

Statistics of utility-scale power generation in South Africa in 2020

CSIR Energy Centre
v2.0

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Summary of 2020 statistics:

Coal still dominates the South African energy mix whilst variable renewables surpassed nuclear energy contribution in 2020 by some margin

By end 2020 – South Africa had 51.6 GW of wholesale/public nominal capacity

- Coal nominal capacity is 37.9 GW
- Nuclear nominal capacity is 1.9 GW
- Diesel (OCGT) nominal capacity is 3.4 GW
- Hydro nominal capacity is 0.6 GW hydro and pumped storage is 2.7 GW
- Wind nominal capacity is 2.5 GW
- Solar PV nominal capacity is 2.0 GW
- CSP nominal capacity is 0.5 GW
- 723 MW of coal, 415 MW of wind and 558 MW of solar PV became operational during 2020

The electricity mix is still dominated by coal-fired power generation which contributed 83.5% to system demand in 2020

- Coal energy contributed 83.5% (184.4 TWh)
- Nuclear energy contributed 5.2% (11.5 TWh)
- Renewable energy contributed 10.5% (23.1 TWh)
- Variable renewable energy contributed 5.6% (12.4 TWh)
- The remaining 0.9% came from diesel (1.9 TWh)

Summary of 2020 statistics:

System demand reduced notably in 2020 due to Covid-19 lockdown and resulting reduced economic activity

In 2020, system demand reduced by 11.8 TWh relative 2019 (-5.1%) whilst residual demand reduced by 12.7 TWh (-5.7%) relative to pre-lockdown forecasts

- Peak system demand in 2020 was 34.1 GW (vs 2019 which was 34.5 GW)
- Reduced system demand in 2020 vs 2019 was met mostly by reduced coal (-10.4 TWh) and nuclear (-2.1 TWh) whilst others increased production (particularly solar PV and pumped storage)
- Weekly residual demand under initial lockdown (March 2020) saw weekly energy demand plummet by over 20% for 4 weeks (biggest reduction of 24.5%)

Over the past 10 years, South African system demand has dropped by 8.8% (mostly seen in 2020) but even without the effects of 2020, system demand has been on a downward trend

- For the period 2010-2020, system demand has reduced from 254 TWh to 234 TWh (-0.8% per year)
- Excluding 2020 (2010-2019), reduction from 254 TWh to 245 TWh (-0.4% per year)

Summary of 2020 statistics:

5.6% of system load was supplied by wind, solar PV & CSP in RSA

By end 2020- total wind, solar PV and CSP production was 12.4 TWh (5.6% of SA system load)

- Maximum daily total energy from solar PV, wind & CSP combined was 59 GWh (1 Dec 2020)
- Wind power achieved a maximum peak power production of 2 114 MW (19h00-20h00, 1 Dec 2020)
- Solar PV power reached a maximum peak power production of 1 929 MW (12h00-13h00, 25 Nov 2020)
- CSP power reached a maximum peak power production of 505 MW (12h00-13h00, 25 Nov 2020)
- Maximum instantaneous contribution of wind, solar PV & CSP was 16.0% (15h00-16h00, 27 Dec 2020)
- Maximum instantaneous power contribution of wind alone was 9.6% (05h00-06h00, 12 Apr 2020)
- Maximum instantaneous power contribution of solar PV alone was 7.9% (12h00-13h00, 26 Dec 2020)
- Maximum instantaneous power contribution of CSP alone was 2.3% (16h00-17h00, 25 Dec 2020)

By end 2020 - monthly wind, solar PV and CSP production combined varied between 784-1161 GWh

- Monthly wind production from Jan to Dec 2020 varied between 404-674 GWh
- Monthly solar PV production from Jan to Dec 2020 varied between 262-477 GWh
- Monthly CSP production from Jan to Dec 2020 varied between 74-198 GWh

Summary of 2020 statistics:

VRE made a notable energy contribution to the energy mix in 2020 whilst residual demand exhibiting slight increasing need for flexible capacity

In 2020, the VRE fleet of 5.0 GW (wind, solar PV, CSP) reduced peak demand slightly but more importantly high demand hours by ~70%

- VRE fleet reduced peak demand by ~1.4 GW
- VRE fleet also reduced high-demand hours (hours with >30 GW system demand) from 492 hours to 151 hours (~341 hours less, -70%)

Flexibility needs are not yet significantly increased with the existing VRE fleet in 2020

- The minimum system demand was 14.9 GW whilst residual demand minimum was 13.8 GW
- System demand & residual demand was above 20.5 GW and 19.5 GW respectively for 90% of 2020
- The residual system demand profile indicates an increasing need for flexible peaking type capacity (+6%), notably less mid-merit type capacity (-12%) and slightly less base-supply type capacity (-4%)
- 1-hourly maximum system demand gradient of 3 498 MW occurred on 23 Jan 2020 and minimum gradient of -3 000 MW on 23 Jul 2020
- 1-hourly maximum residual demand gradient of 3 514 MW occurred on 17 Feb 2020 and minimum gradient of -2 930 MW on 17 Aug 2020
- 3-hourly maximum system demand gradient of 7 094 MW occurred on 16 Jun 2020 and minimum gradient of -7 925 MW on 1 Sep 2020
- 3-hourly maximum residual demand gradient of 7 053 MW occurred on 25 Jul 2020 and minimum gradient of -7 672 MW on 1 Sep 2020

NOTES: Residual demand = System demand less variable renewable energy (solar PV, CSP and wind).

VRE – Variable Renewable Energy.

Peaking type capacity is considered as capacity that would operate for <1000 hrs/yr.

Mid-merit type capacity is considered as capacity that would operate for >1000 hrs/yr and <6000 hrs/yr.

Base-supply type capacity is considered as capacity that would operate >6000 hrs/yr.

Summary of 2020 statistics:

2020 saw 859 hours of loadshedding and seemingly the most intense yet (upper limit 1798 GWh) whilst actually achieved was 1269 GWh

In 2020, loadshedding occurred for 859 hours of the year (9.8%) with an upper limit of 1798 GWh relative to actually achieved energy shed of 1269 GWh

- Intensive loadshedding before Covid-19 related lockdown (63% of 2020 loadshedding)
- Loadshedding dominated by Stage 2 type loadshedding with smaller contributions from other stages
- Previous CSIR publications considered available public data and an upper limit to loadshedding (based on announcements and loadshedding stages)
- Available data in 2020 has made more accurate findings possible – 1798 GWh would be the upper limit based on announcements and stages but actually achieved loadshedding was 1269 GWh

Eskom fleet EAF is on a declining trend and drove loadshedding events in 2020

- Eskom fleet annual average EAF of 65% (relative to 2019 of 66.9% and 2018 of 71.9%)
- EAF comprised of planned maintenance at 11.2% (PCLF), unplanned outages at 20.9% (UCLF) & other outages at 2.8% (OCLF)
- The best hourly EAF of 78.8% was achieved on 10 Jun 2020 and worst of 51.7% on 31 Dec 2020

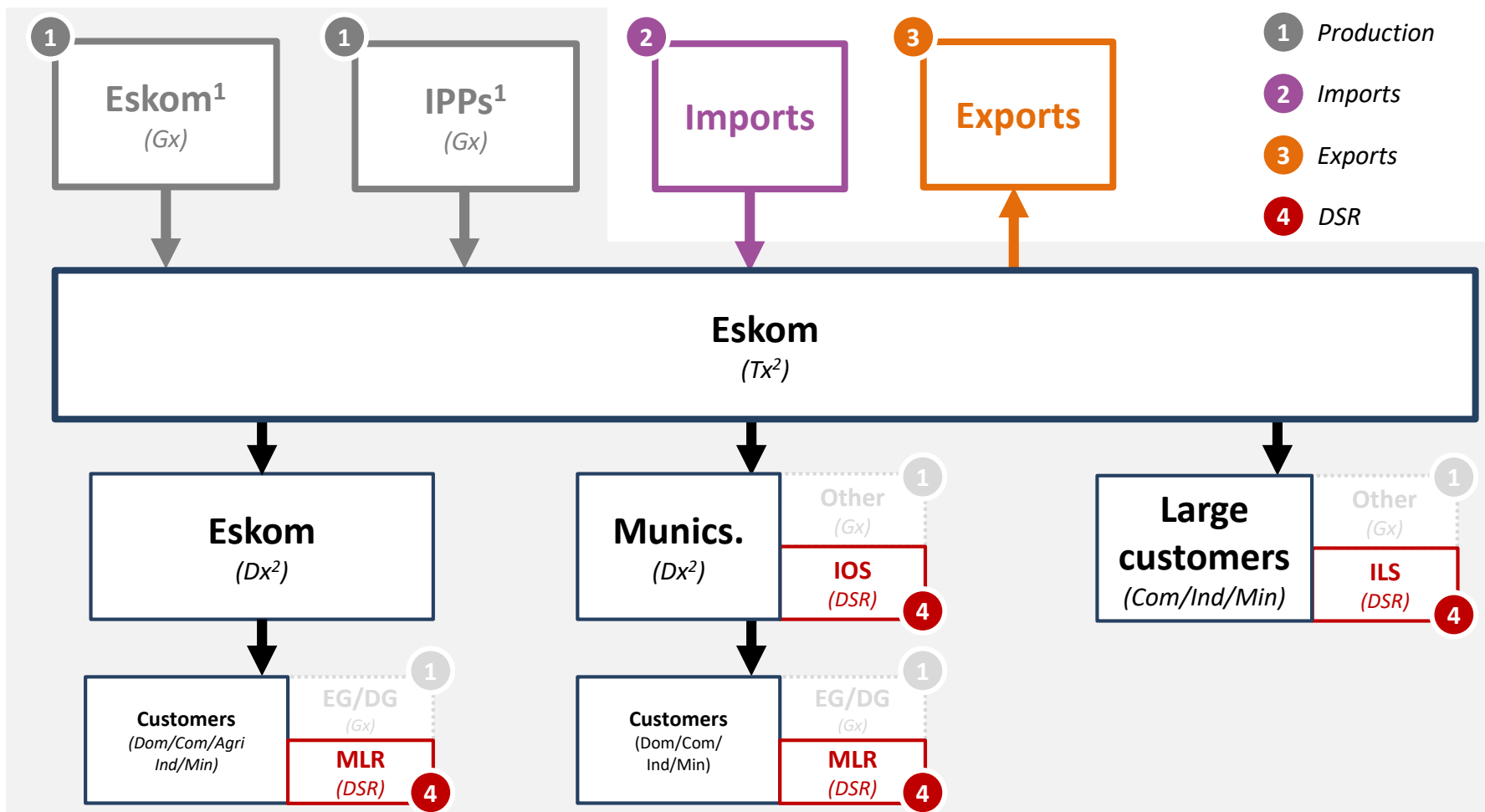
Agenda

- 1 Overview actual electricity production (2020)
- 2 Monthly electricity production (2020)
- 3 Weekly electricity production (2020)
- 4 Daily electricity production (2020)
- 5 Hourly electricity production (2020)
- 6 Actual load shedding in 2020
- 7 Other power system statistics

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



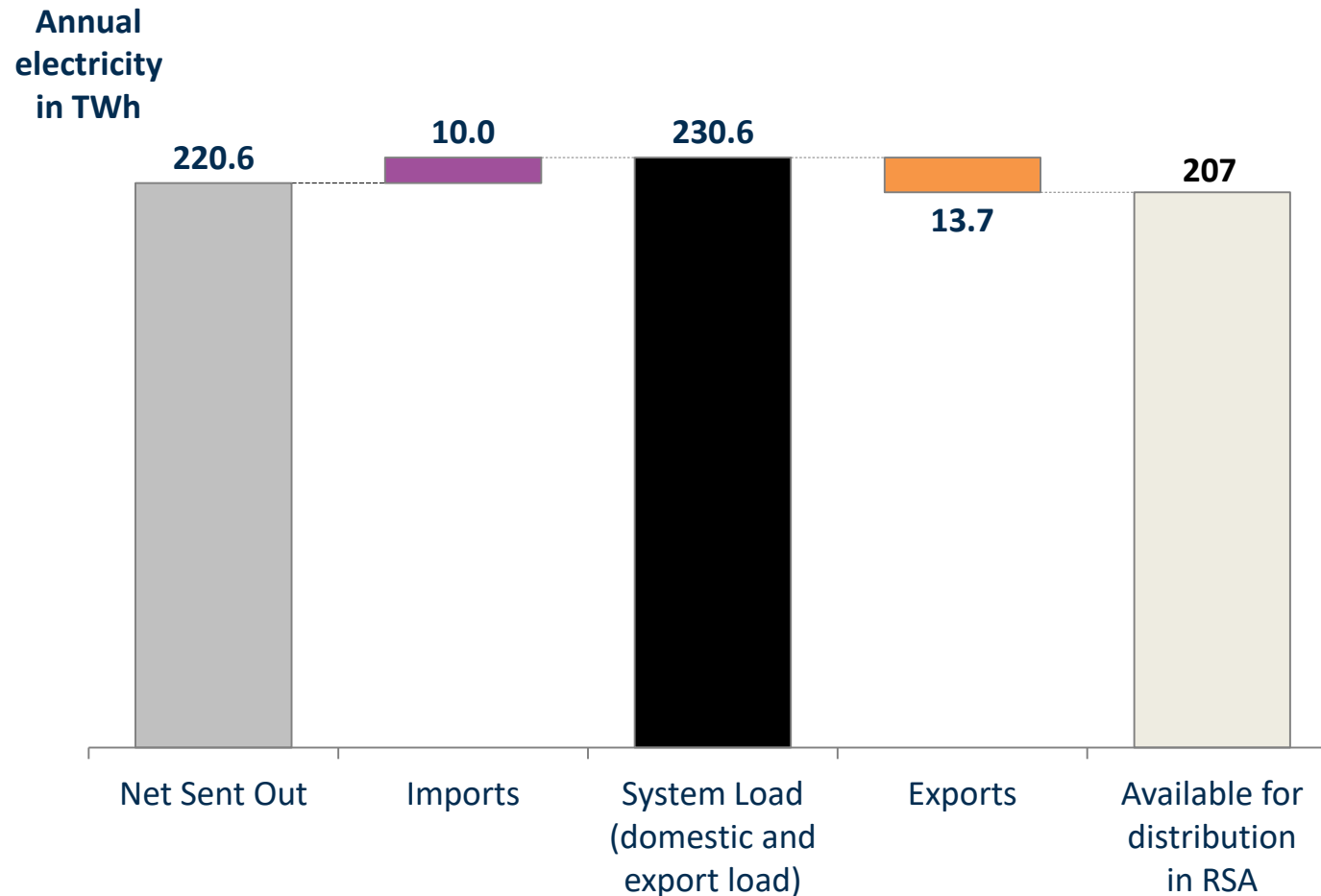
EG = Embedded Generation; DG = Distributed Generation; Gx = Generation; Tx = Transmission; Dx = Distribution; Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS);

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

From Jan-Dec 2020, 221 TWh of net electricity was produced in SA

Actuals captured in wholesale market for Jan-Dec 2020 (i.e. without self-consumption of embedded plants)

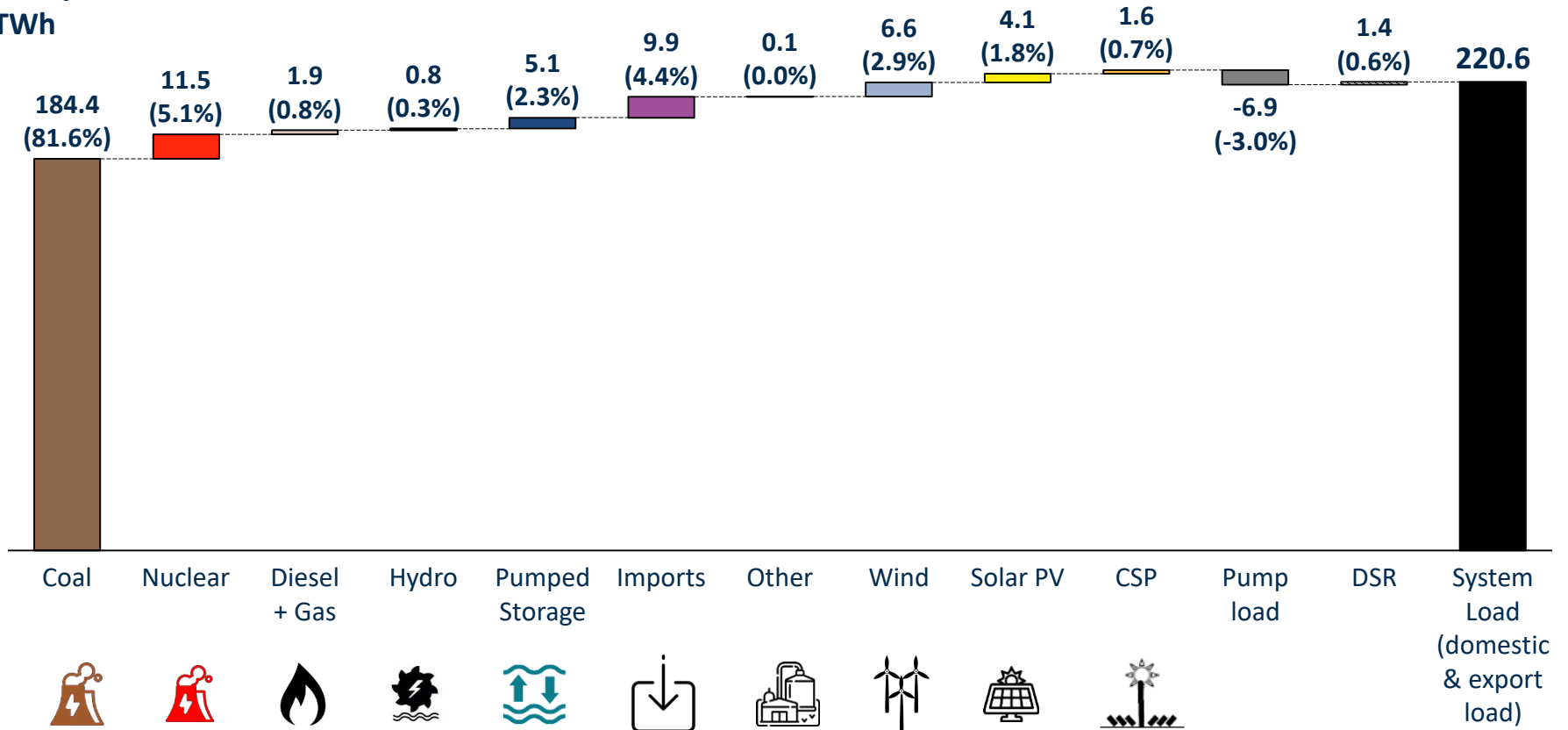


Notes: "Net Sent Out" = Total domestic generation (Sent Out) minus pumping load (not shown separately); Demand not served is excluded from graph = Interruptible load supply (ILS) + manual load reduction (MLR)
Sources: Eskom; Statistics South Africa for imports and exports

