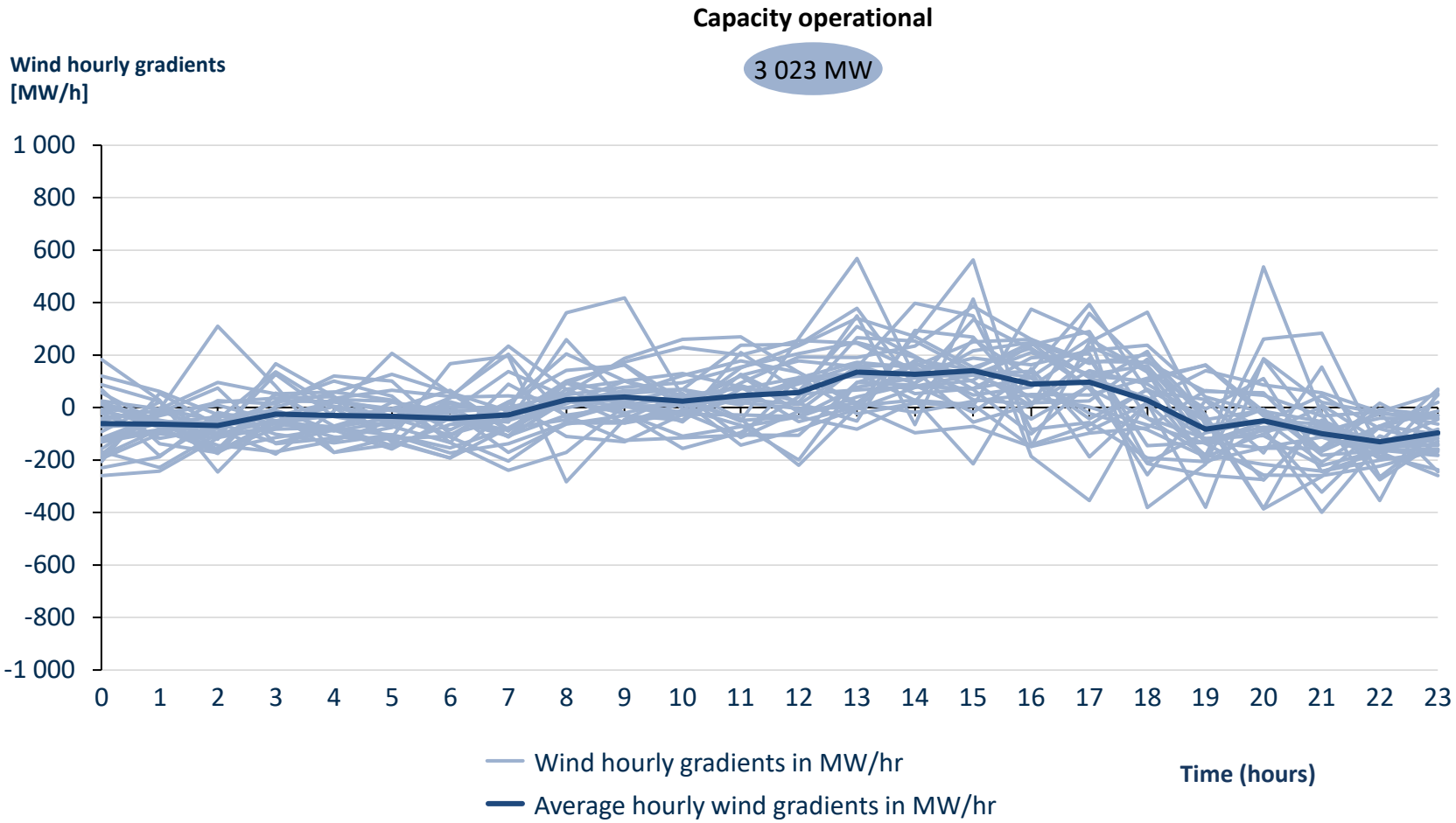
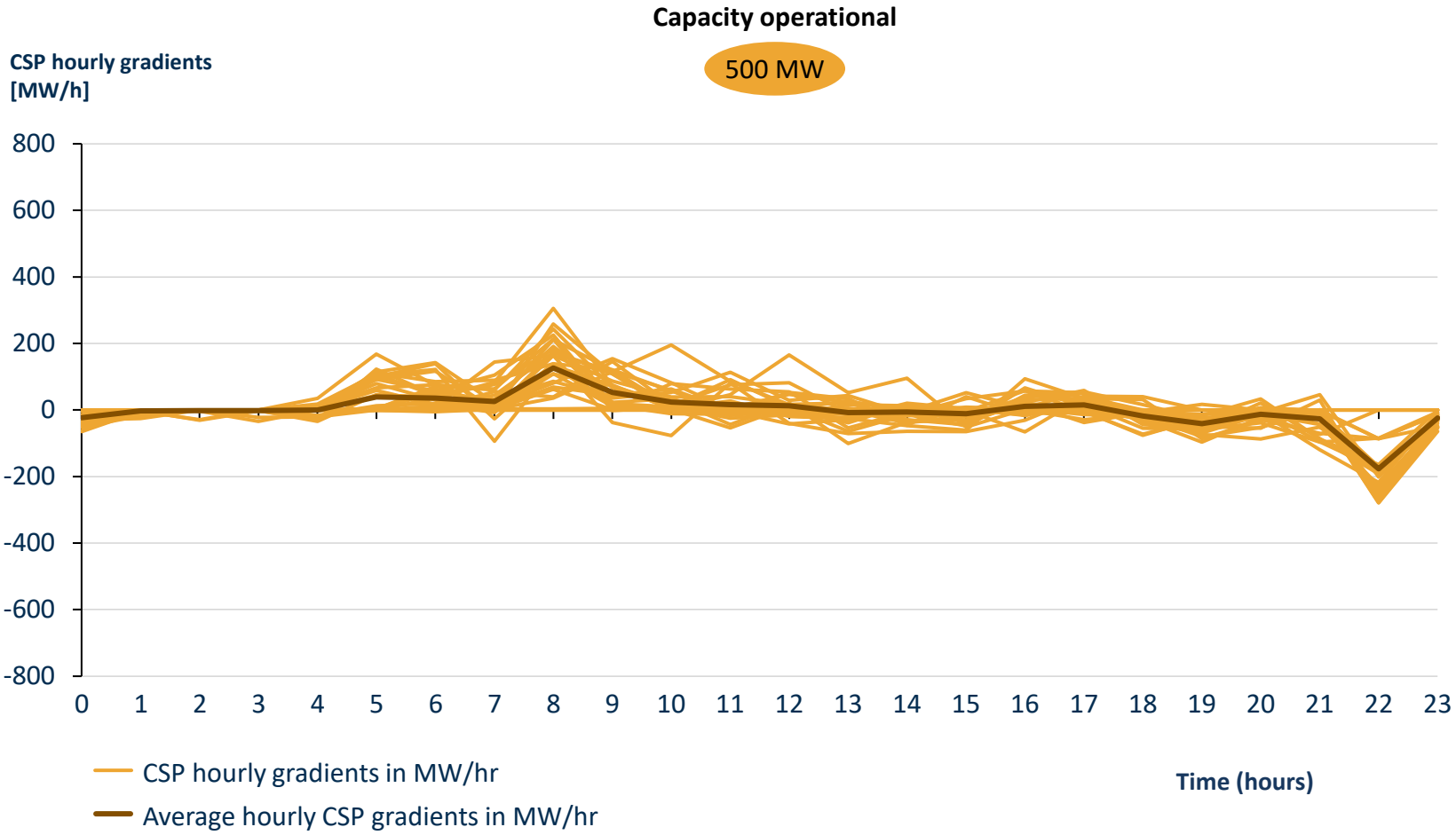
Wind 1-hour gradients in December 2021



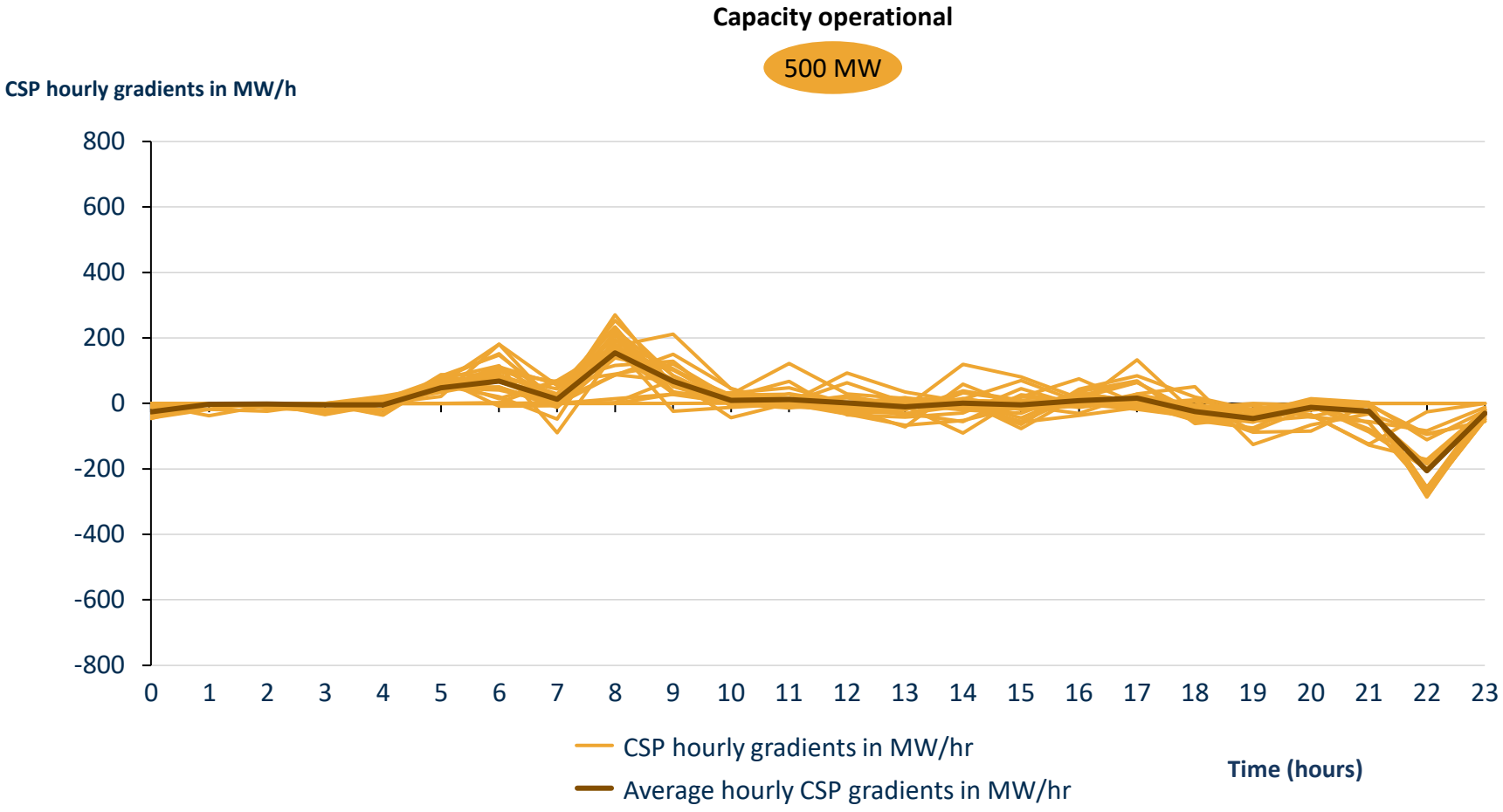
Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in January 2021