In 2020, coal dominated the energy mix at 184 TWh of the 221 TWh of total system load whilst PV, wind and CSP contributed 12.4 TWh (5.6%)

Actuals captured in wholesale market for Jan-Dec 2020 (i.e. without self-consumption of embedded plants)

Annual electricity in TWh



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

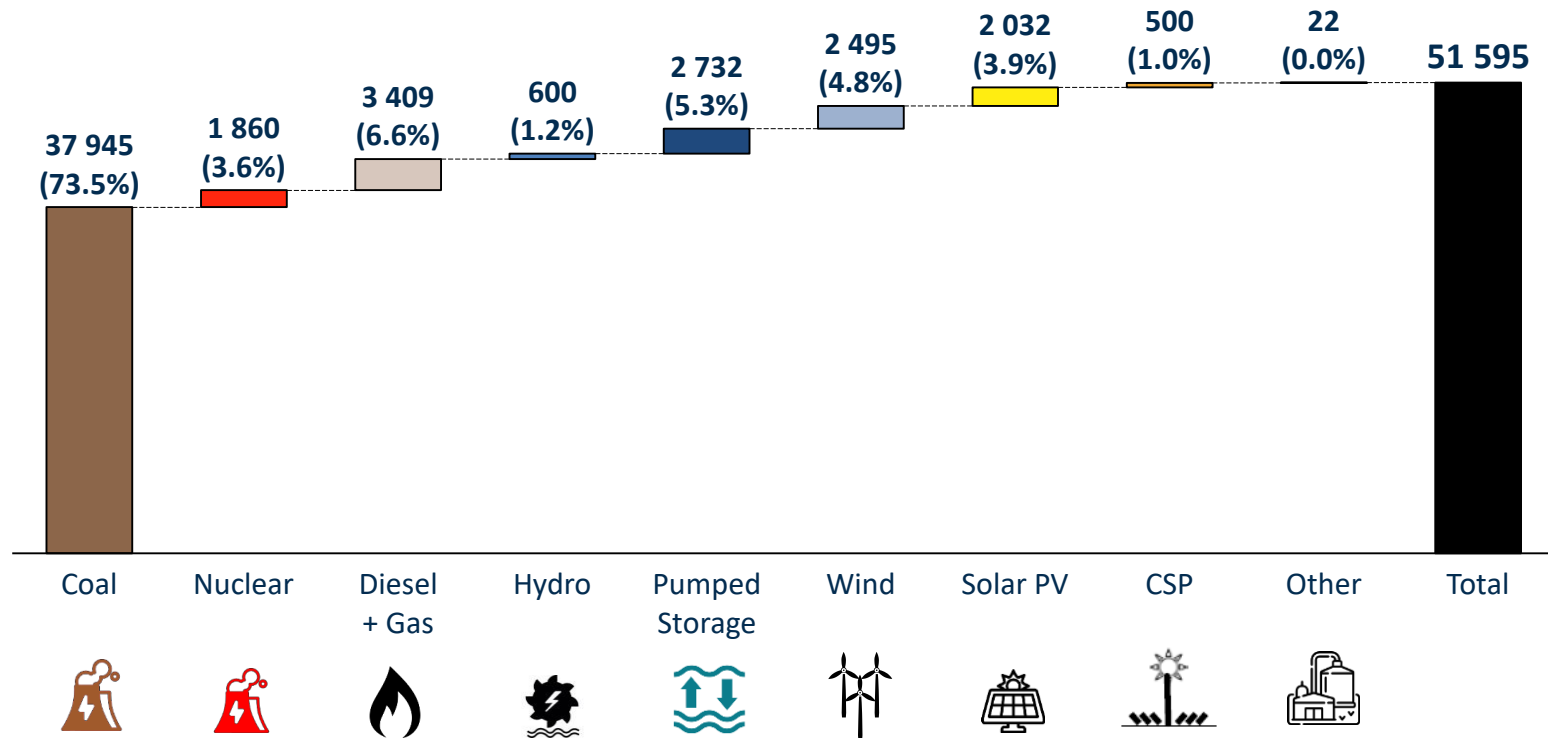
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)

Sources: Eskom

Nominal capacity in 2020

Actual nominal installed capacity as at 31 Dec 2020 (excluding embedded generation capacity and private capacity)

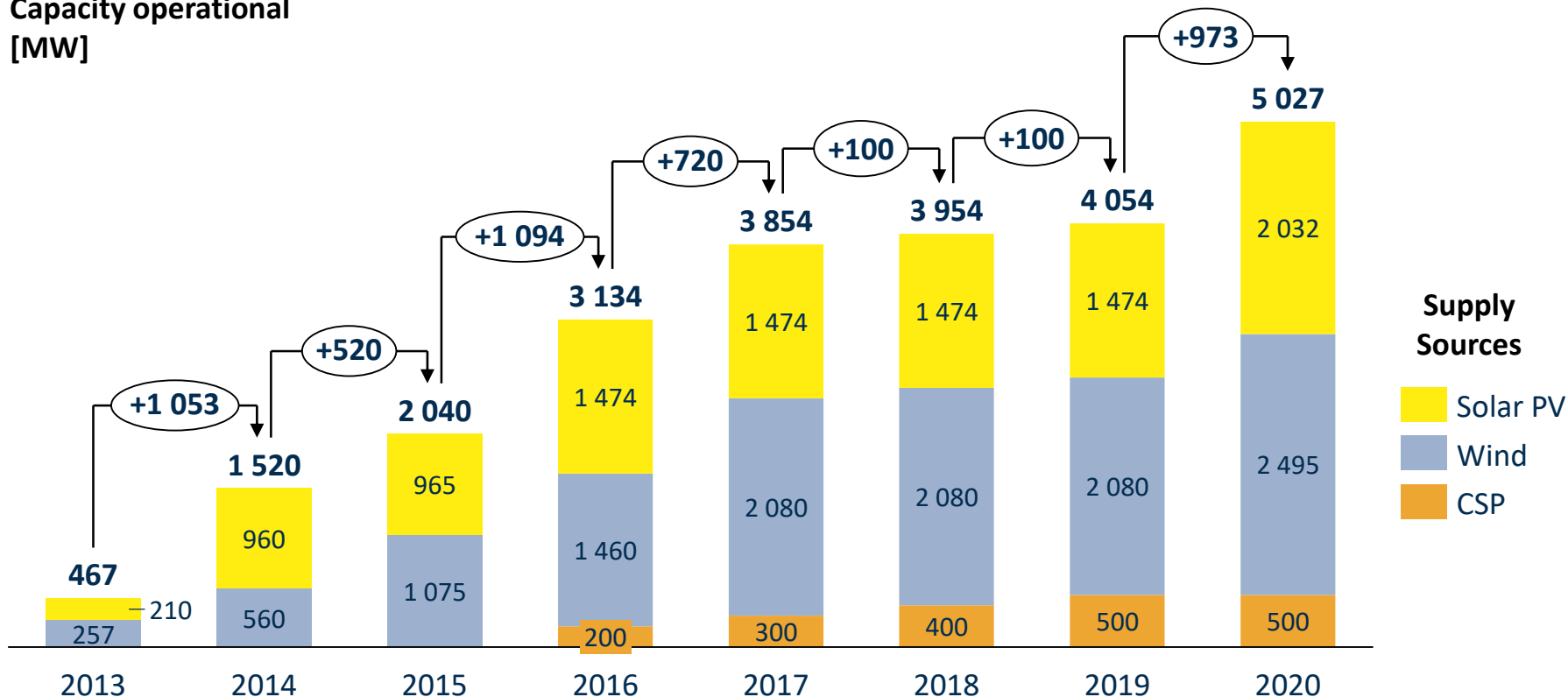
Nominal Capacity in MW



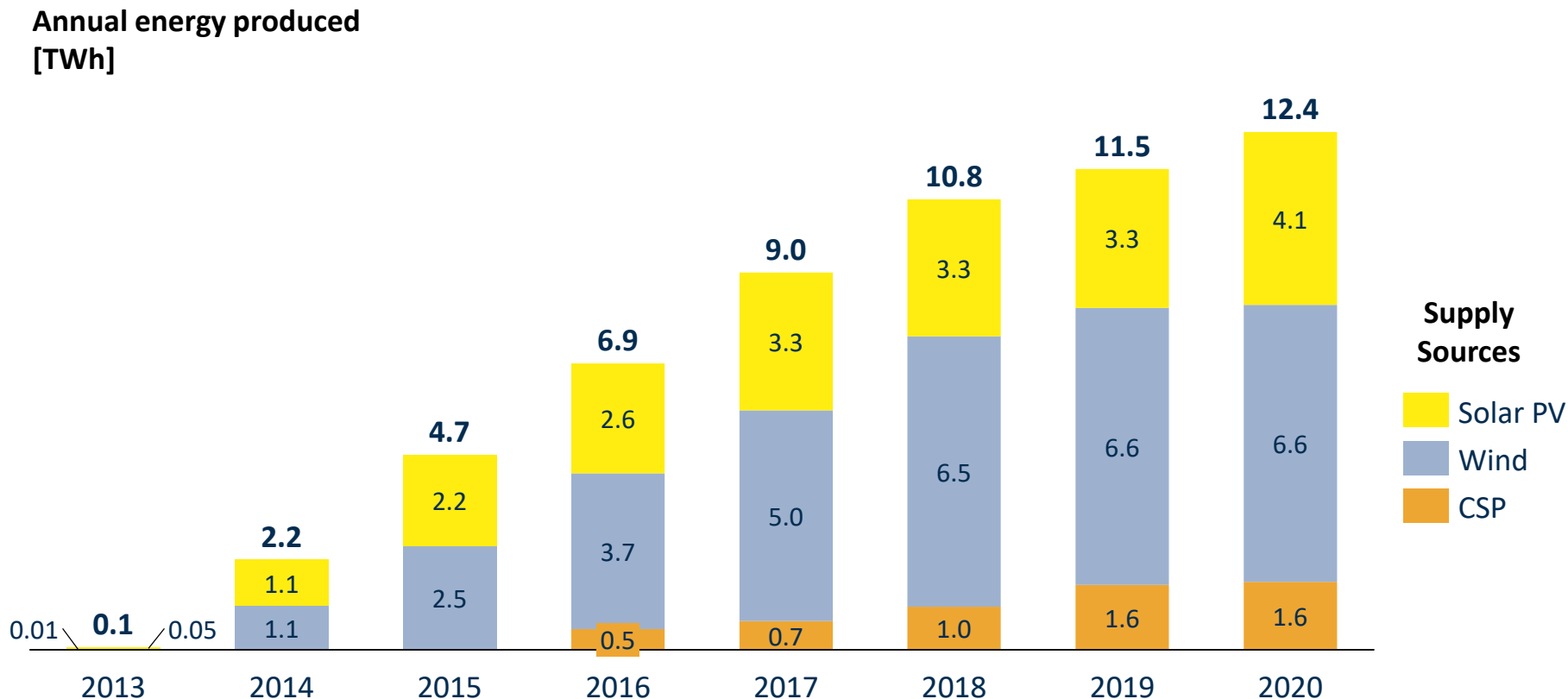
Notes: RE = Renewable Energy; Total nominal installed capacity = Eskom capacity + IPPs; Embedded generation and municipal-owned capacity excluded
Sources: Eskom

From 1 Nov 2013 to 31 Dec 2020, 2 495 MW of wind, 2 032 MW of large-scale solar PV and 500 MW of CSP became operational in RSA

Capacity operational
[MW]



In 2020 - 12.4 TWh of wind, solar PV & CSP energy produced in RSA



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

Production dropped by 4.3% (2010-2019) and 8.8% (2010-2020) resulting in annual average reductions of -0.5% (2010-2019) and -0.9% (2010-2020)

Historical annual electricity production per supply source in TWh

Annual electricity production in TWh

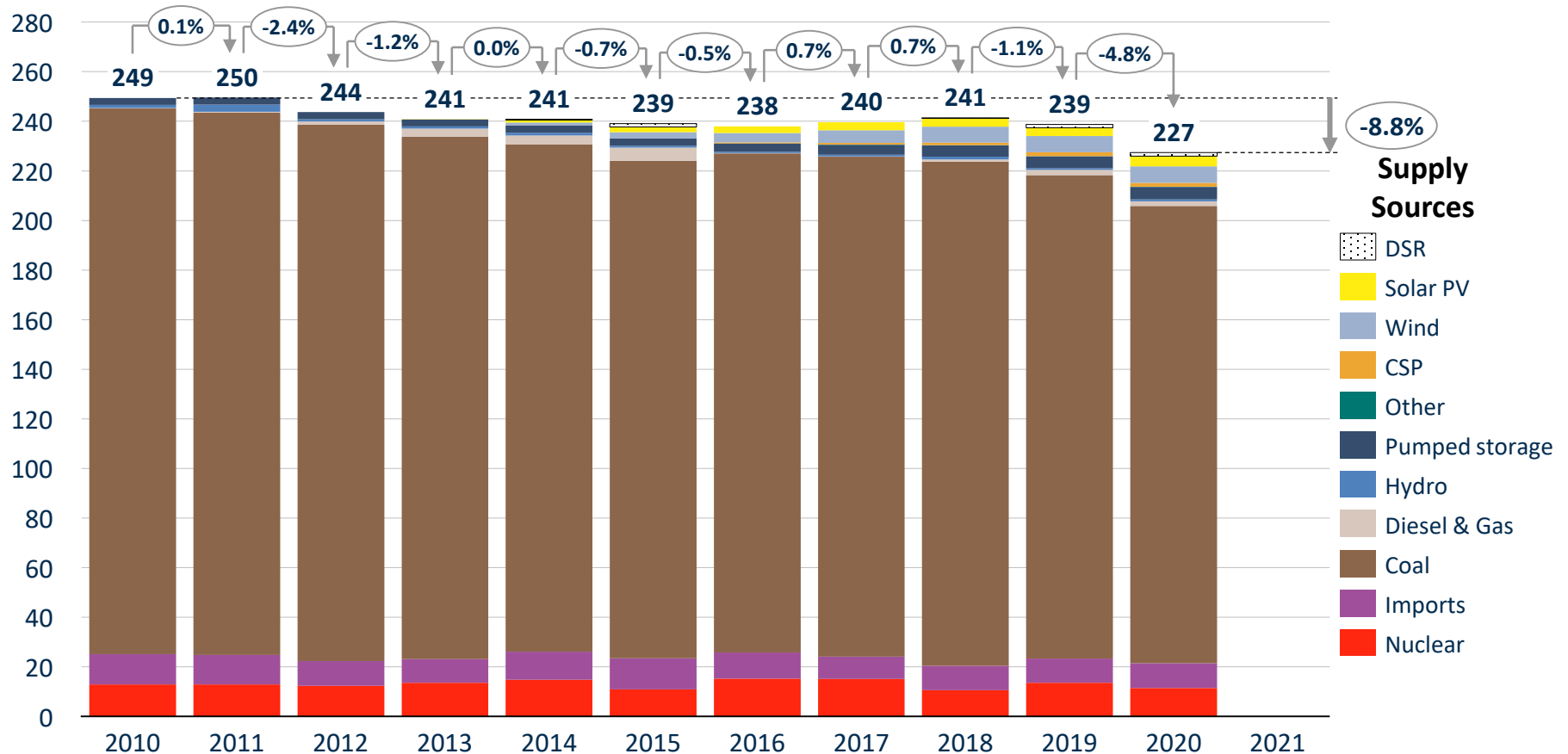
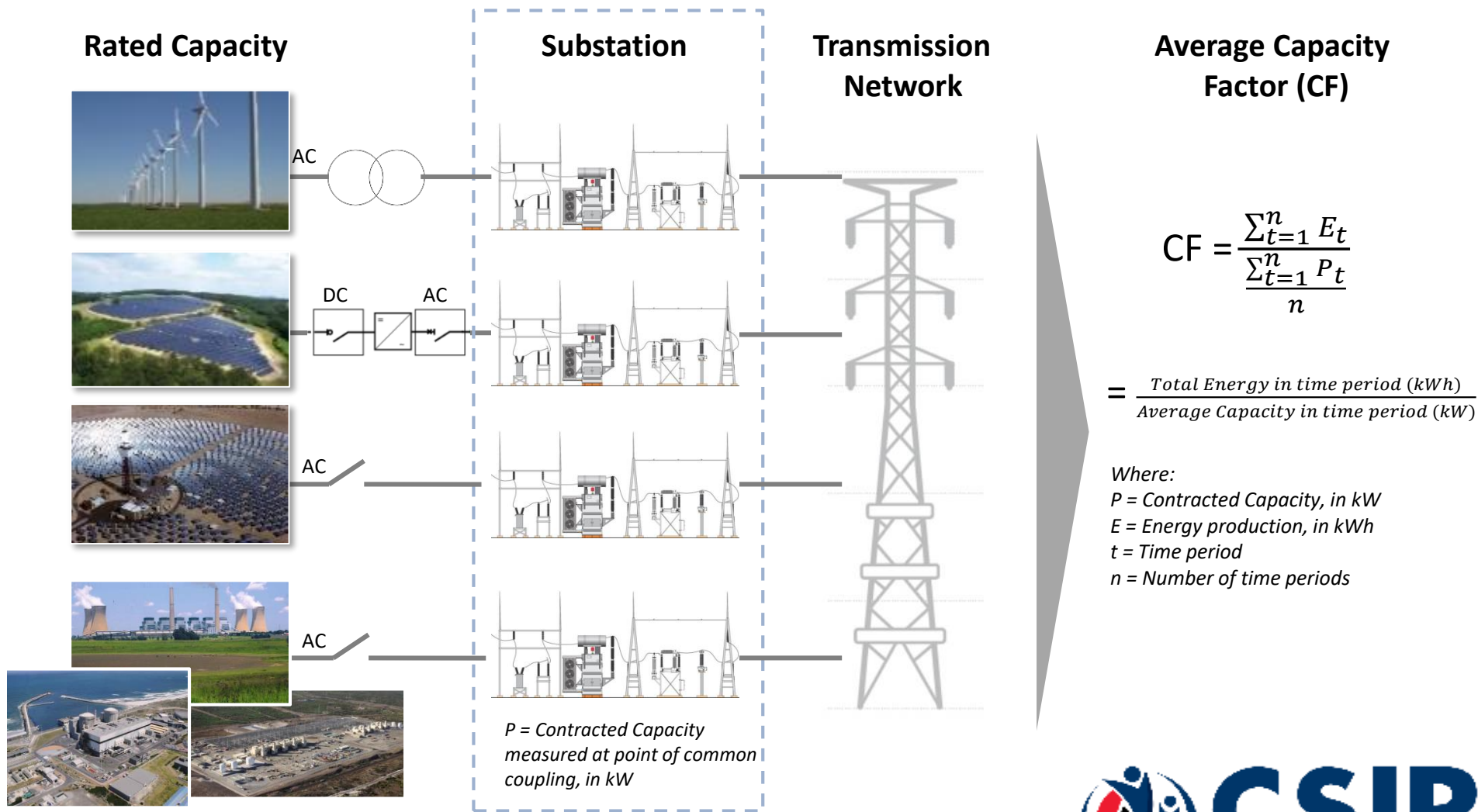