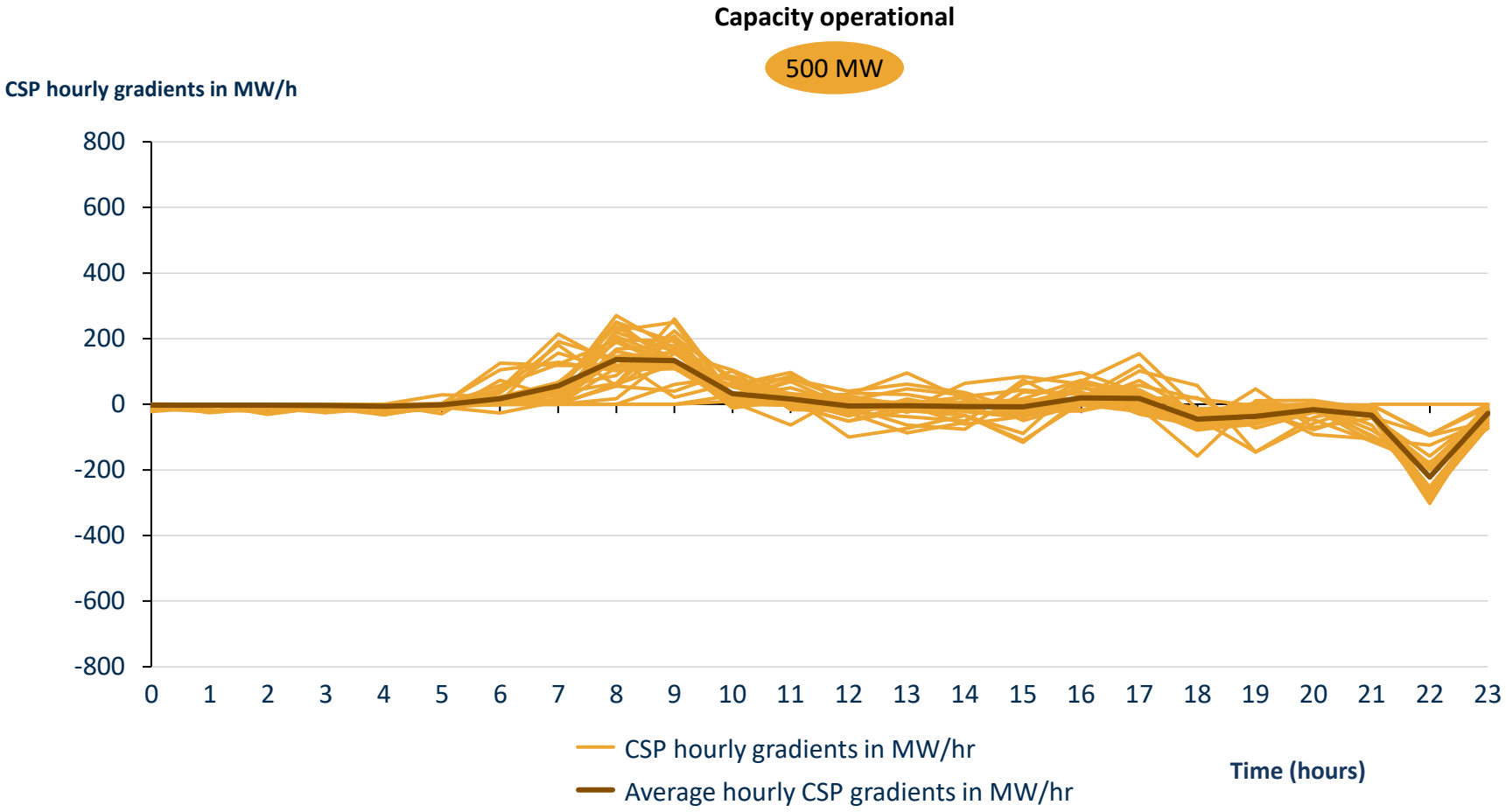
Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in February 2021



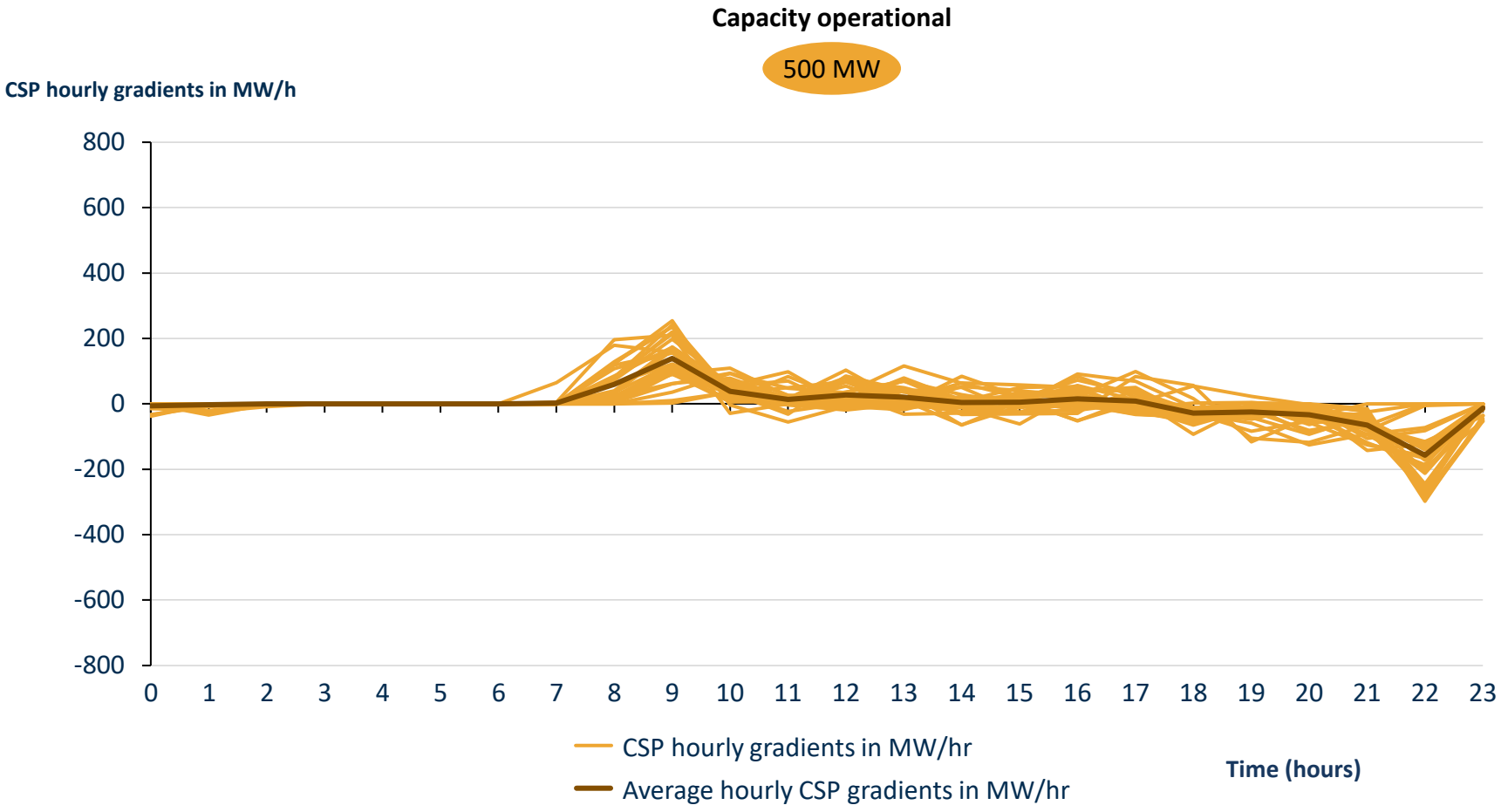
Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in March 2021



Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in April 2021



Sources: Eskom; CSIR Energy Centre analysis

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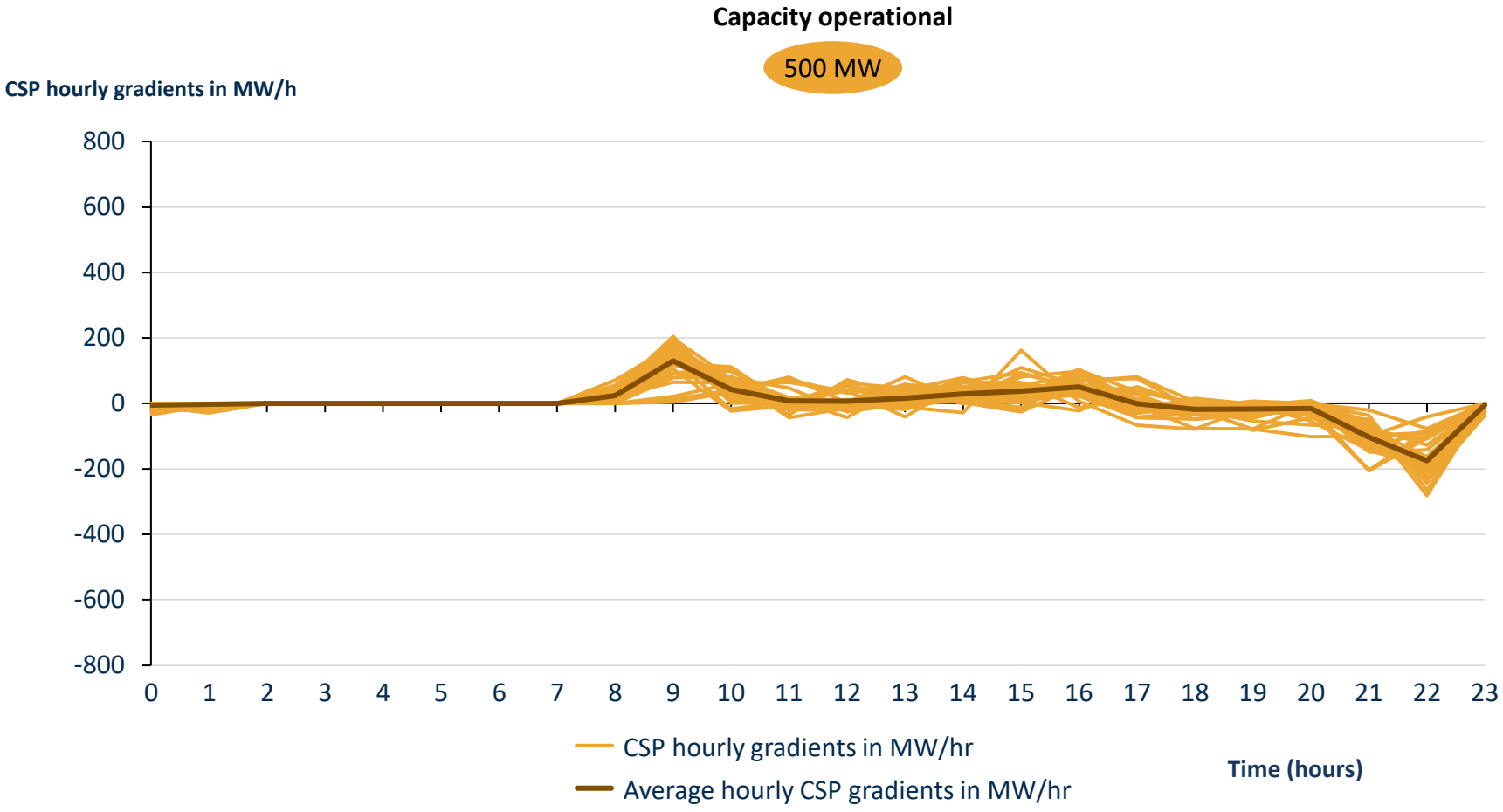
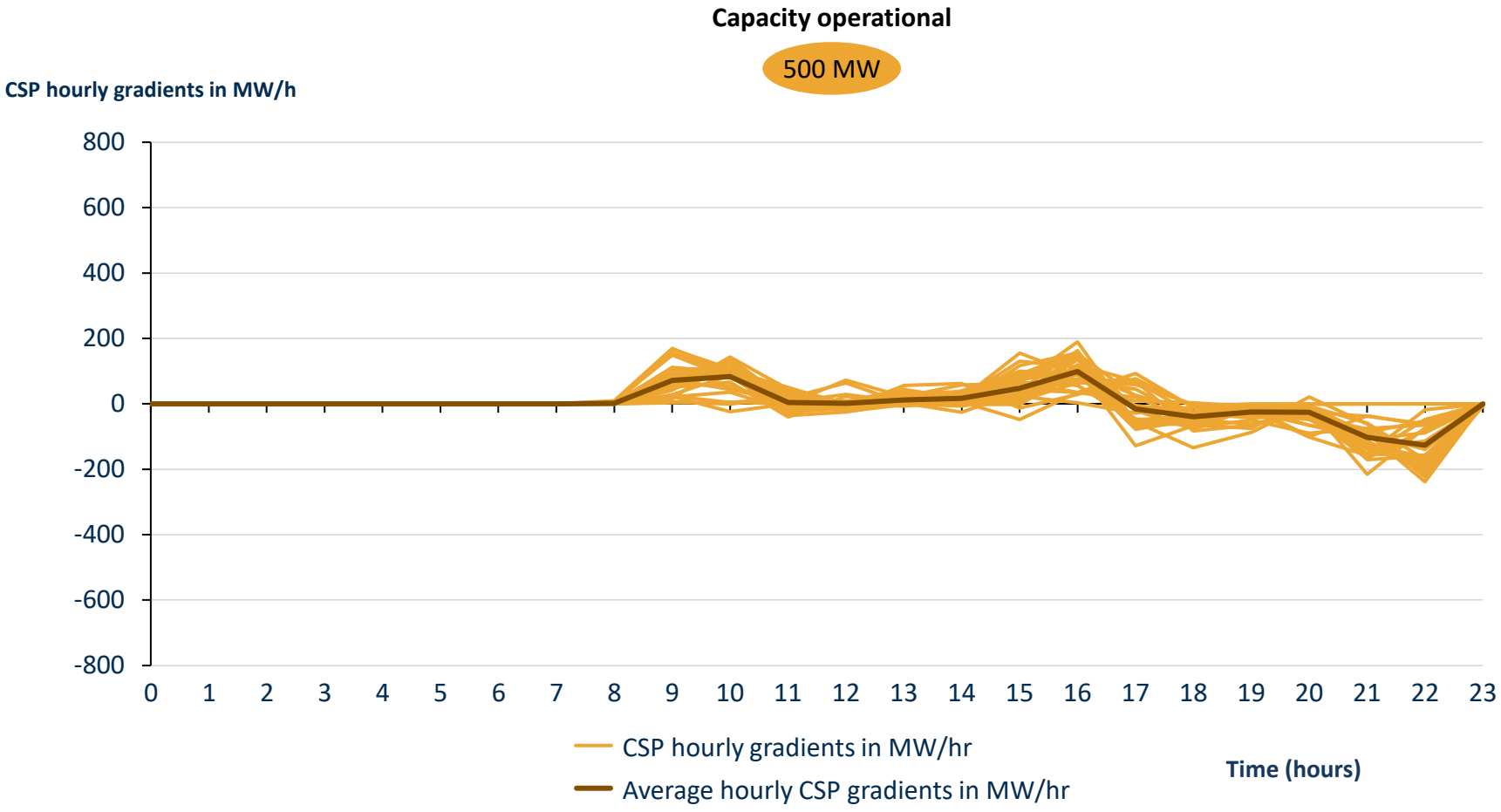
CSP 1-hour gradients in May 2021



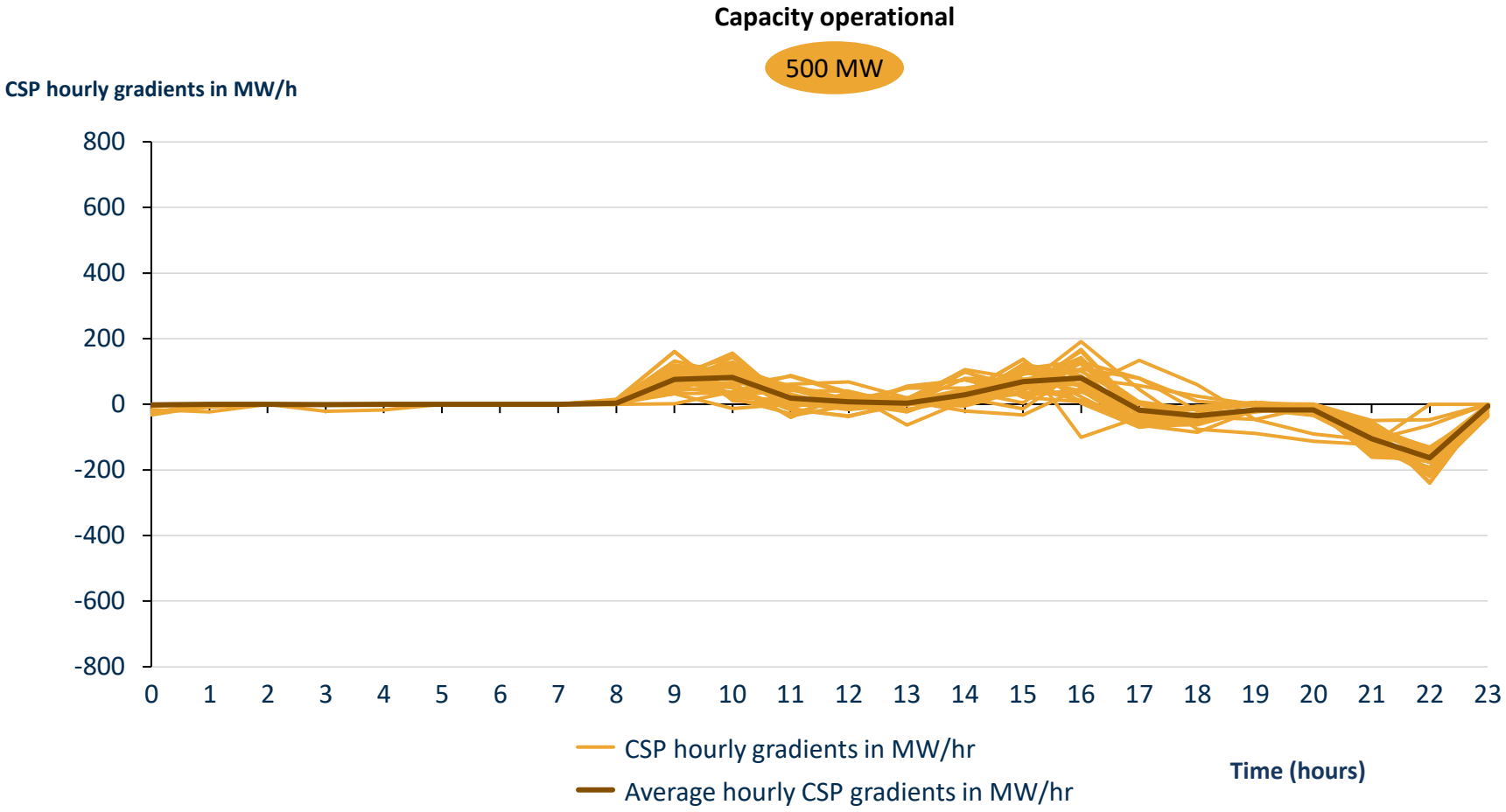
Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in June 2021



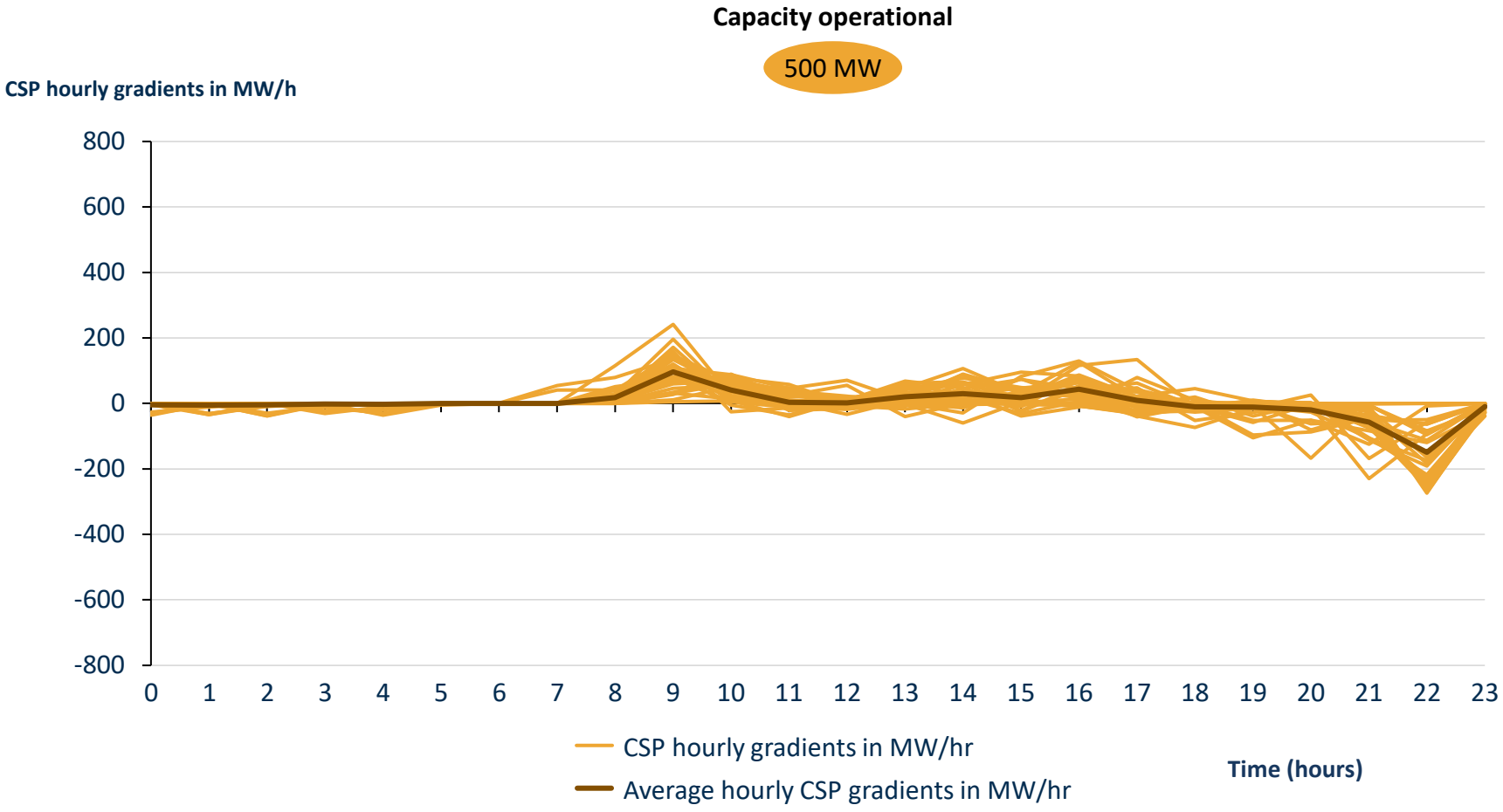
Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in July 2021