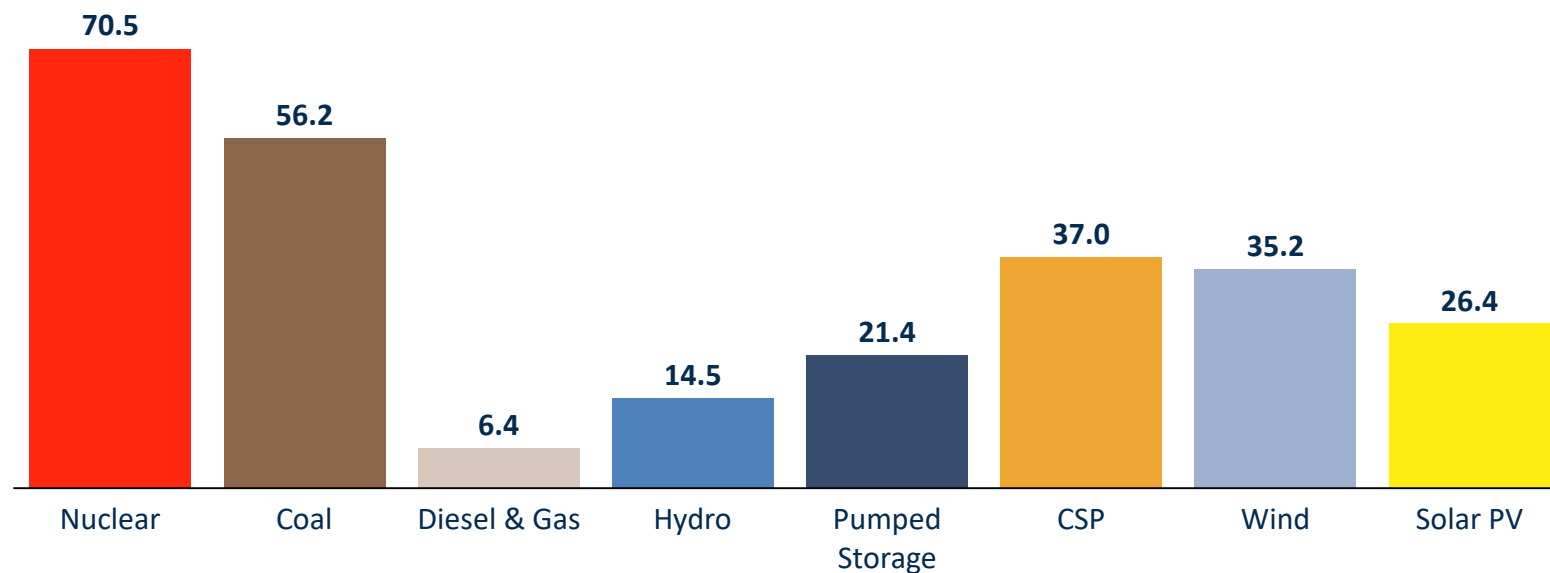
Illustration: Calculation of average capacity factor of operational power plant categories in RSA



Annual capacity factors per supply source in South Africa in 2020

2020

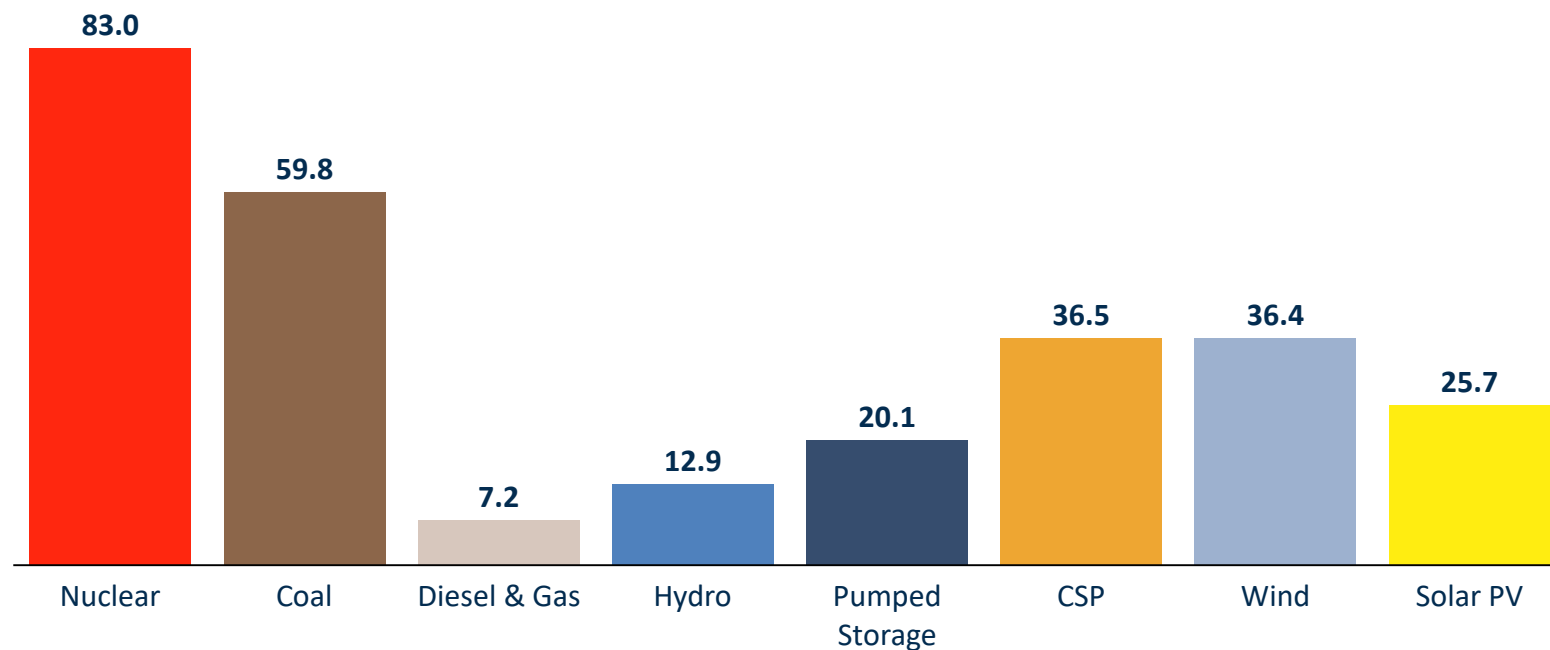
Annual Capacity Factors %



Annual capacity factors per supply source in South Africa in 2019

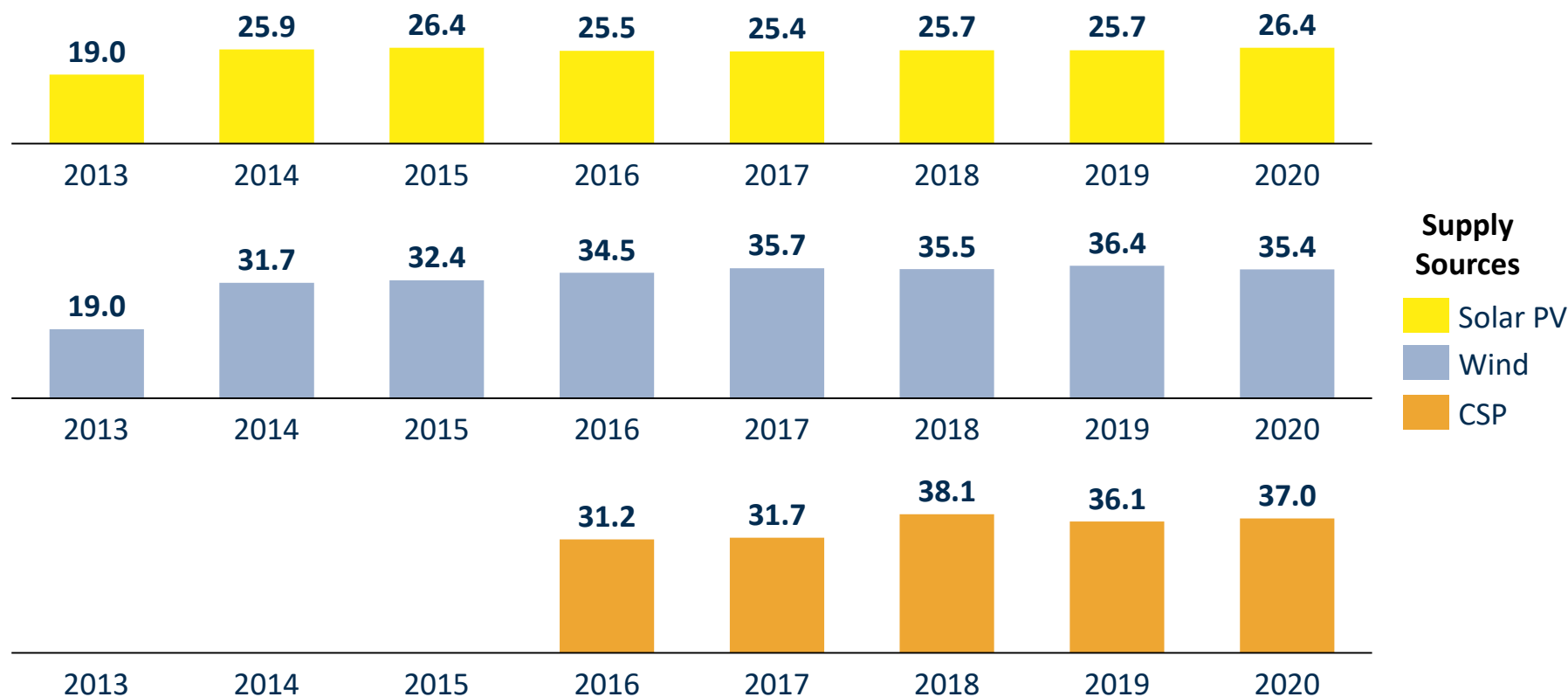
2019

Annual Capacity Factors %



In 2020, the average annual capacity factor of the solar PV, wind & CSP fleet was 26%, 35% and 37% respectively

Average Capacity Factor

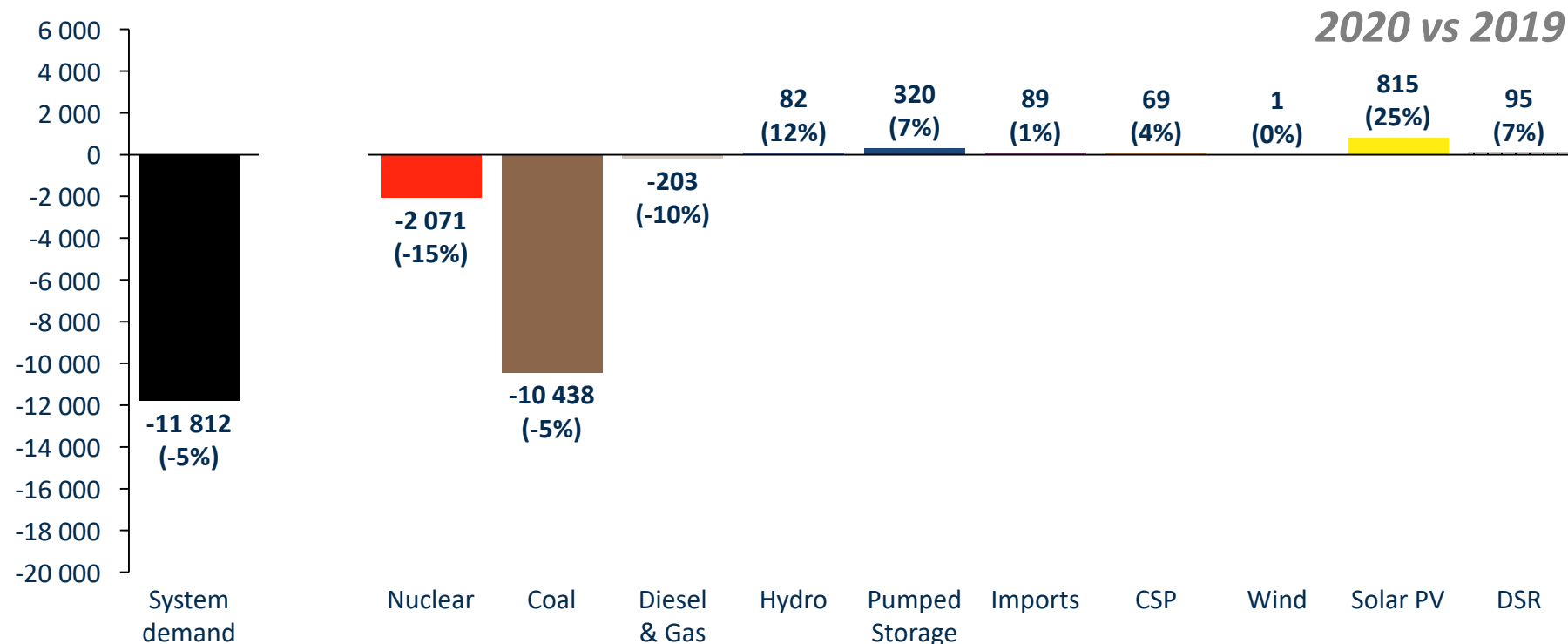


NOTES: Historical capacity factors for other technologies not available at the time of publication; Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants commissioned. Wind includes Sere wind farm (100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

Significantly lower production from coal in 2020 relative to 2019 by 10.4 TWh (-5%) - Covid-19 lockdown (reduced demand)

Difference in annual electricity production 2020 vs 2019

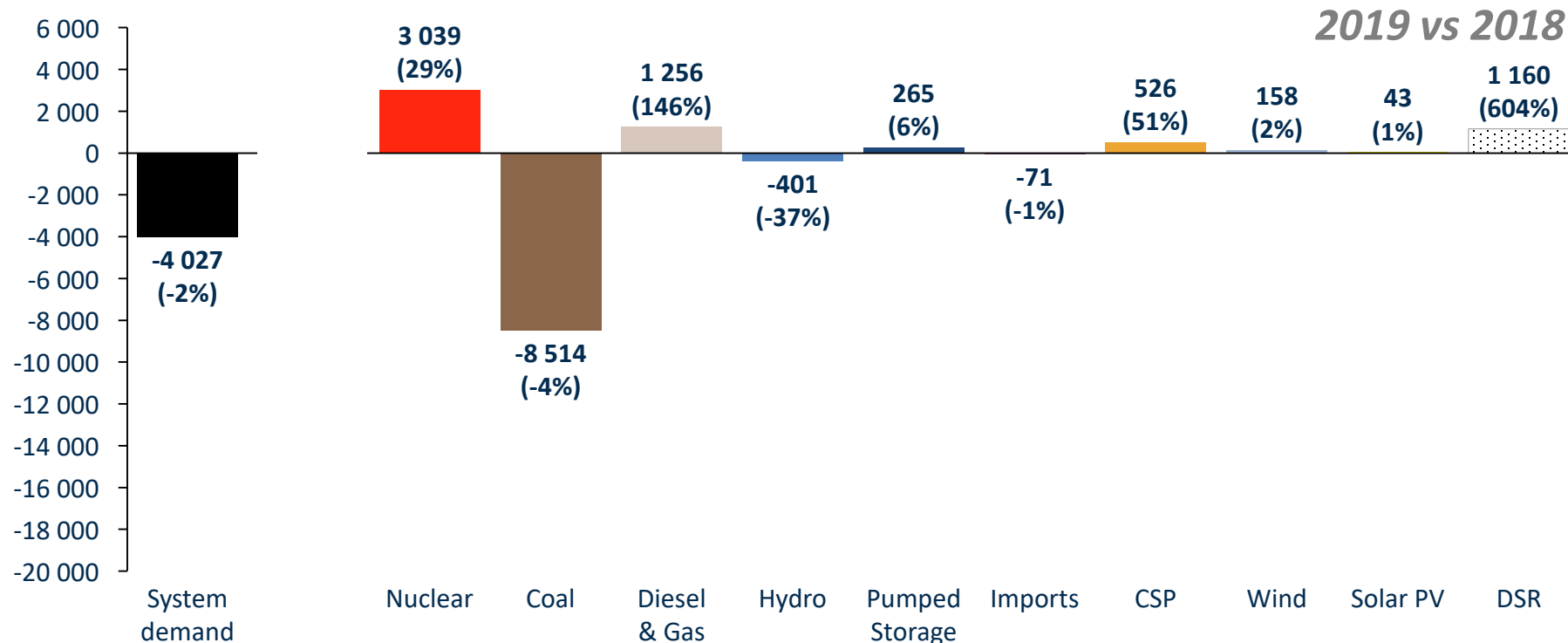
Difference, 2020 vs 2019
in GWh



Similar reduction in coal production from 2018 to 2019 (-8.5 TWh) but largely driven by lower EAF – drives increased diesel usage and DSR

Difference in annual electricity production 2019 vs 2018

Difference, 2019 vs 2018
in GWh

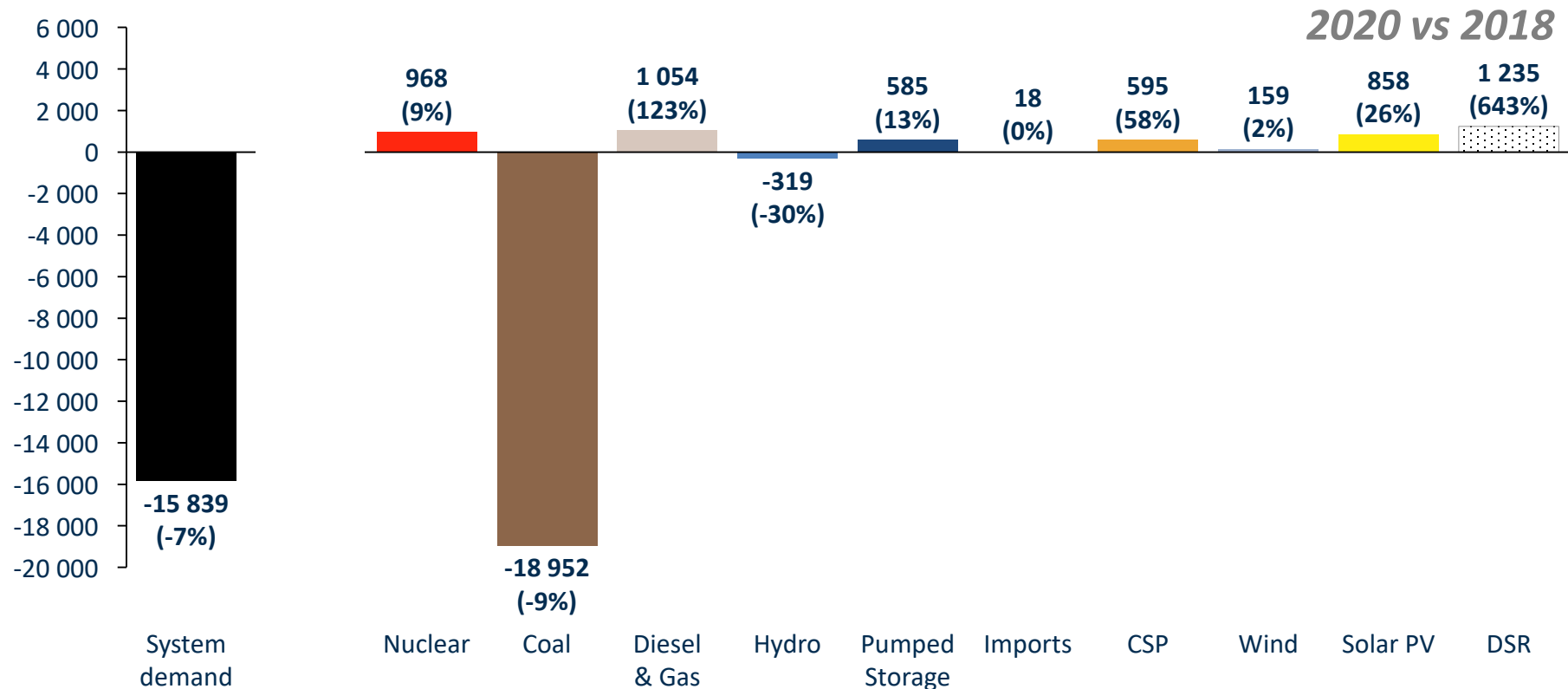


2019 vs 2018

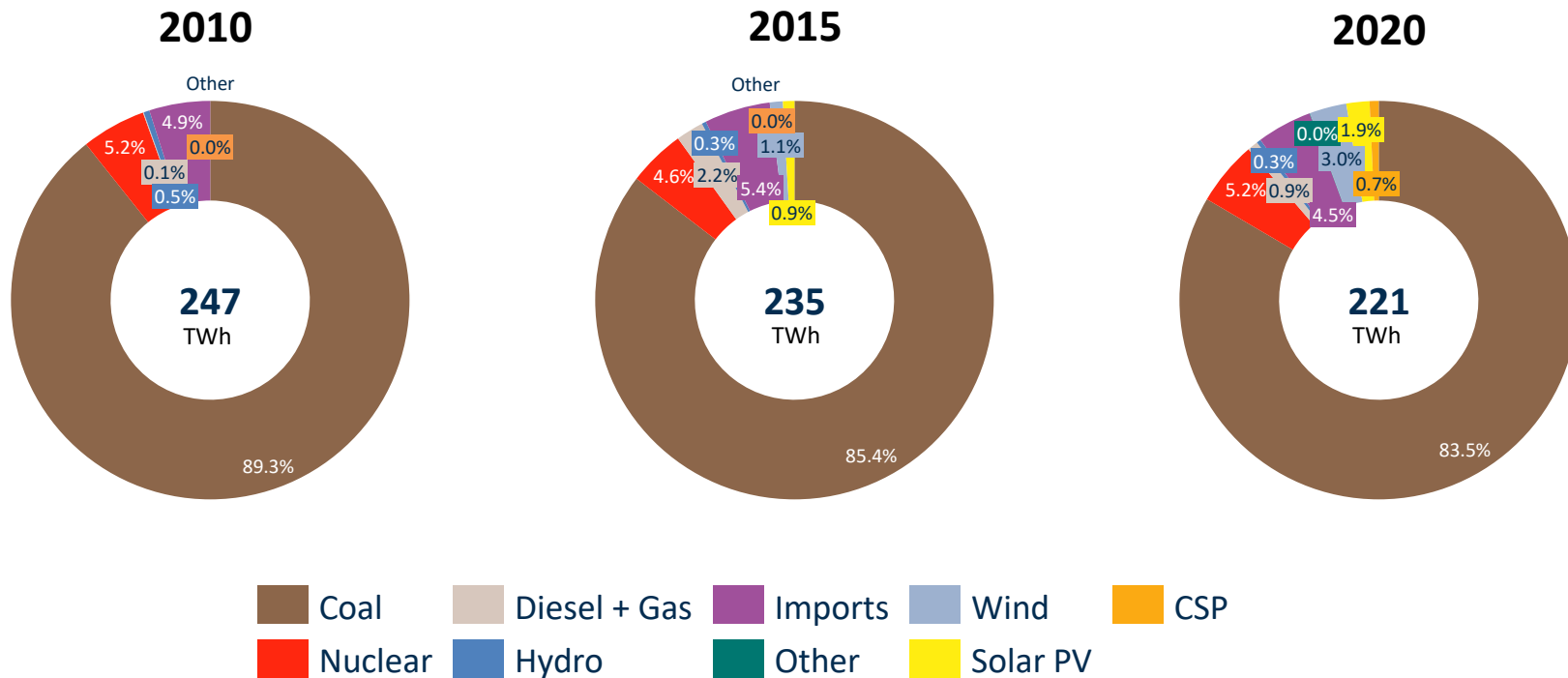
Relative to 2018, 2020 saw combined effects of dramatically lower EAF & demand, large reduction in coal (-18.9 TWh) but increase in diesel & DSR

Difference in annual electricity production 2020 vs 2018

Difference, 2020 vs 2018
in GWh



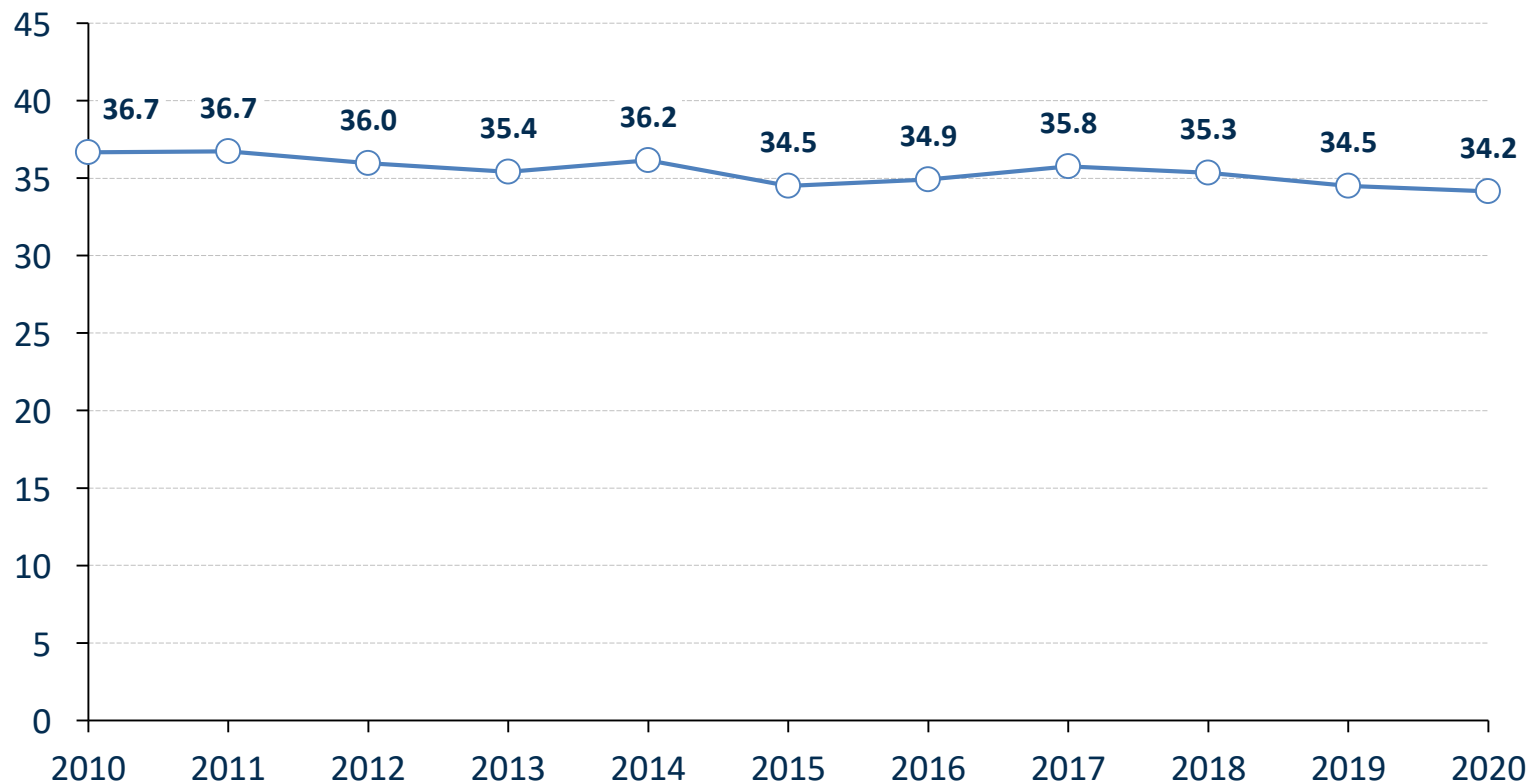
Generation share from primary supply sources in 2010, 2015 and 2020 in South Africa – marginal shifts in energy mix over past 10 years



Annual peak demand has been declining over the last 10 years

Historical annual peak demand in GW

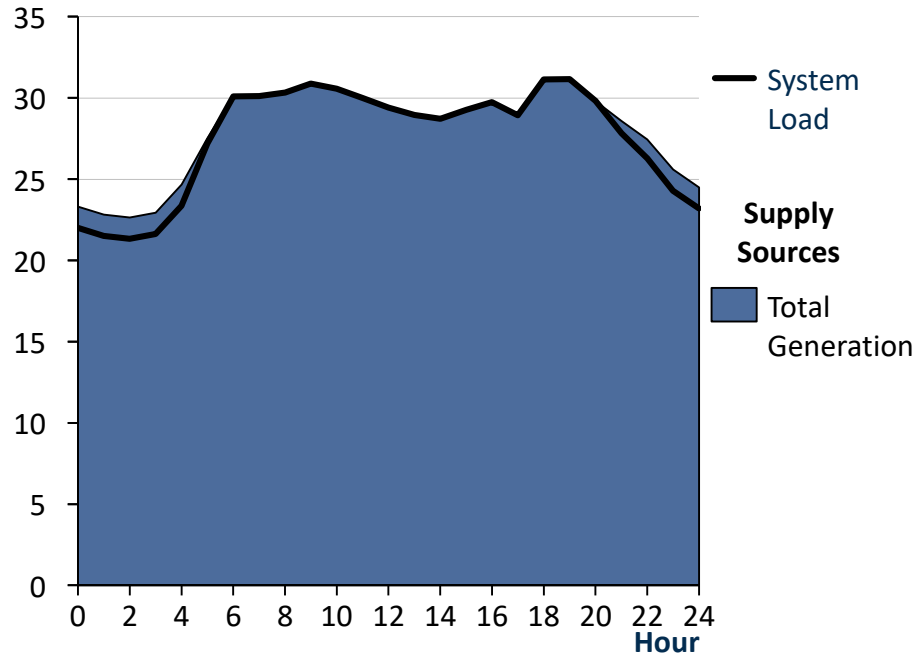
RSA Peak Demand in GW



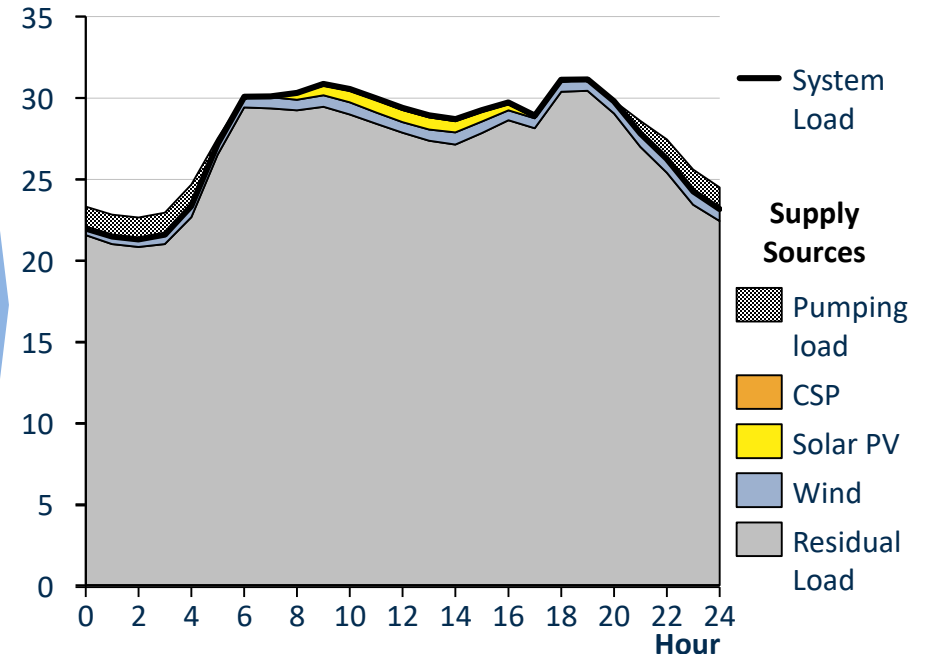
Illustrative day explaining terminologies used

Hourly South African supply structure for a random day

Power in GW



Power in GW



Total Generation

= domestic generation (Eskom + IPPs) + imported generation

System Load

= domestic generation (Eskom + IPPs) + imported generation – pumping load

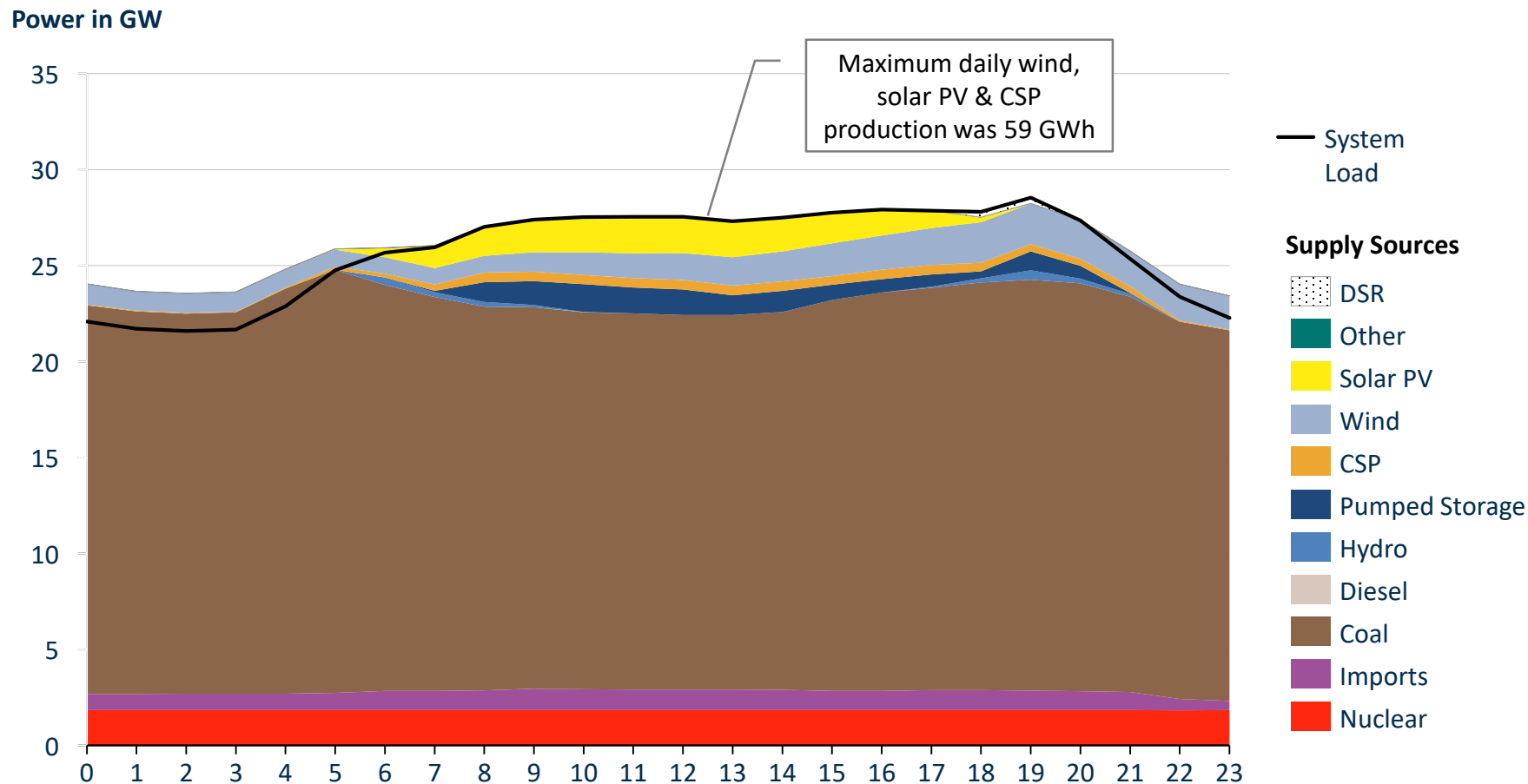
= domestic customer load without pumping load (also referred to as simply "domestic load") + export load