Sources: Eskom; CSIR Energy Centre analysis

CSP 1-hour gradients in August 2021



Sources: Eskom; CSIR Energy Centre analysis

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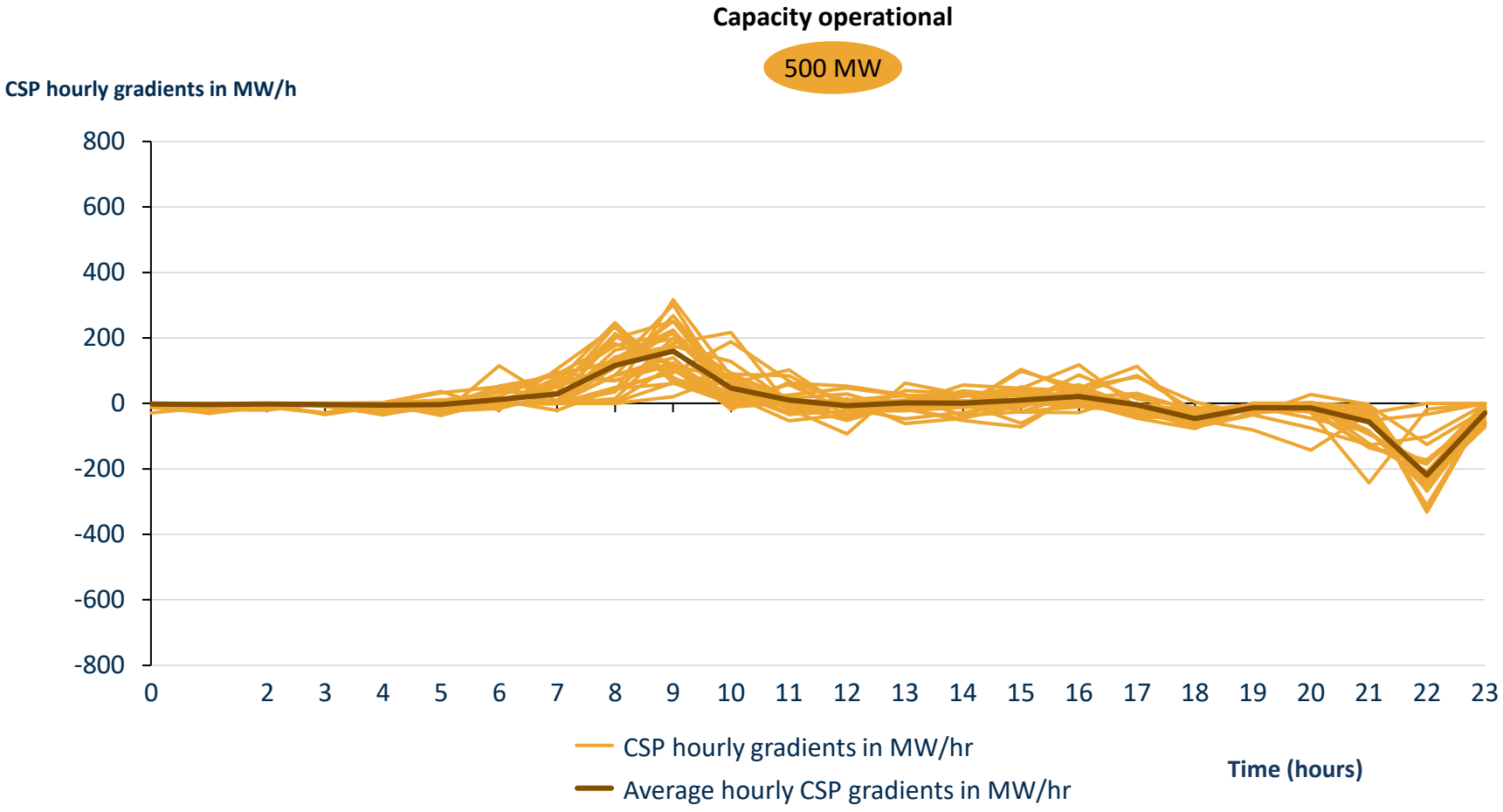
CSP 1-hour gradients in September 2021



Sources: Eskom; CSIR Energy Centre analysis

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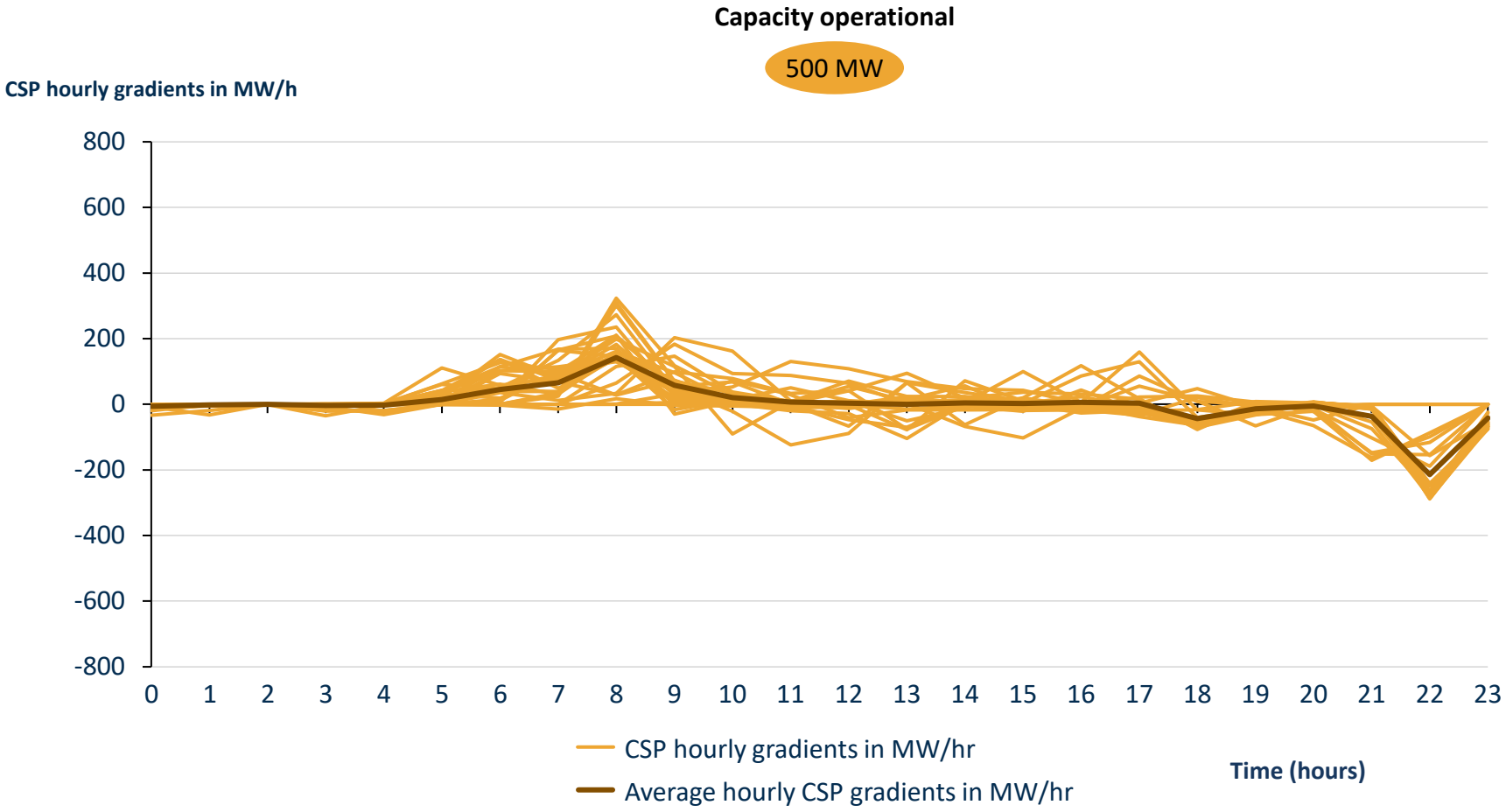
CSP 1-hour gradients in October 2021



Sources: Eskom; CSIR Energy Centre analysis

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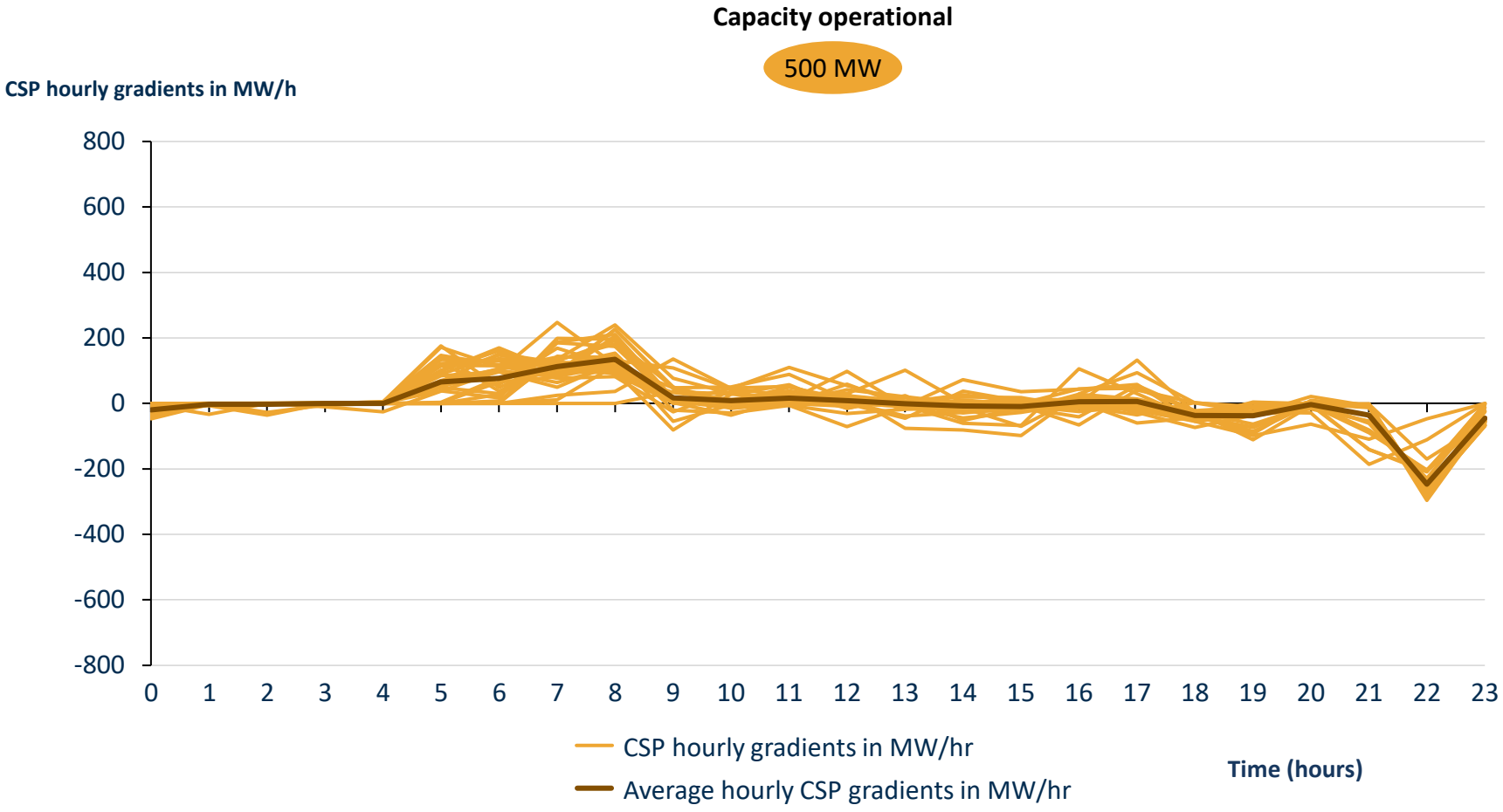
CSP 1-hour gradients in November 2021