Residual Load

= System Load – wind – solar PV – CSP

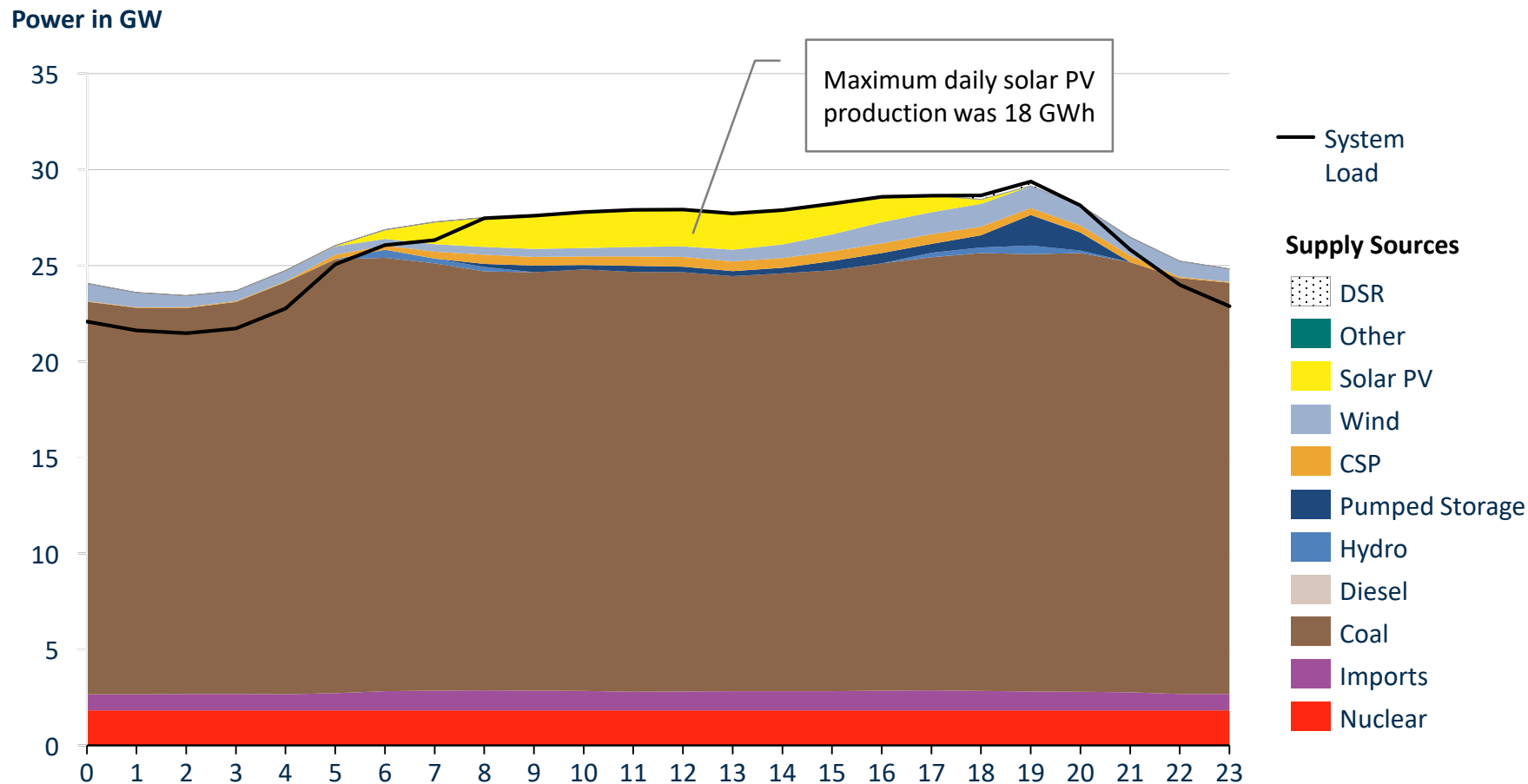
Maximum daily wind, solar PV & CSP energy of 59 GWh on 1 Dec 2020

Actual hourly energy production in South Africa on 1 December 2020 (Tuesday)



Maximum daily solar PV energy of 18 GWh achieved on 25 Nov 2020

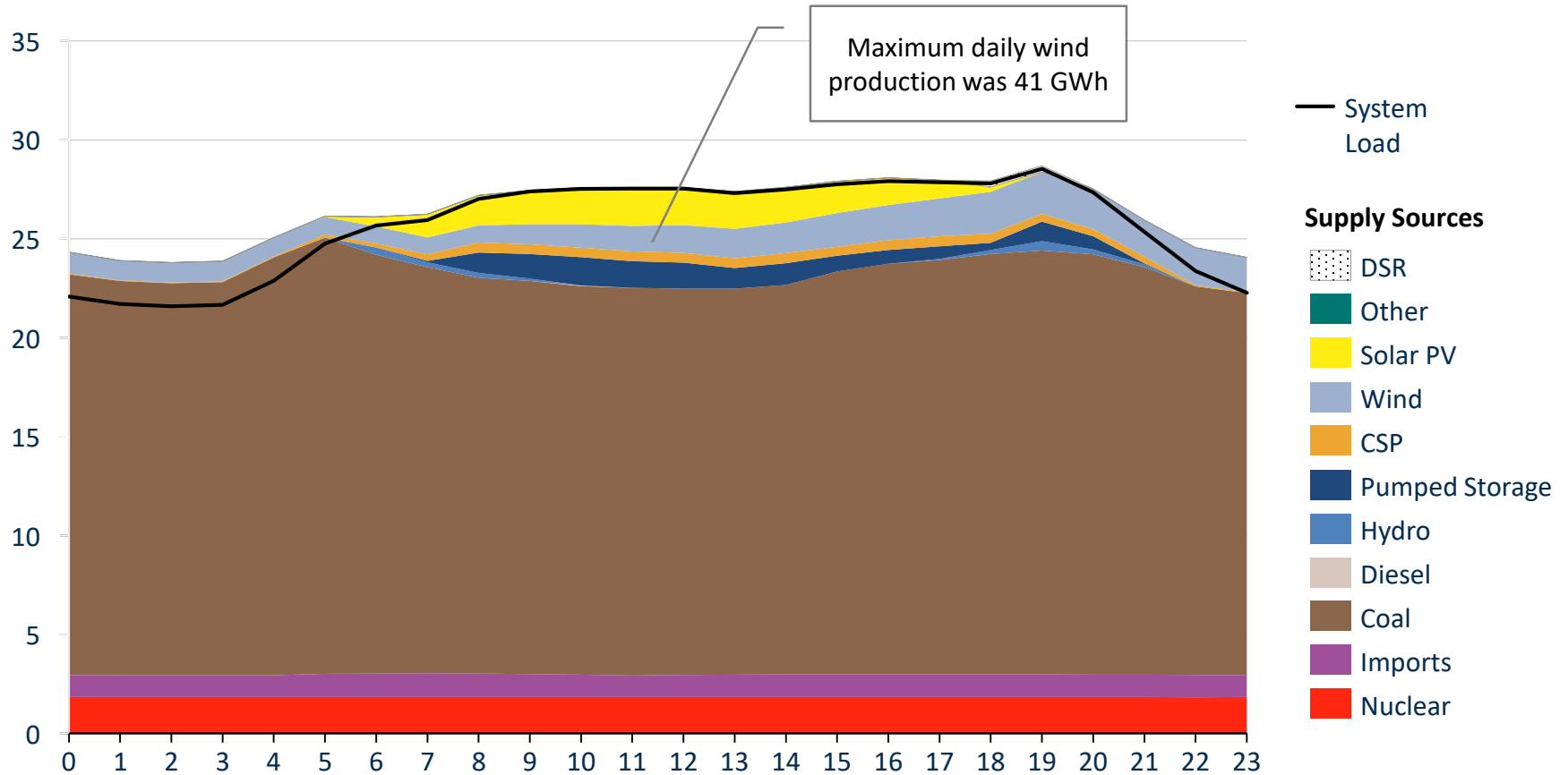
Actual hourly energy production in South Africa on 25 November 2020 (Wednesday)



Maximum daily wind energy of 41 GWh was achieved on 13 July 2020

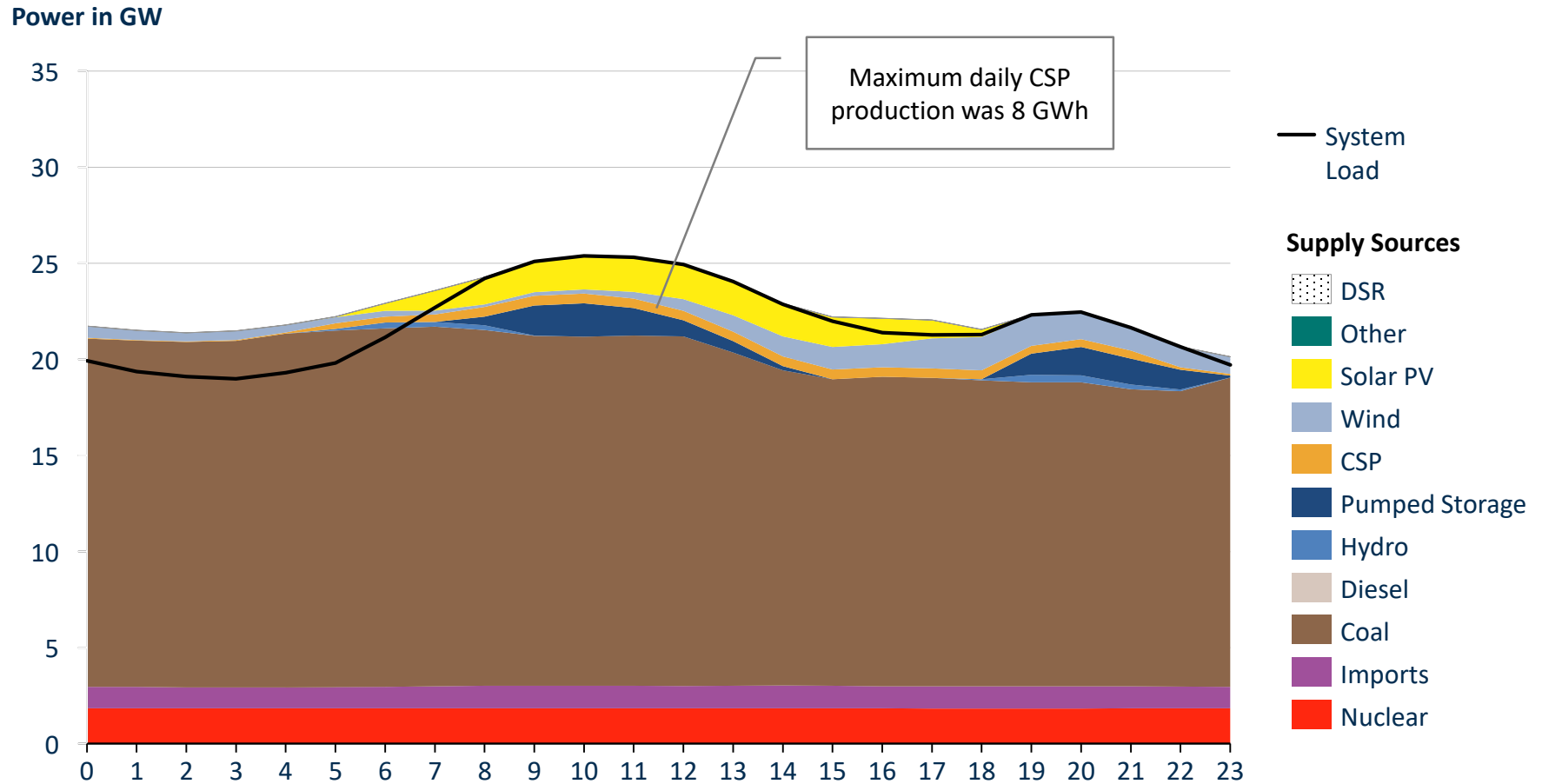
Actual hourly energy production in South Africa on 13 July 2020 (Monday)

Power in GW



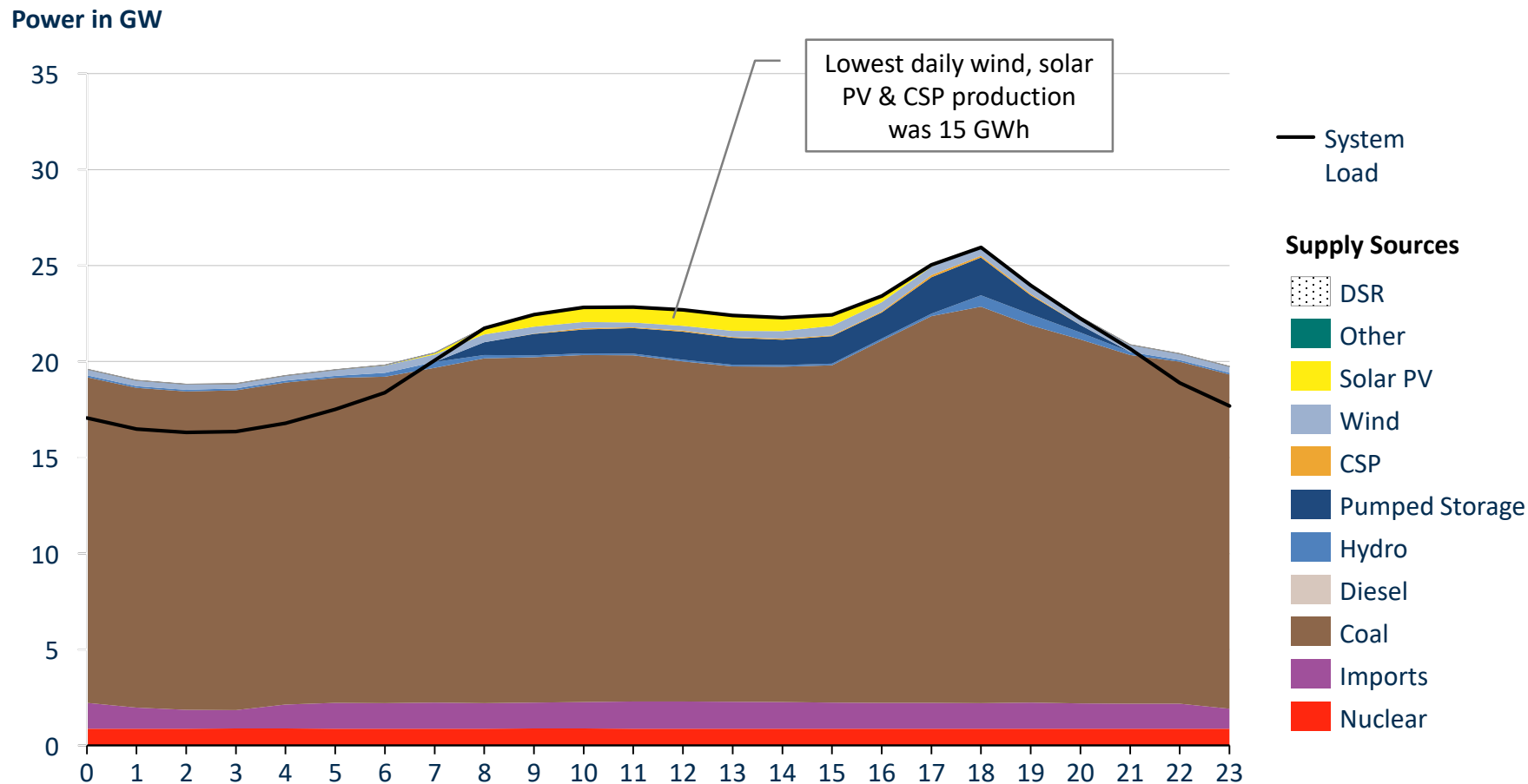
Maximum daily CSP energy of 8 GWh achieved on 25 Dec 2020

Actual hourly energy production in South Africa on 25 December 2020 (Friday)



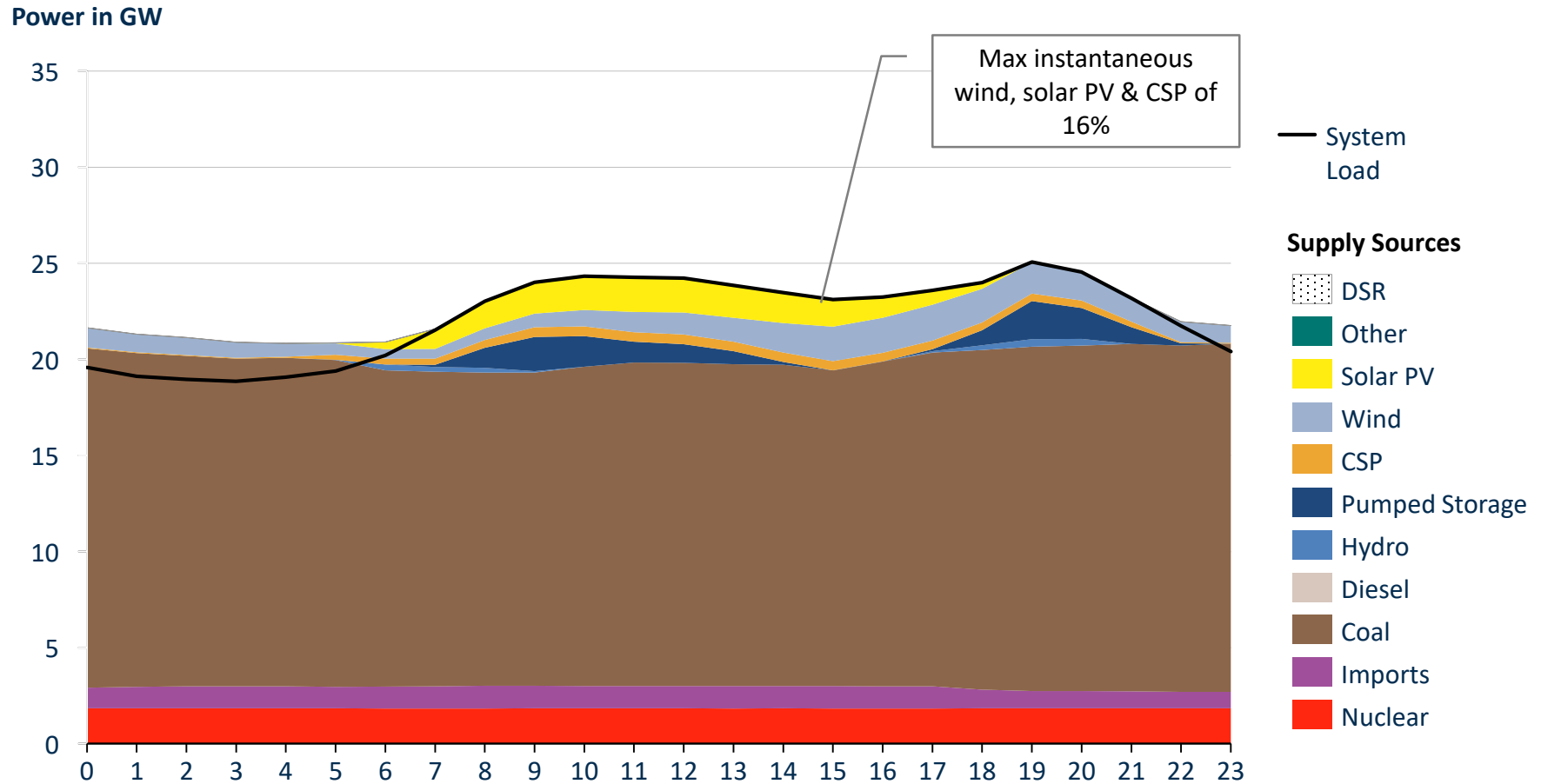
Lowest combined wind, solar PV & CSP energy of 15 GWh on 24 Apr '20