Sources: Eskom; CSIR Energy Centre analysis

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Agenda

1 Overview actual electricity production (2021)

2 Monthly electricity production (2021)

3 Weekly electricity production (2021)

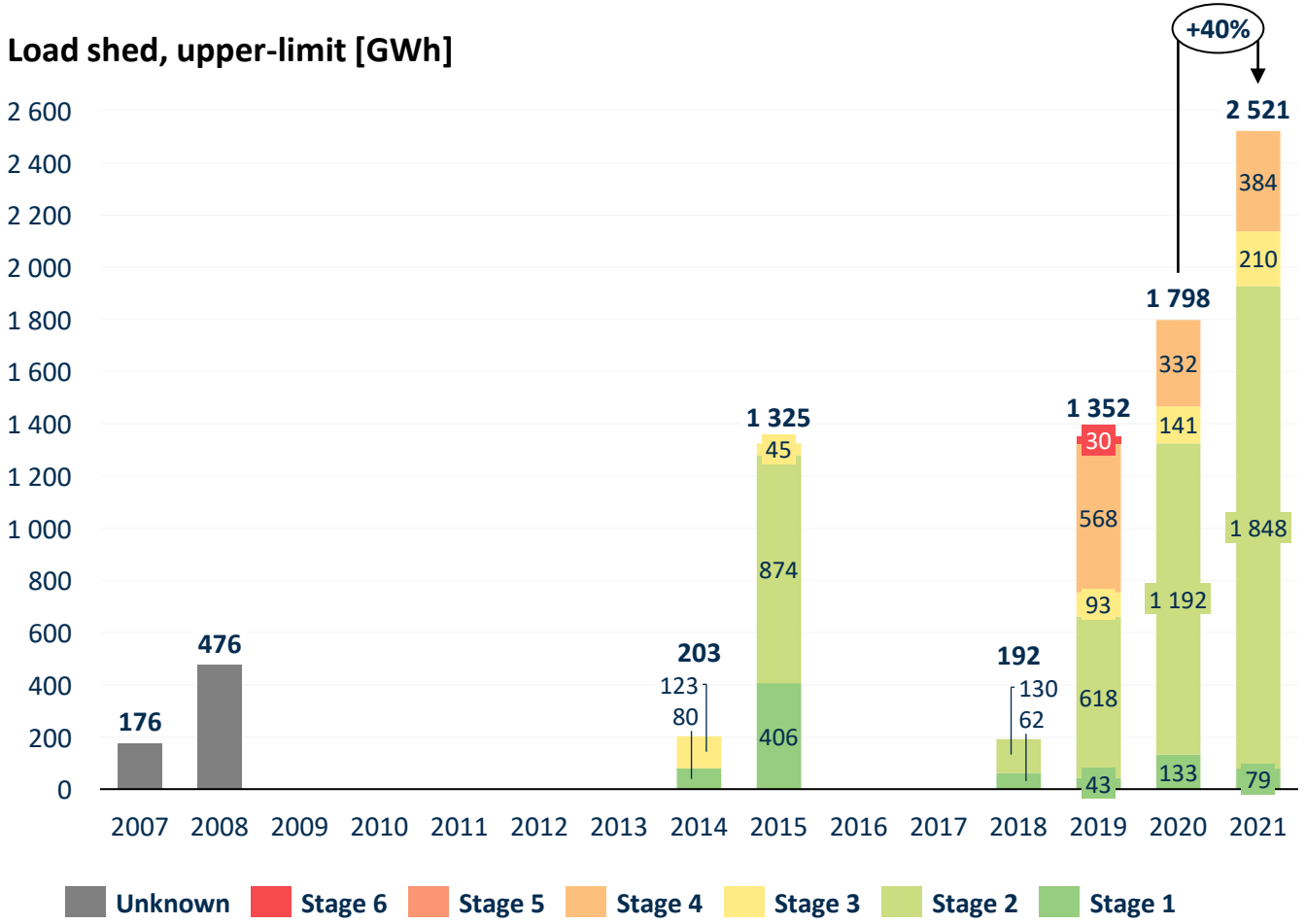
4 Daily electricity production (2021)

5 Hourly electricity production (2021)

6 Actual load shedding (2021)

7 Other power system statistics

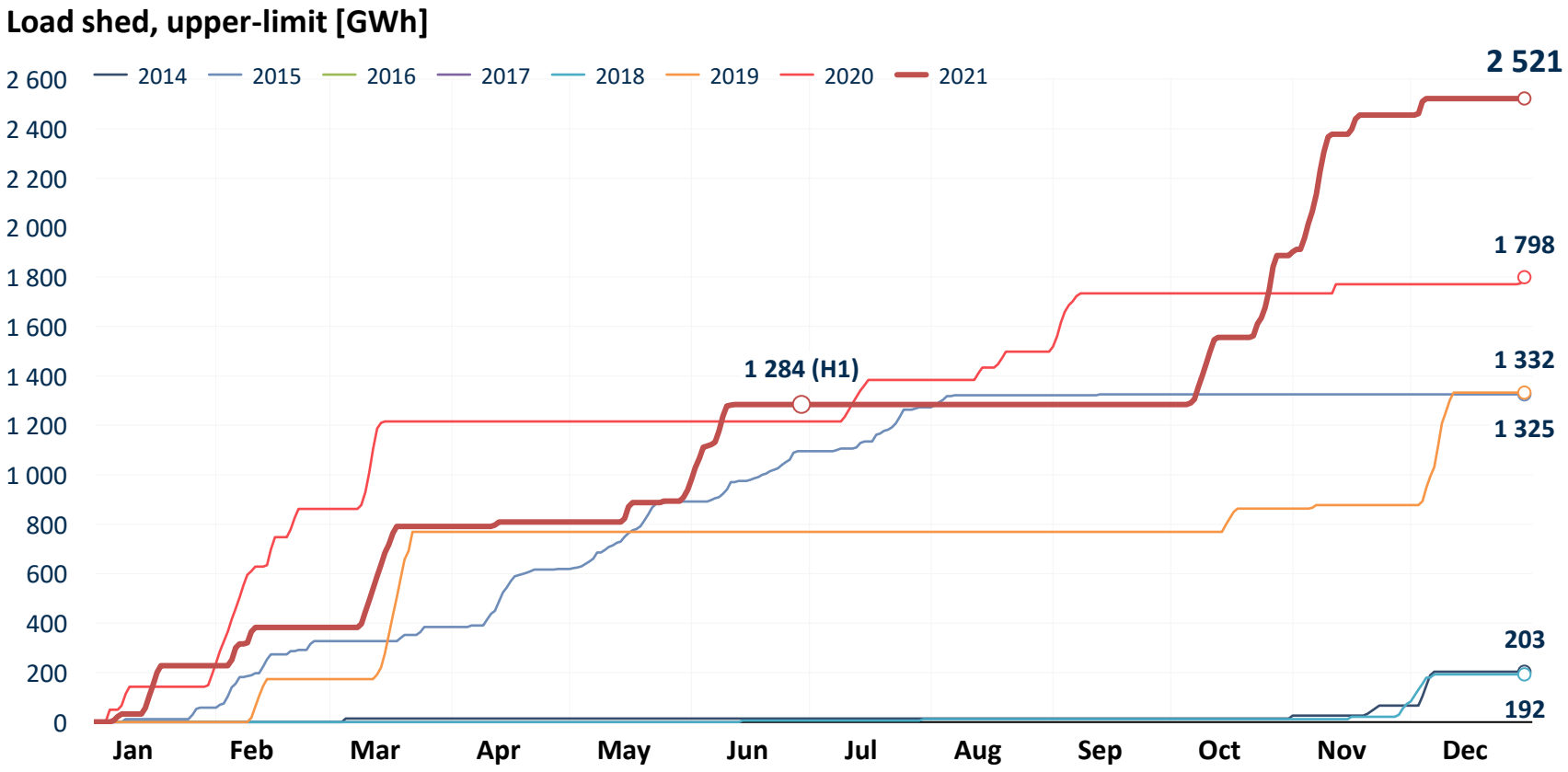
2021 overtakes 2020 as the most intensive loadshedding year yet – based on upper limit of loadshedding (as in previous publications)



Year	Duration of outages (hours)	Energy Shed (GWh)
2007	-	176
2008	-	476
....	....	....
2014	121	203
2015	852	1325
2016	-	-
2017	-	-
2018	127	192
2019	530	1352
2020	859	1798
2021	1169	2521

Notes: Loadshedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occassionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW, Stage 5 = 5 000 MW, Stage 6 = 6 000 MW;
Sources: Eskom Twitter account; Eskom Hld SOC Ltd FaceBook page; Eskom se Push (mobile app); Nersa; CSIR analysis

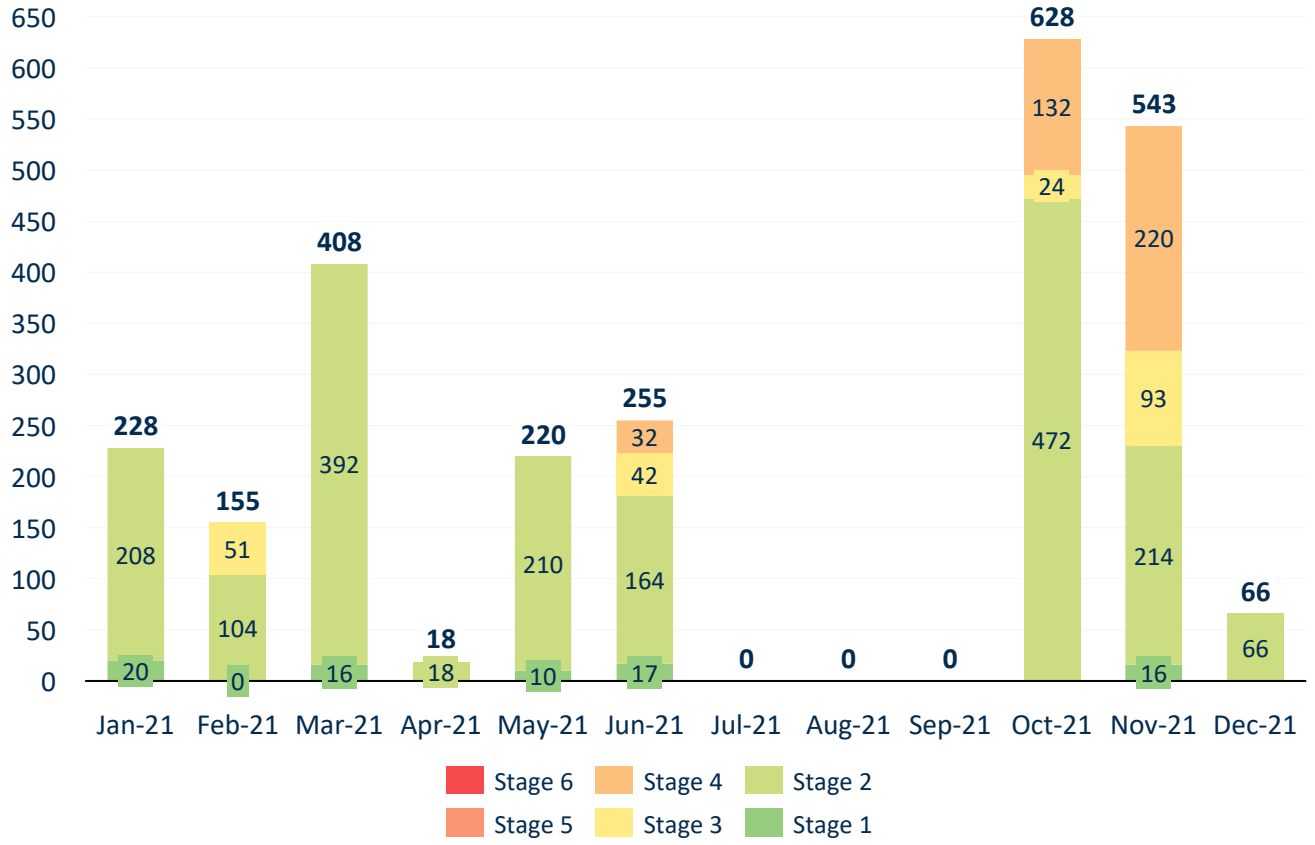
Annual upper limit of cumulative loadshedding Jan 2015 – Dec 2021



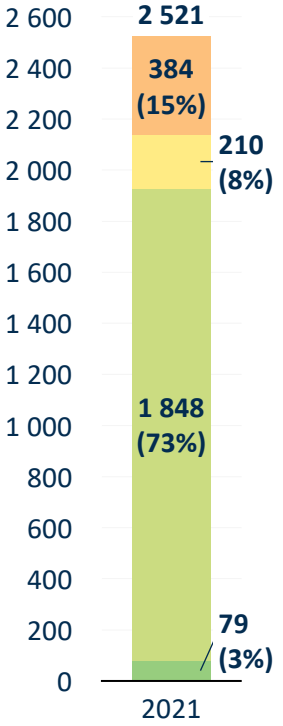
Notes: Loadshedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occassionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW, Stage 5 = 5 000 MW, Stage 6 = 6 000 MW;
Sources: Eskom Twitter account; Eskom Hld SOC Ltd FaceBook page; Eskom se Push (mobile app); Nersa; CSIR analysis

In 2021, loadshedding concentrated in Oct & Nov, and was dominated by Stage 2 type loadshedding overall

Monthly loadshedding (upper-limit) [GWh]



Annual loadshedding (upper limit) [GWh]



Notes: Loadshedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occassionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW, Stage 5 = 5 000 MW, Stage 6 = 6 000 MW;
Cost to the economy of load shedding is estimated using COUE (cost of unserved energy) = 87.50 R/kWh
Sources: Eskom Twitter account; Eskom Hld SOC Ltd FaceBook page; Eskom se Push (mobile app); Nersa; CSIR analysis

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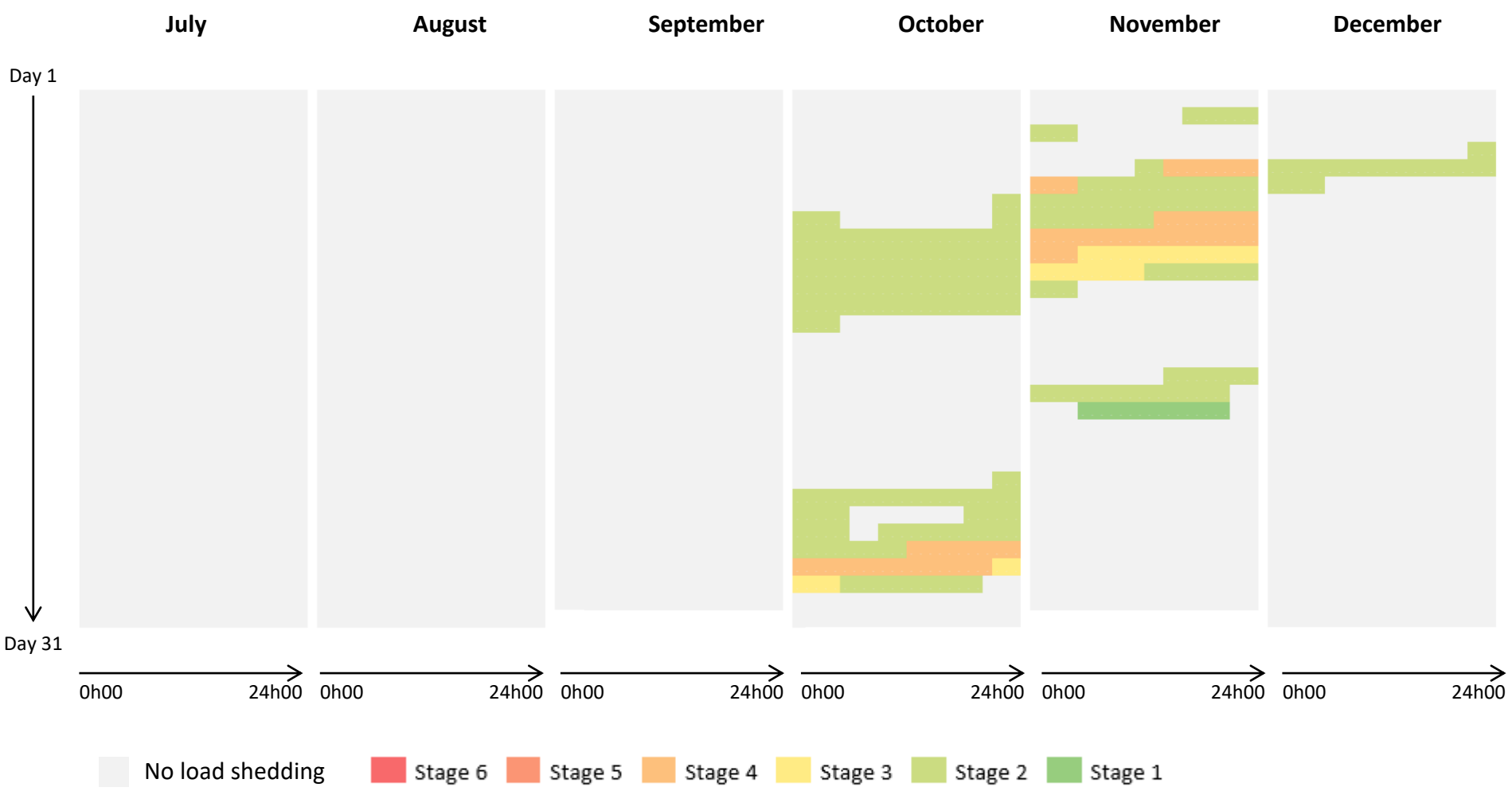
Hourly distribution of loadshedding Jan – Jun 2021

Notes: Load shedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occassionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW, Stage 5 = 5 000 MW, Stage 6 = 6 000 MW
Sources: Eskom Twitter account; Eskom Hld SOC Ltd FaceBook page; Eskom se Push (mobile app); CSIR analysis

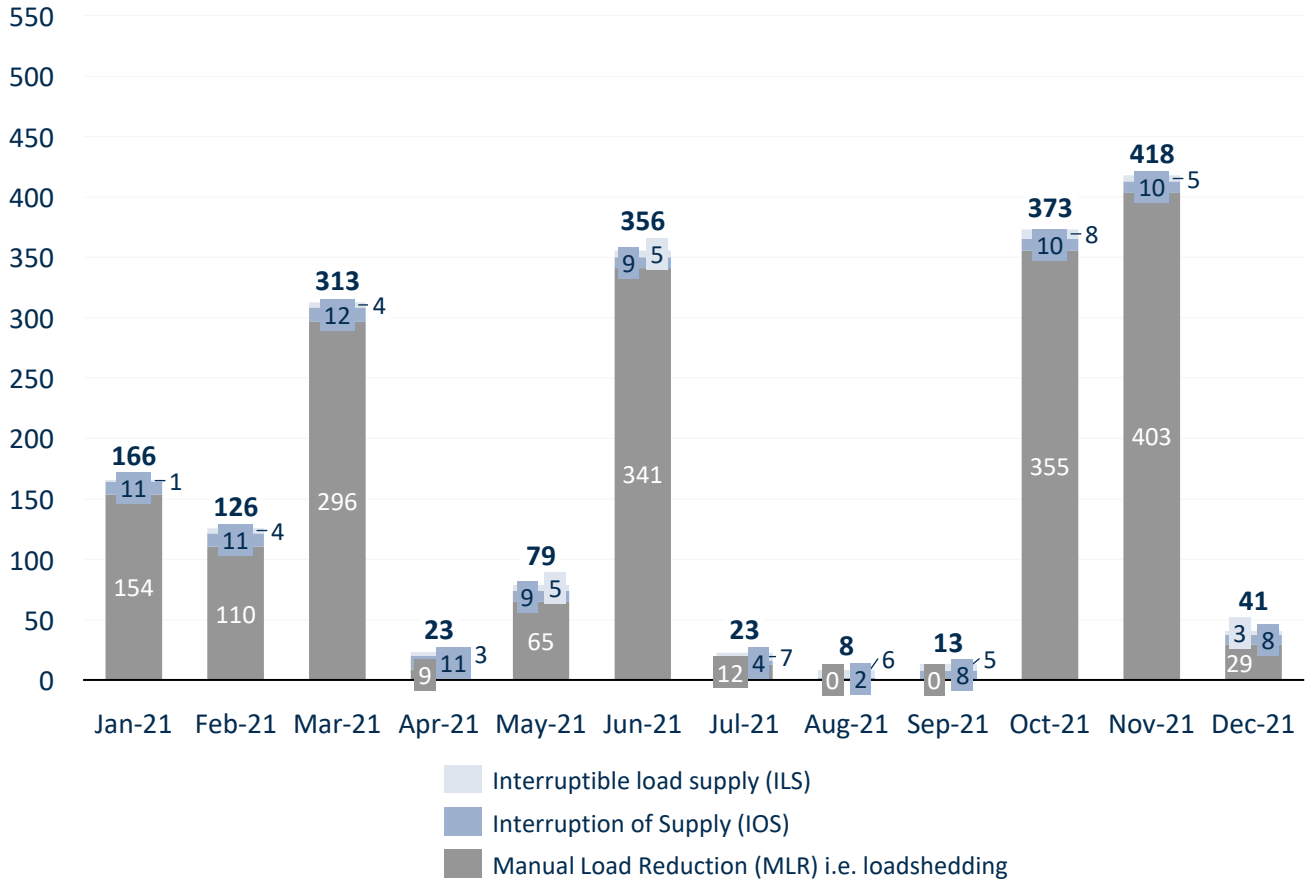
Hourly distribution of loadshedding Jul – Dec 2021