Actual hourly energy production in South Africa on 24 April 2020 (Friday)



Maximum inst. solar PV, wind & CSP power of 16% on 27 Dec 2020

Actual hourly energy production in South Africa on 27 December 2020 (Sunday)



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1 Overview actual electricity production (2020)

2 Monthly electricity production (2020)

3 Weekly electricity production (2020)

4 Daily electricity production (2020)

5 Hourly electricity production (2020)

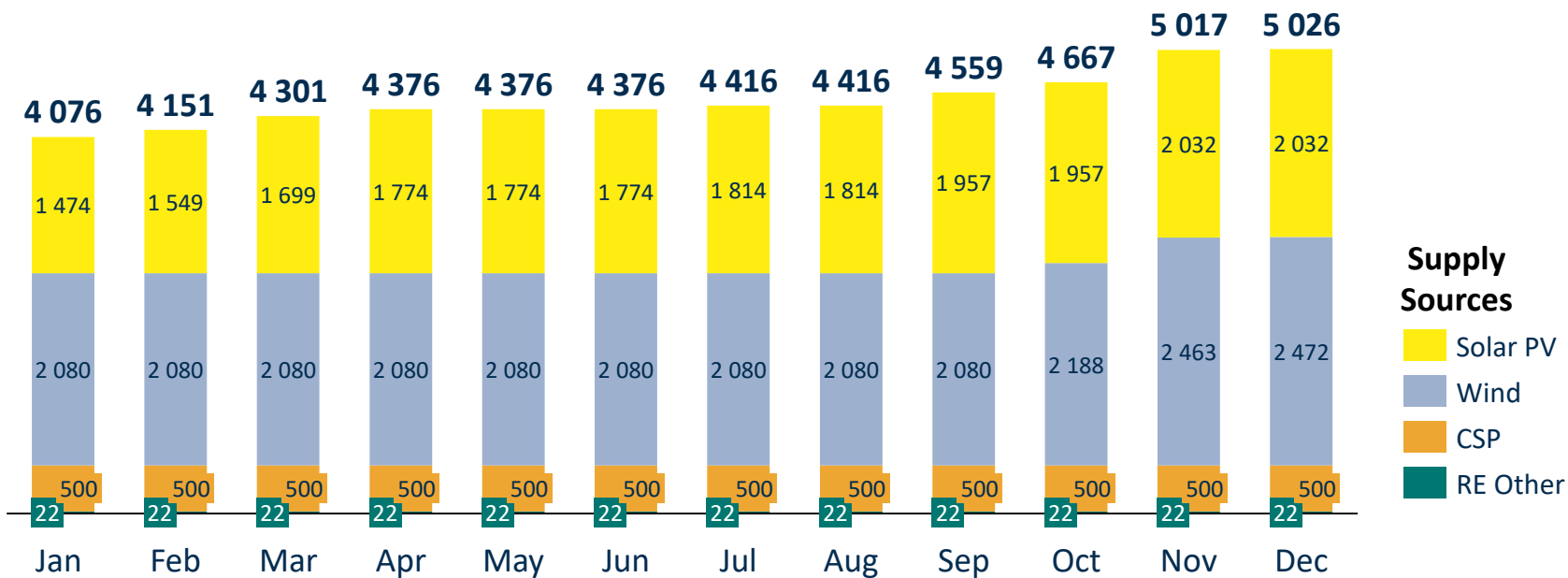
6 Actual load shedding in 2020

7 Other power system statistics

In 2020: 415 MW of wind & 558 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 2020

Capacity operational
in 2020 [MW]
(end of month)

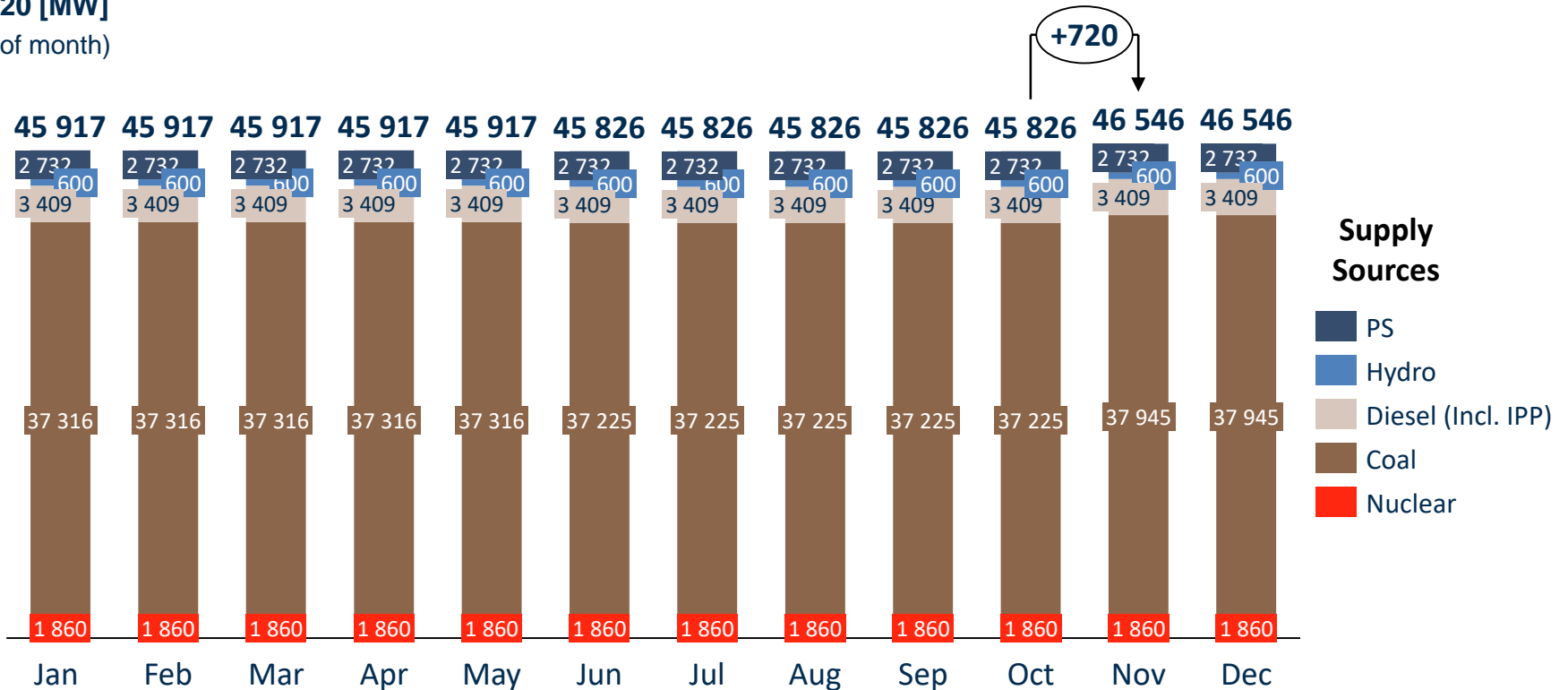


Notes: Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants commissioned. Wind includes Sere wind farm (100 MW). RE = renewable energy
Sources: Eskom

In 2020: 720 MW of coal (Kusile) was added to the grid over and above the additional RE capacity

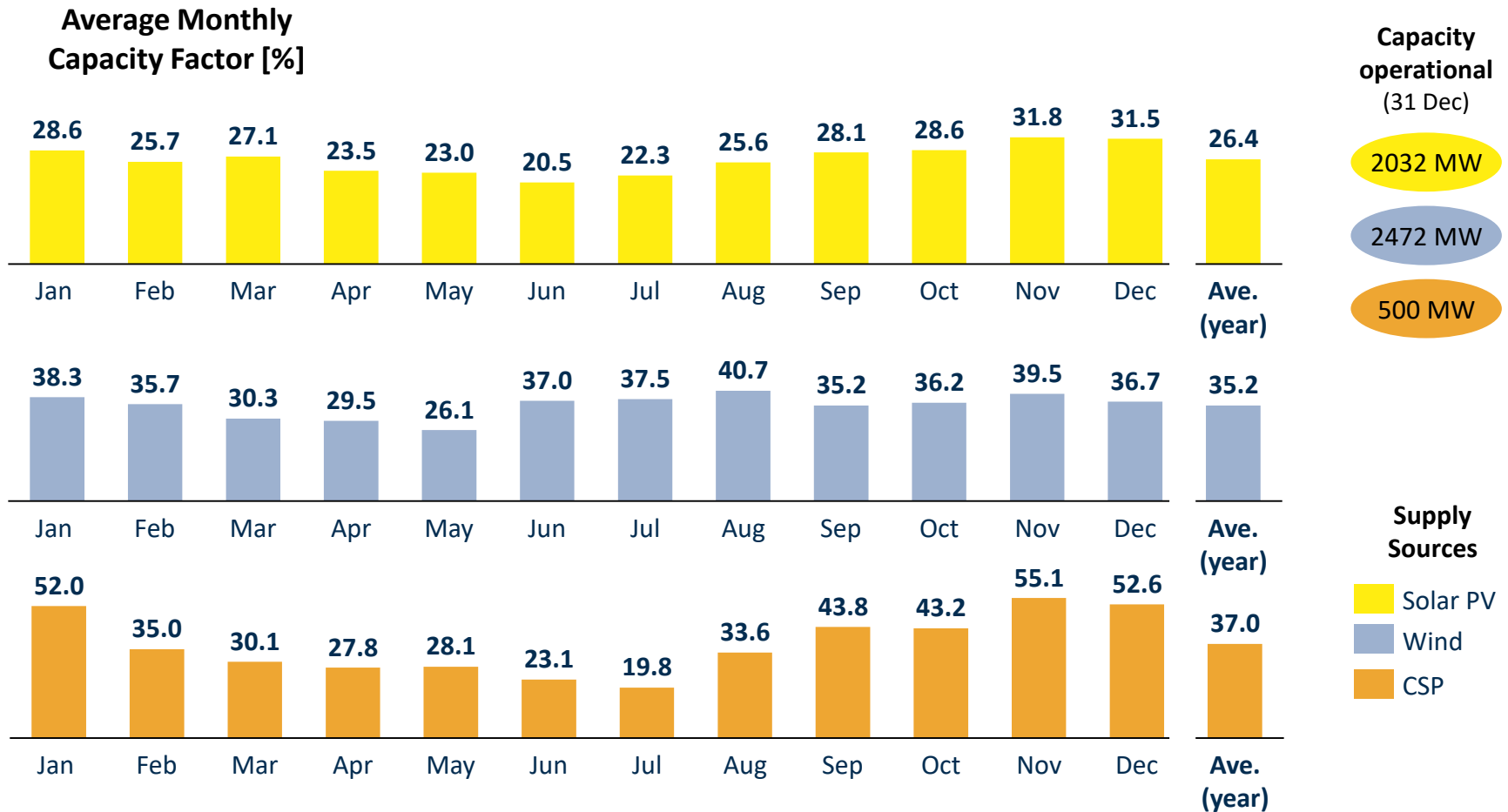
Total monthly installed capacity of utility-scale generation capacity in RSA from Jan-Dec 2020

Capacity operational
in 2020 [MW]
(end of month)



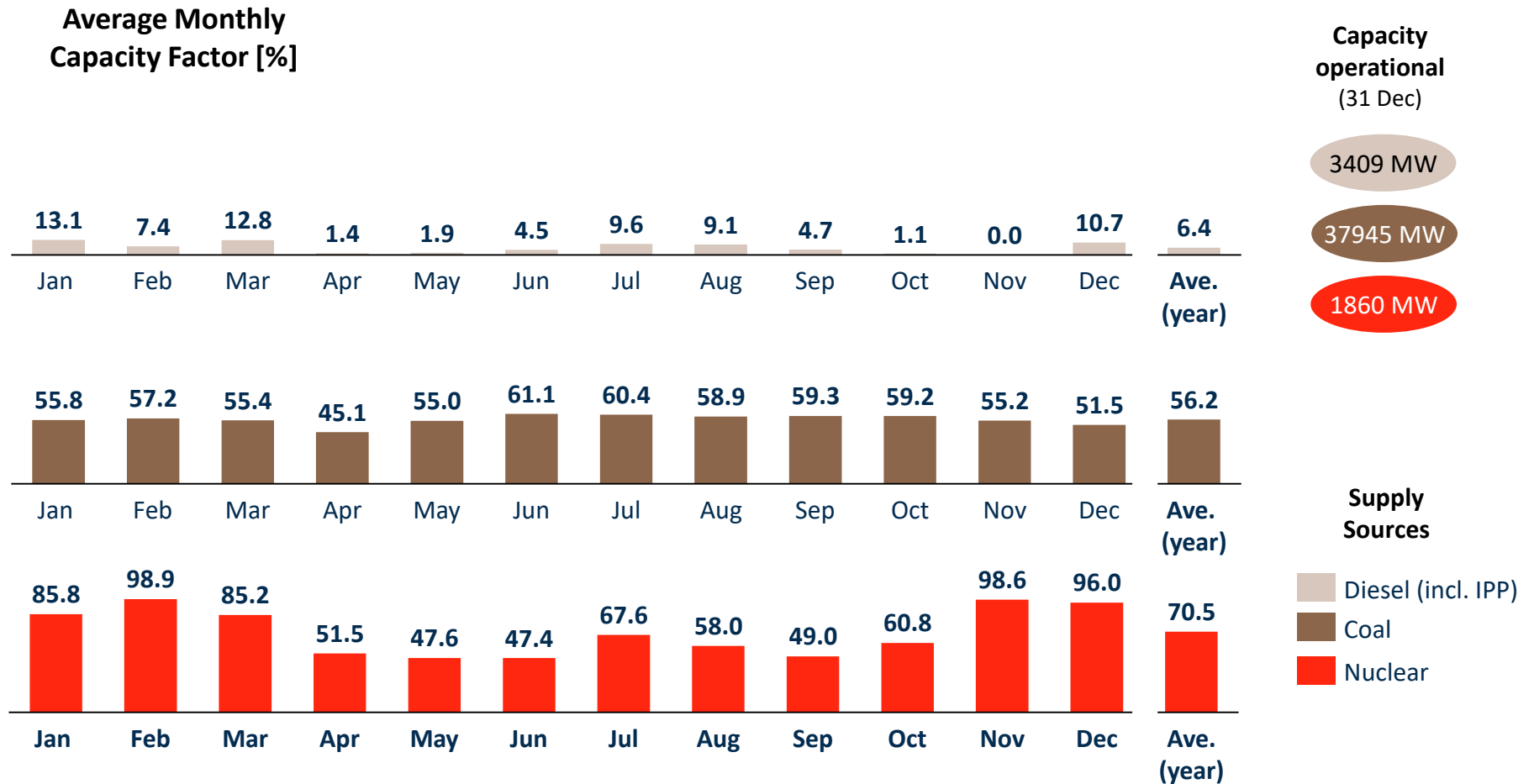
Average monthly capacity factors for solar PV, wind and CSP

Average monthly capacity factors of solar PV, wind and CSP in RSA from Jan-Dec 2020



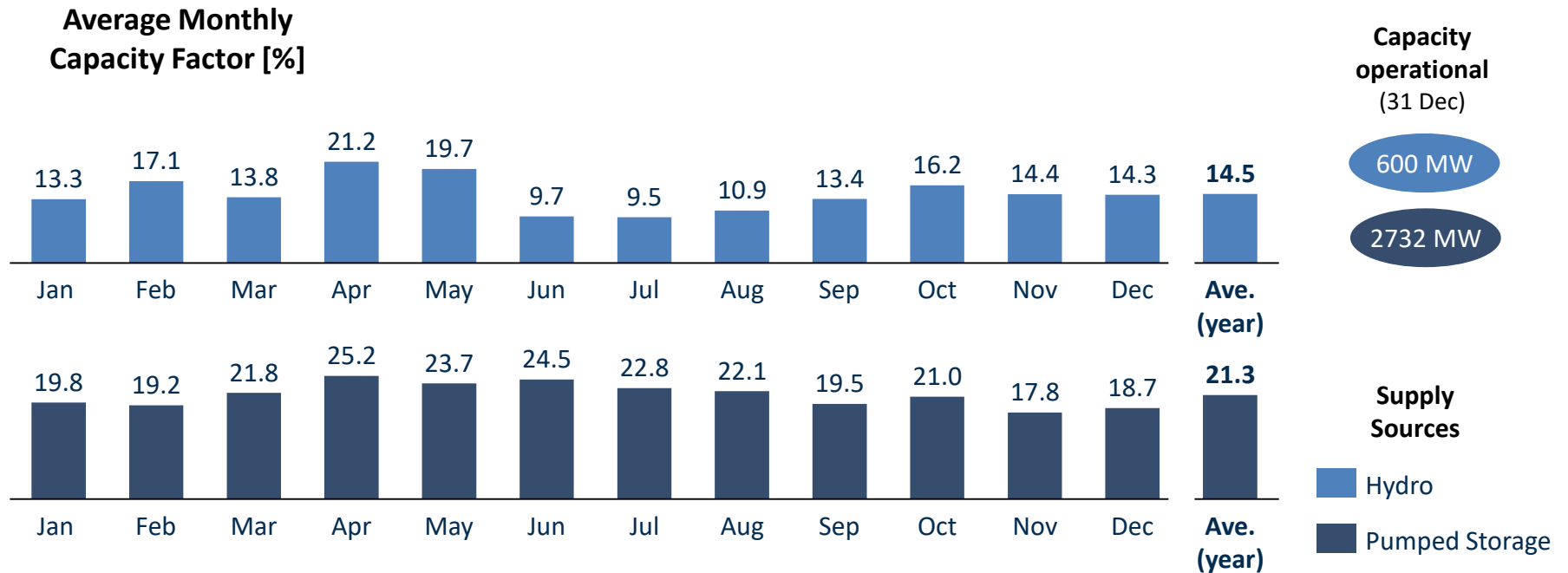
Average monthly capacity factors for thermal plants