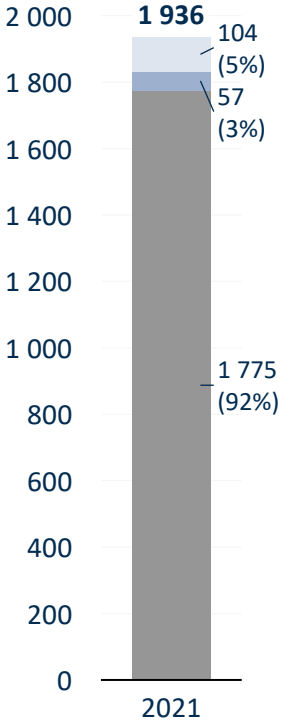
Notes: Load shedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occassionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW, Stage 5 = 5 000 MW, Stage 6 = 6 000 MW
Sources: Eskom Twitter account; Eskom Hld SOC Ltd FaceBook page; Eskom se Push (mobile app); CSIR analysis

Actual demand side response (DSR) in 2021 reveals how actual MLR (loadshedding) dominated over other DSR interventions

Monthly demand side response (DSR) [GWh]



Annual DSR [GWh]



Notes:Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS);
Sources: Eskom; CSIR analysis

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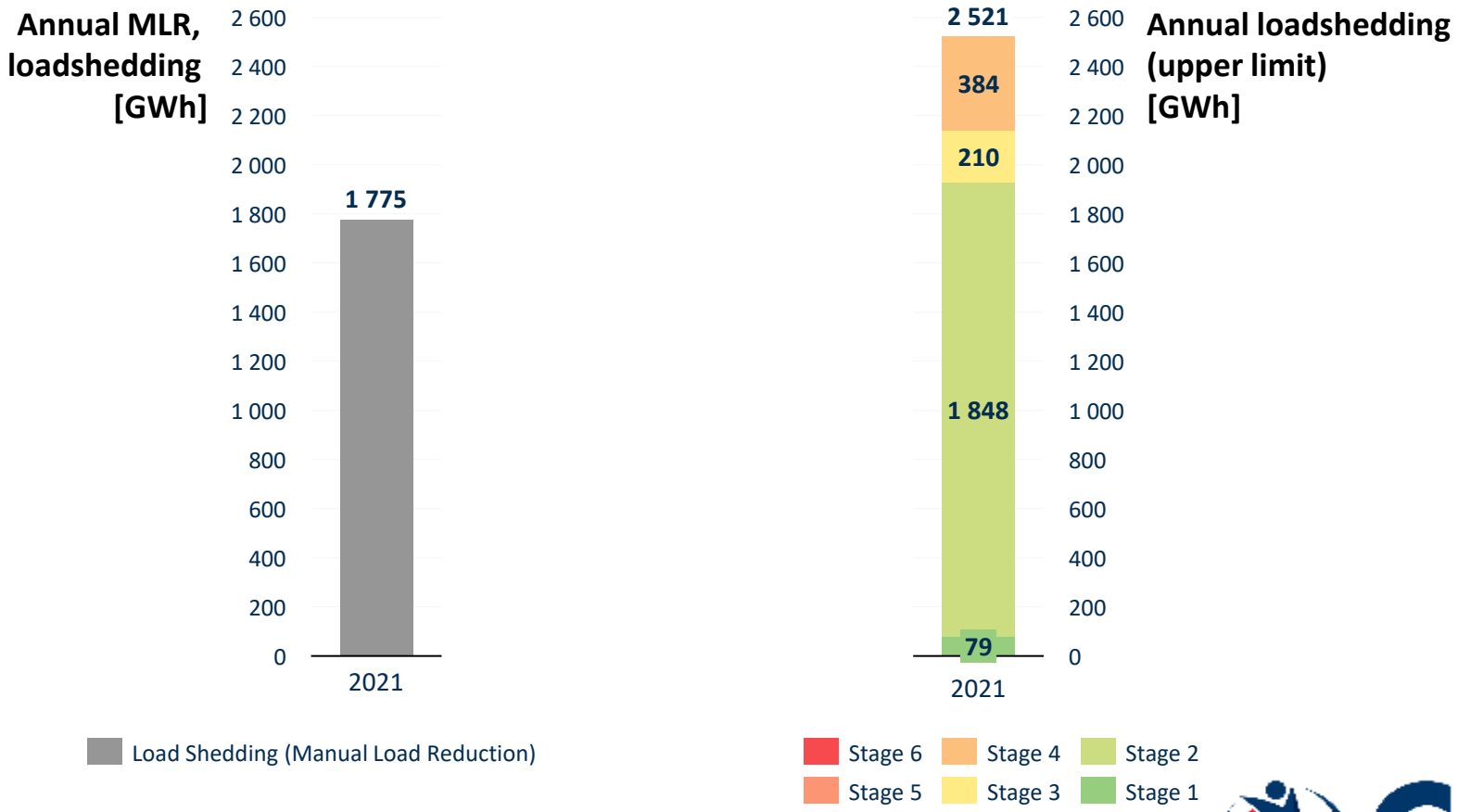
Similarly actual manual load reduction (MLR) in 2021 was ~70% of announced levels of loadshedding



Notes: Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS);
Sources: Eskom; CSIR analysis

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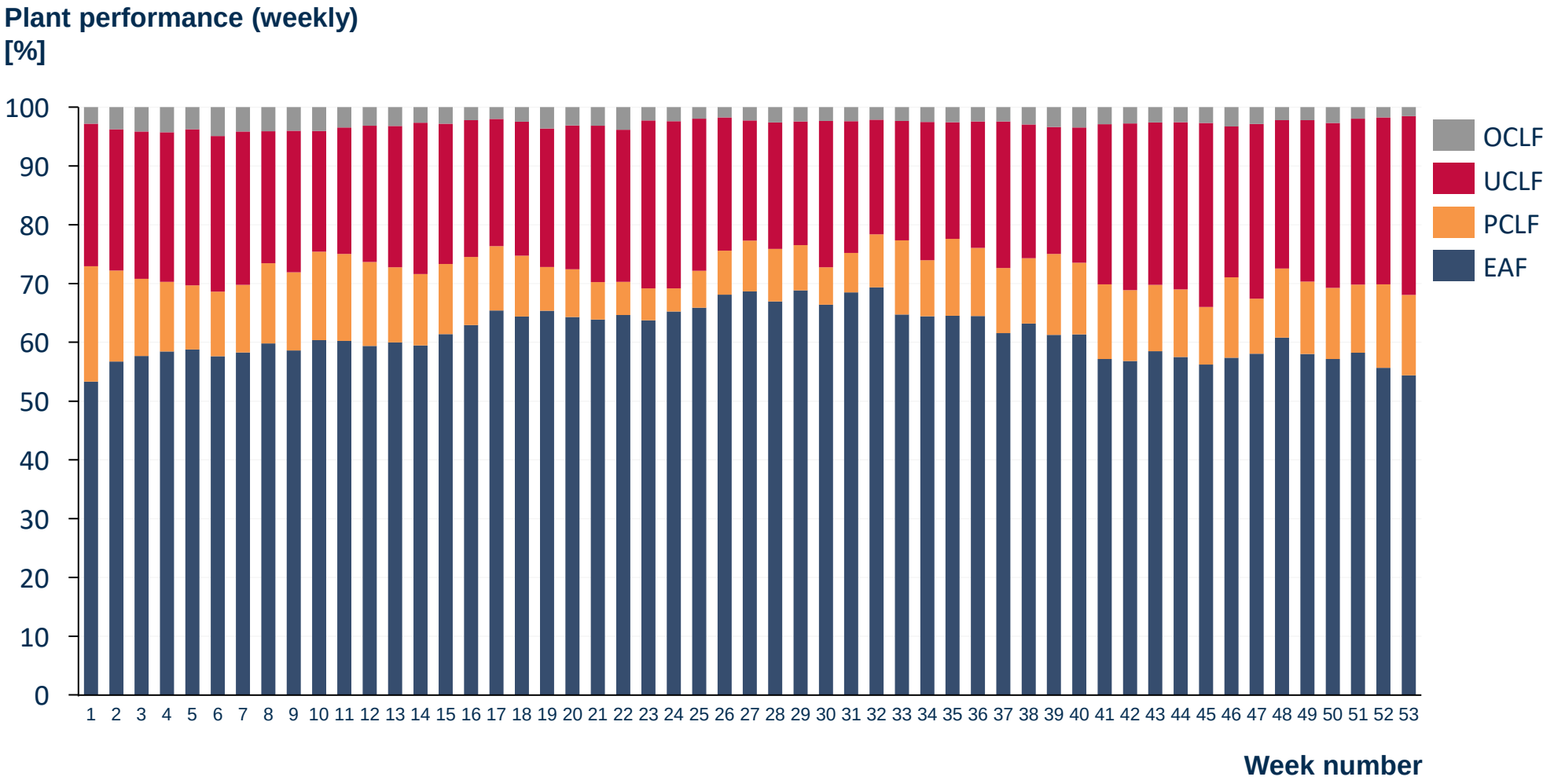
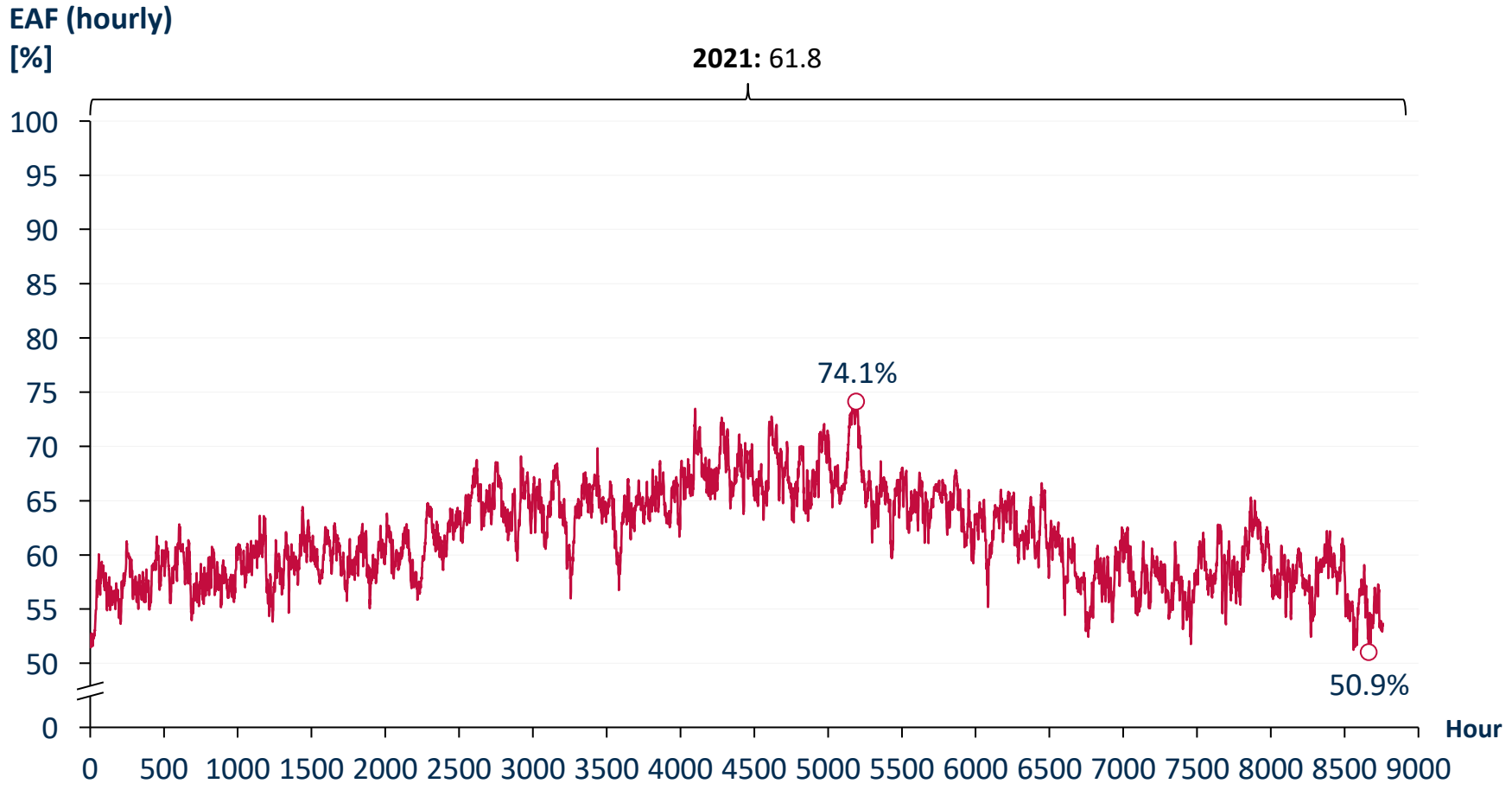
7 Other power system statistics