Average monthly capacity factors of thermal capacity in RSA from Jan-Dec 2020



Average monthly capacity factors for hydro and pumped storage plants

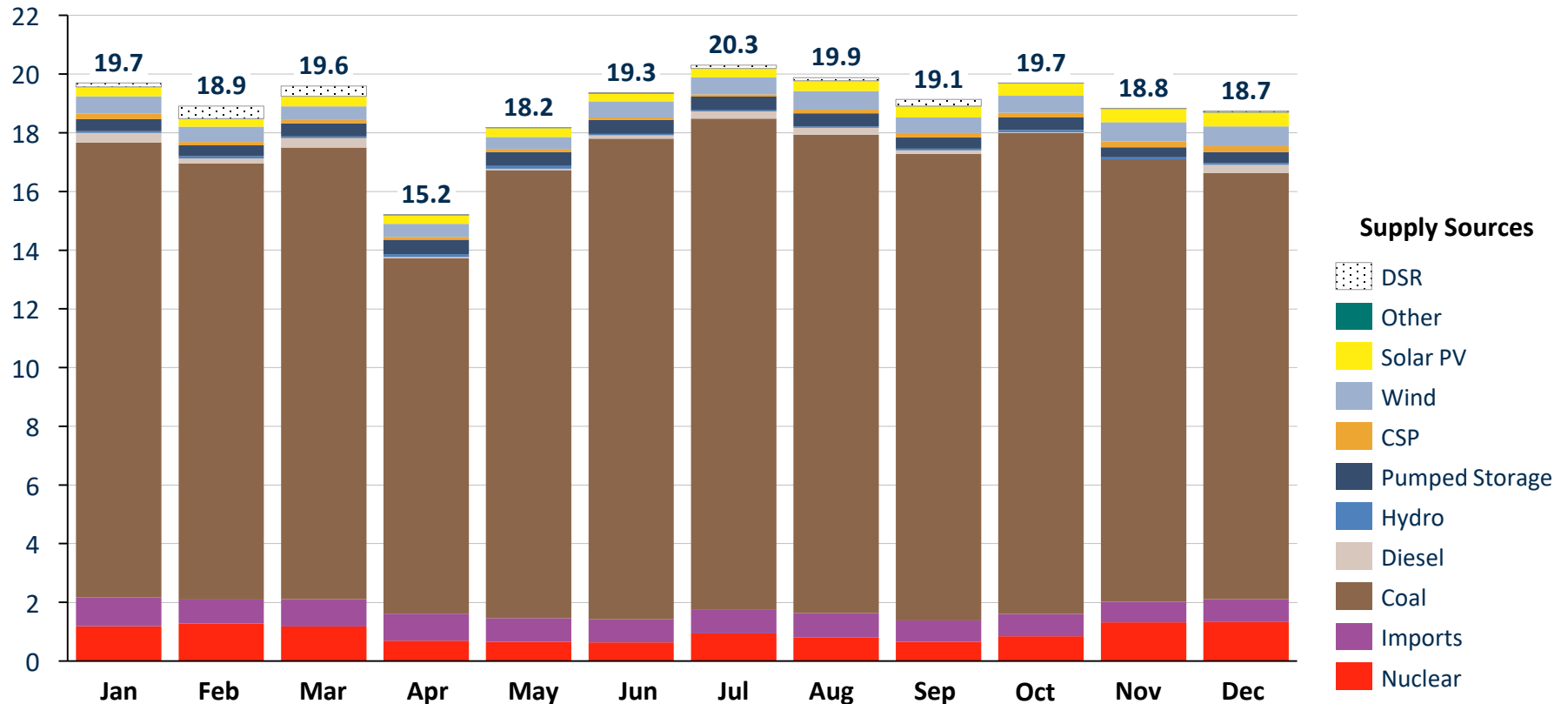
Average monthly capacity factors of hydro & pumped storage in RSA from Jan-Dec 2020



Monthly electricity production from all power supply sources (absolute)

Actual monthly electricity production for Jan-Dec 2020 from the different supply sources in RSA

Monthly electricity production in TWh

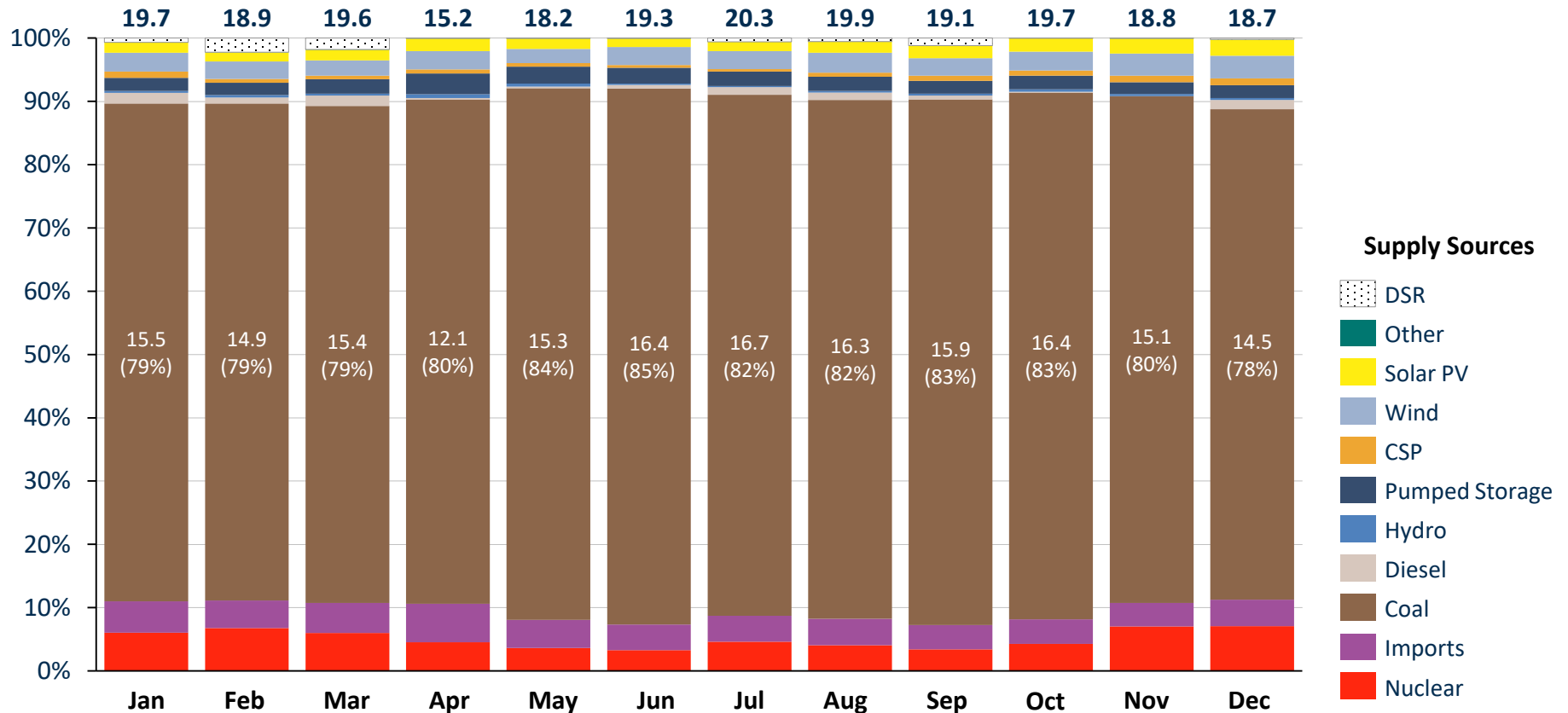


Notes: Pumping load excluded. Wind generation includes Eskom's 100 MW Sere wind farm.
 Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
 Sources: Eskom; CSIR Energy Centre analysis

Monthly electricity production from all power supply sources (share)

Actual monthly electricity production for Jan-Dec 2020 from the different supply sources in RSA

Monthly electricity production in TWh

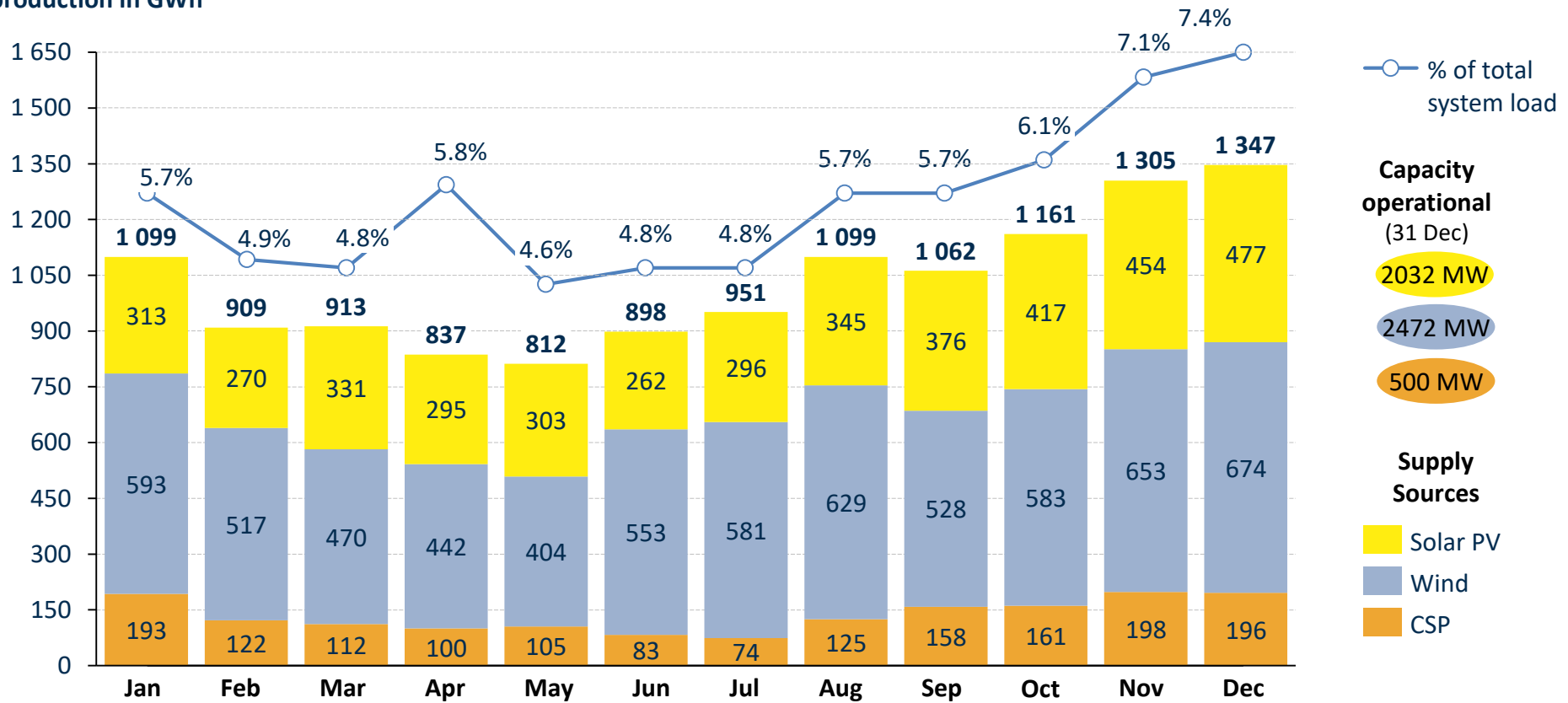


Notes: Pumping load excluded. Wind generation includes Eskom's 100 MW Sere wind farm.
 Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
 Sources: Eskom; CSIR Energy Centre analysis

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 2020

Monthly electricity production in GWh



Capacity operational (31 Dec)

- 2032 MW
- 2472 MW
- 500 MW

Supply Sources

- Solar PV
- Wind
- CSP

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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- 2 Monthly electricity production (2020)

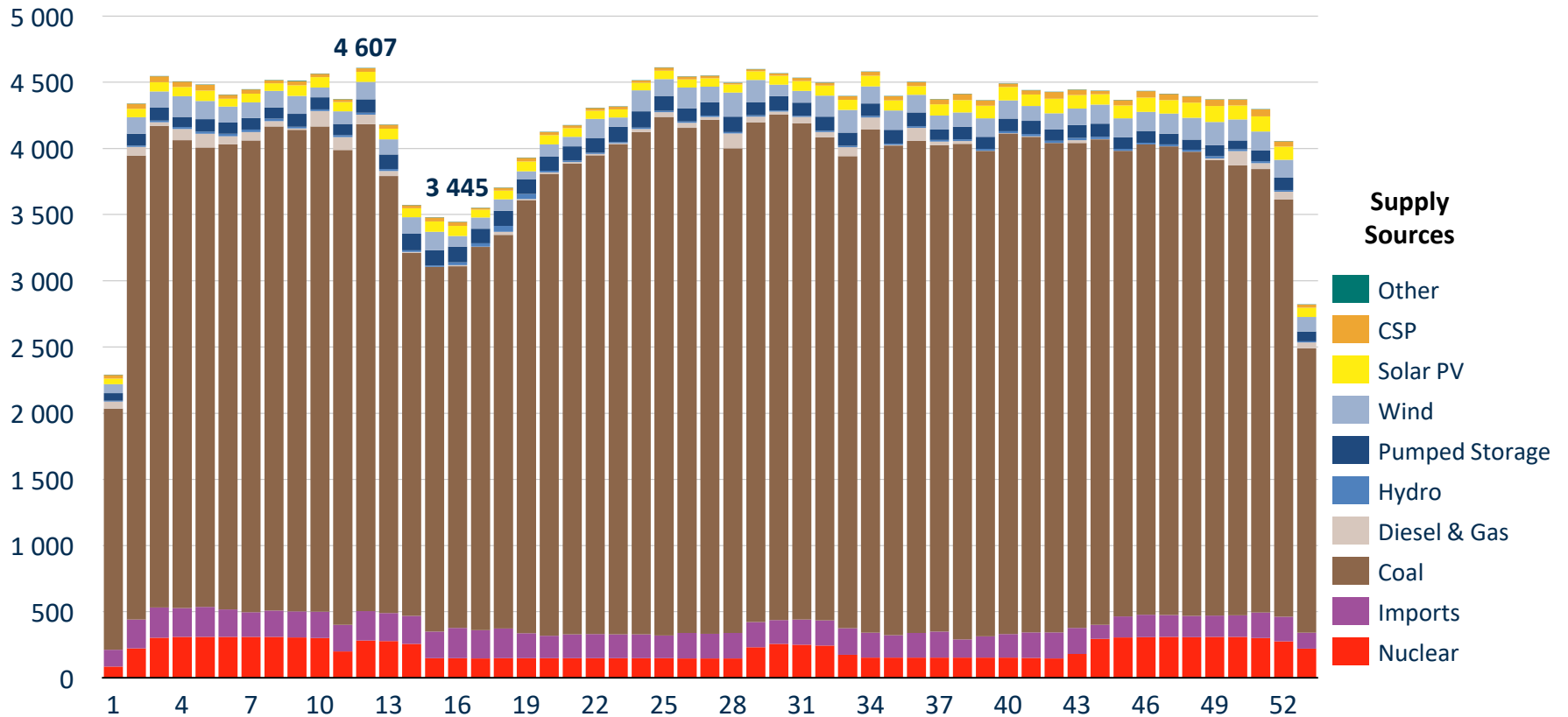
- 3 Weekly electricity production (2020)

- 4 Daily electricity production (2020)
- 5 Hourly electricity production (2020)
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Weekly electricity production for all power supply sources

Actual weekly production: conventional fleet, wind, solar PV & CSP (Jan-Dec 2020)