Eskom fleet performance for 2021 reveals annual EAF of 61.8% with planned maintenance of 10.8%, unplanned of 24.6% and other at 2.9%



NOTES: EAF - Energy Availability Factor; PCLF - Planned capability Loss Factor; UCLF – Unplanned Capability Loss Factor; OCLF – Other Capability Loss Factor
Sources: Eskom; CSIR Energy Centre analysis

Eskom fleet EAF for 2021 (hourly) exhibits similar seasonality as in other years



NOTES: EAF - Energy Availability Factor
Sources: Eskom; CSIR Energy Centre analysis

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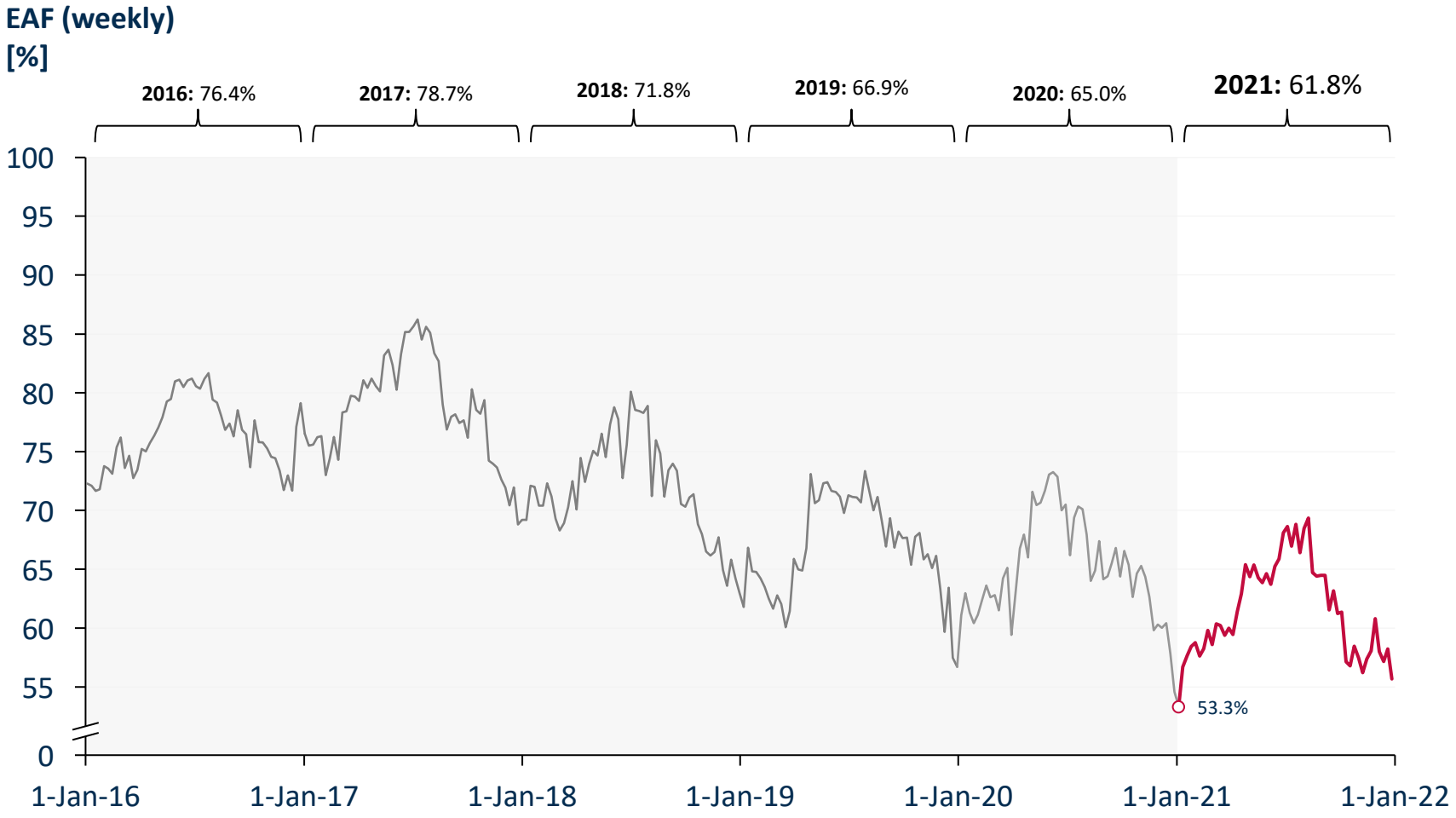
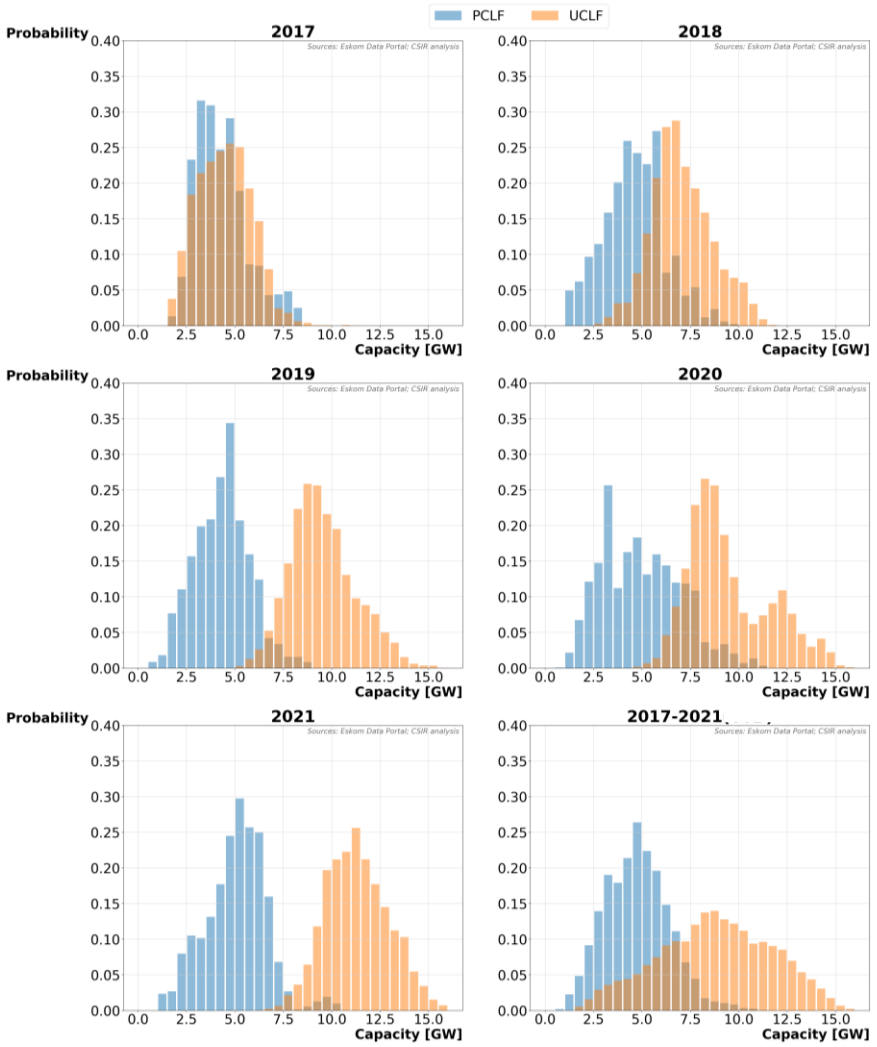
Declining EAF trend continues into 2021 to an average EAF 61.8%

The weekly average EAF hit a new low of 53.3% in 2021



Notes: EAF - Energy Availability Factor. Average annual EAF is calculated as an average of the hourly EAF values.
Sources: Eskom; CSIR Energy Centre analysis

Unplanned outage component is increasingly trending in a worrying direction



- **Shift from equal level of planned maintenance (PCLF) and unplanned outages (UCLF) in 2017 towards increasing distribution of UCLF as years progress**
- **Transition starts already in 2018 and progresses further**
- **2020 was an unusual year with a bimodal distribution (twin peaks) of UCLF**
- **2021 shows the distinct separation (in the statistical distribution) of UCLF and PCLF as unplanned maintenance continues to increase**

NOTE: Data presented is hourly temporal resolution;
Installed Eskom capacity is dynamic: [2017] 44.0-45.4 GW, [2018] 45.4-44.1 GW, [2019] 44.1-45.0, [2020] 45.0-45.6 GW, [2021] 45.6-46.4 GW

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Thank you

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