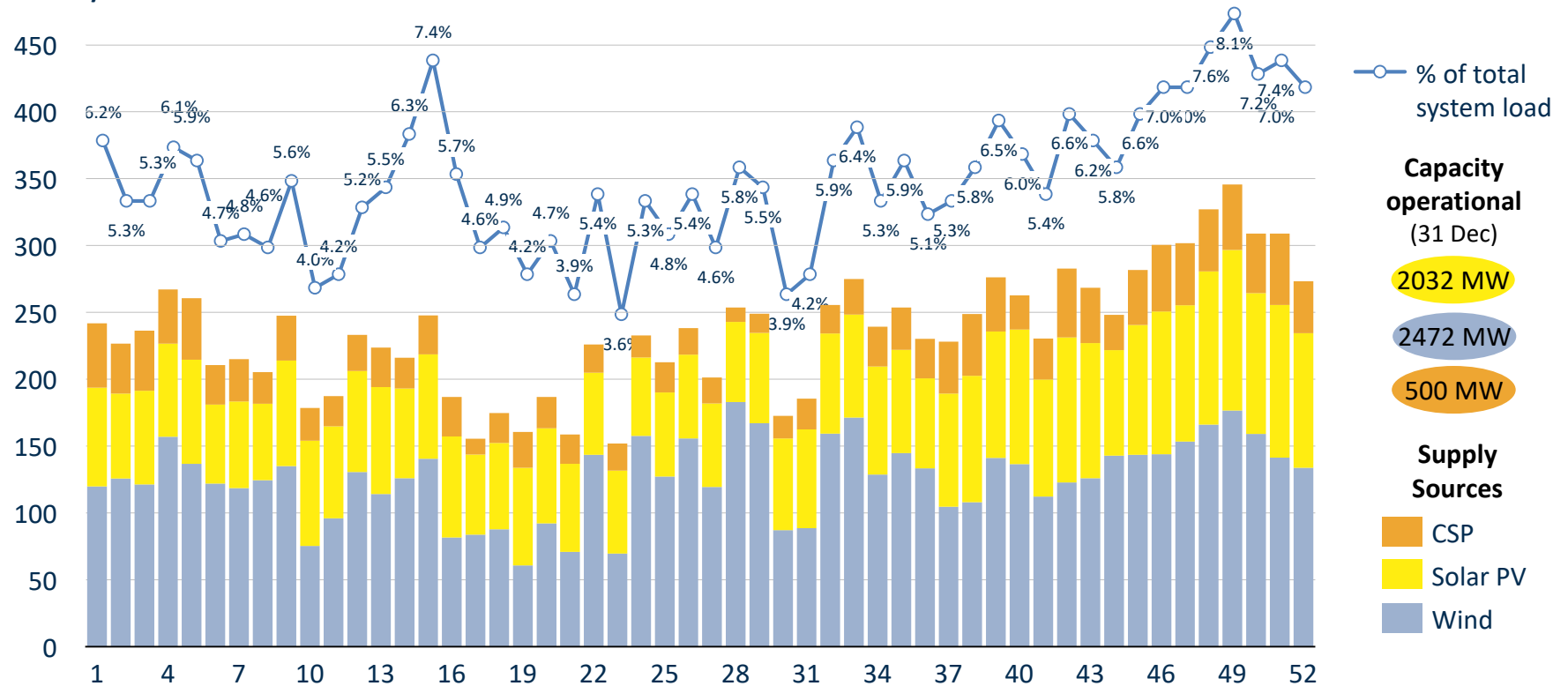
Electricity production
in GWh/week



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 2020

Electricity production in GWh/week



- Maximum wind + solar PV + CSP weekly production of 346 GWh in week 49 (29 Nov – 6 Dec)
- Minimum wind + solar PV + CSP weekly production of 152 GWh in week 23 (31 May – 6 Jun)



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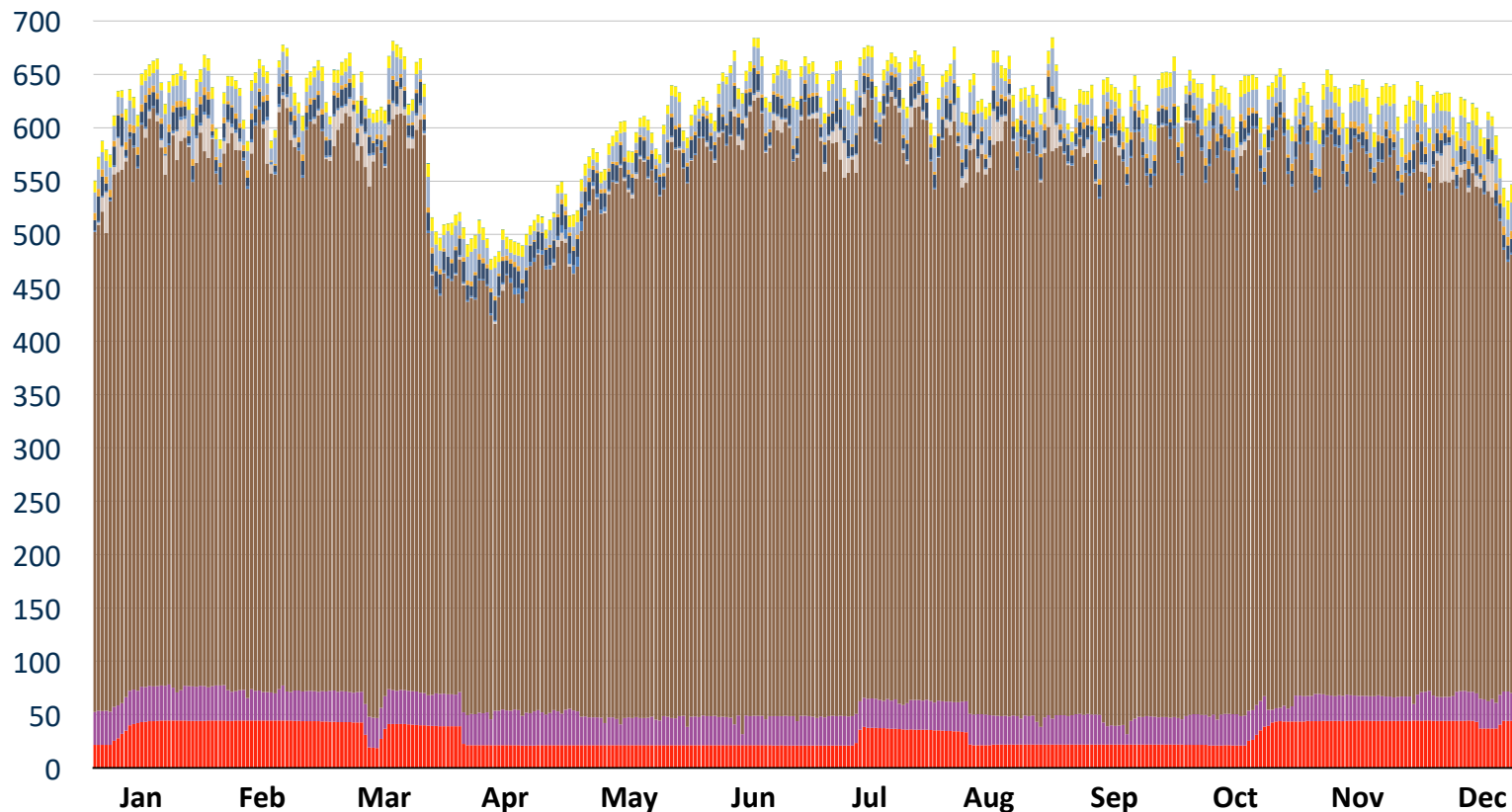
- 4 Daily electricity production (2020)

- 5 Hourly electricity production (2020)
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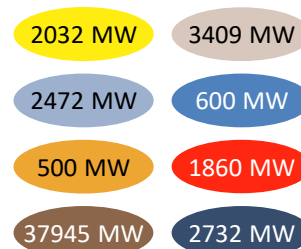
Daily electricity production wind, solar PV & CSP fleet Jan to Dec 2020

Actual daily production from large-scale solar PV, wind and CSP plants under the REIPPPP from Jan-Dec 2020

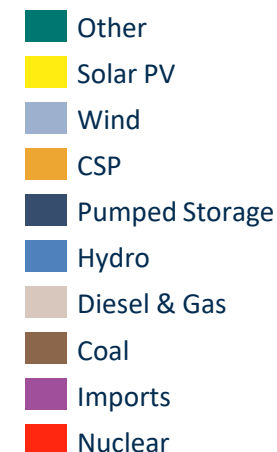
Electricity production
in GWh/day



Capacity
operational
(31 Dec)



Supply Sources

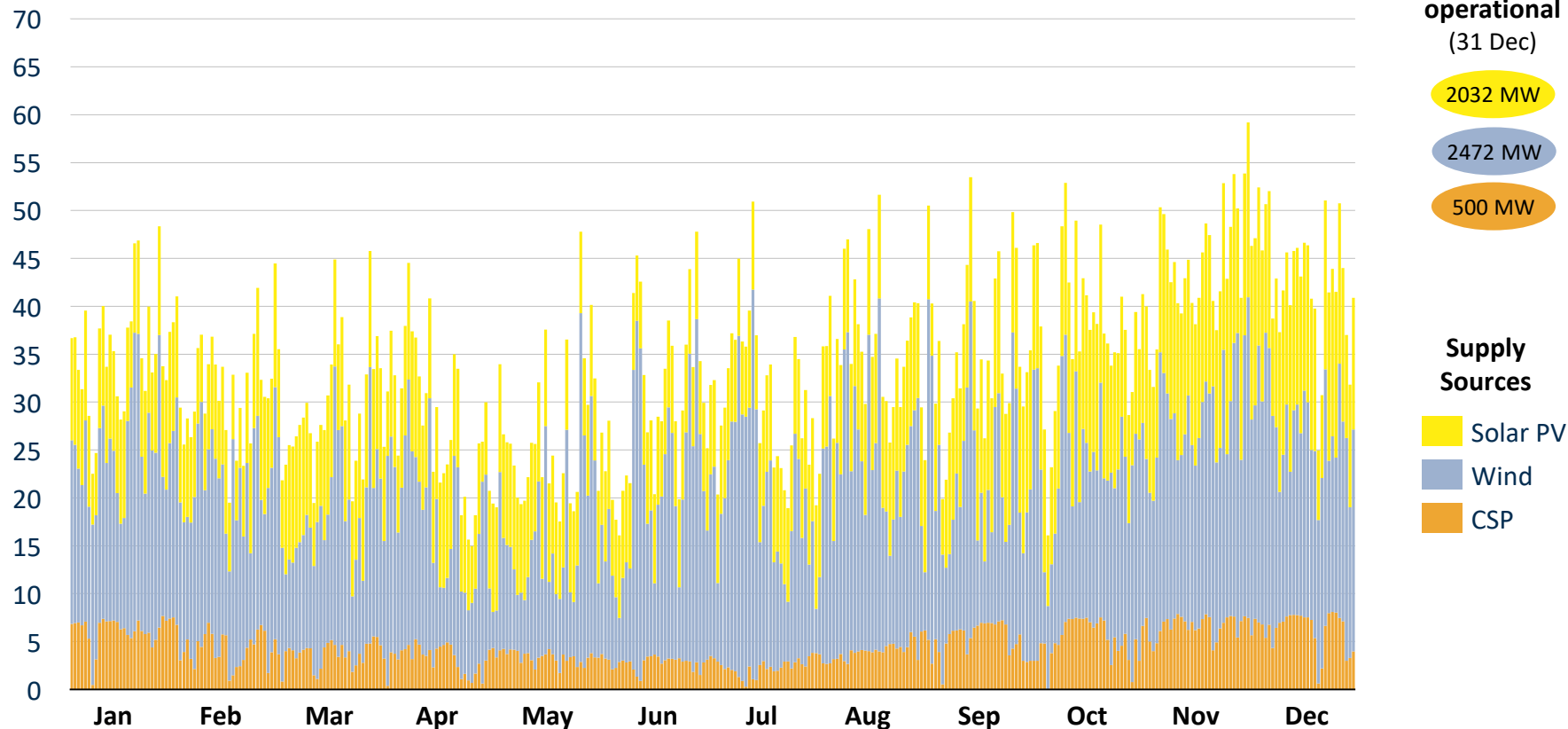


- Maximum daily production of 59 GWh on 2 Dec 2020 (Wednesday)
- Minimum daily production of 15 GWh on 25 Apr 2020 (Saturday)

Daily electricity production wind, solar PV & CSP fleet Jan to Dec 2020

Actual daily production from large-scale solar PV, wind and CSP plants under the REIPPPP from Jan-Dec 2020

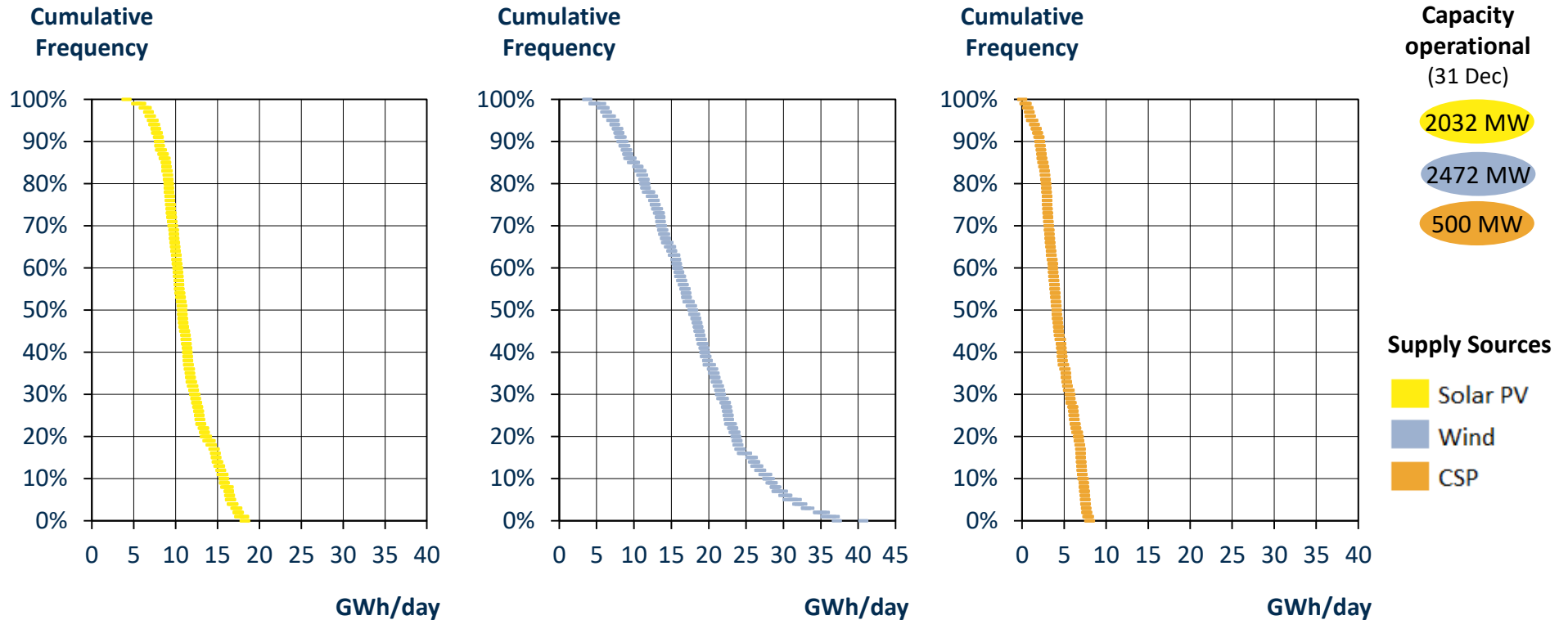
Electricity production
in GWh/day



- Maximum daily production of 59 GWh on 2 Dec 2020 (Wednesday)
- Minimum daily production of 15 GWh on 25 Apr 2020 (Saturday)

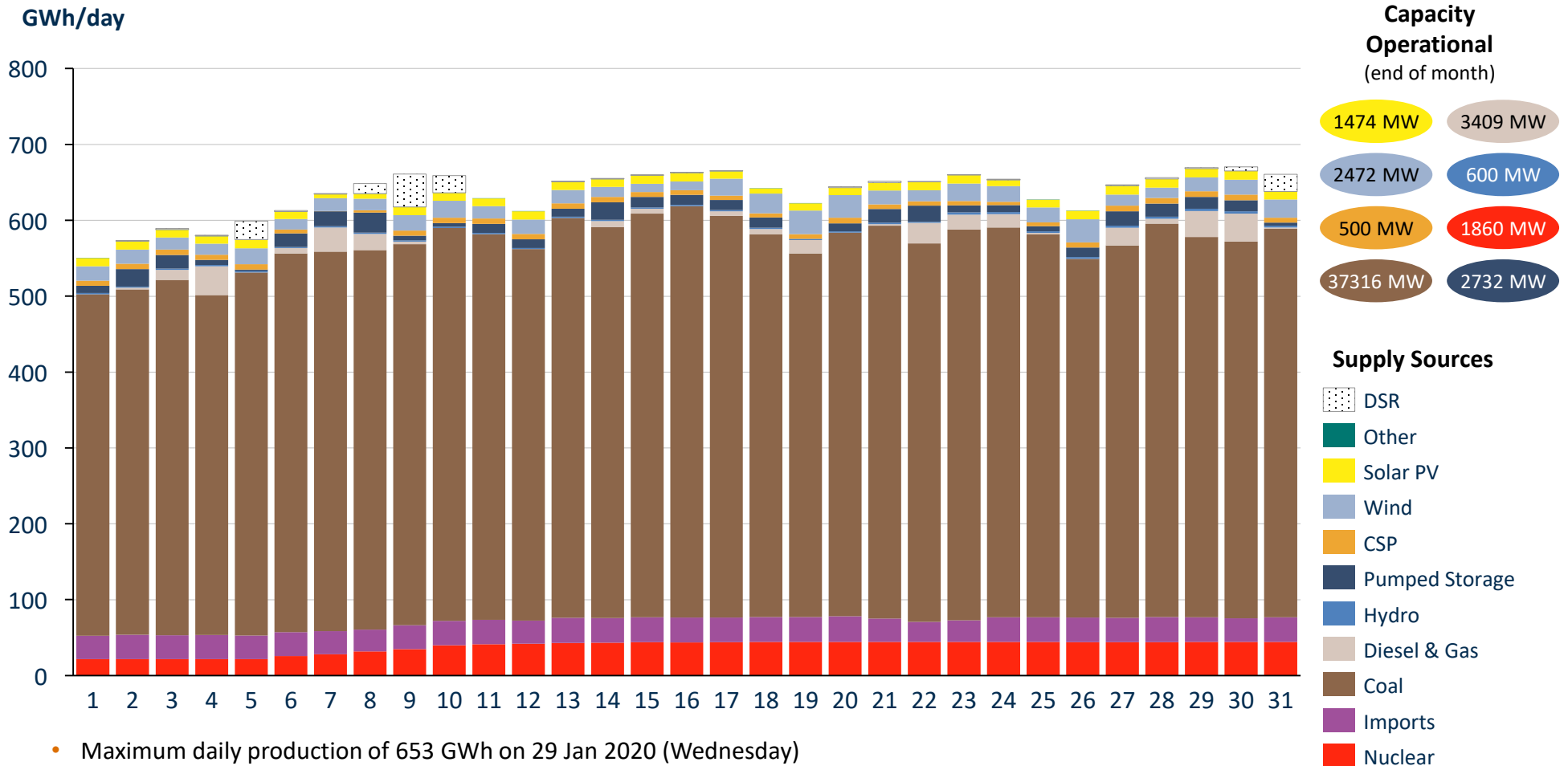
On 90% of the days from Jan - Dec 2020, solar PV and wind had a daily energy production of 8 GWh or more

Frequency distribution of daily solar PV, wind and CSP electricity production for January - December 2020



Daily electricity production of between 530-653 GWh in Jan 2020

Actual daily production from all power supply sources in South Africa for January 2020

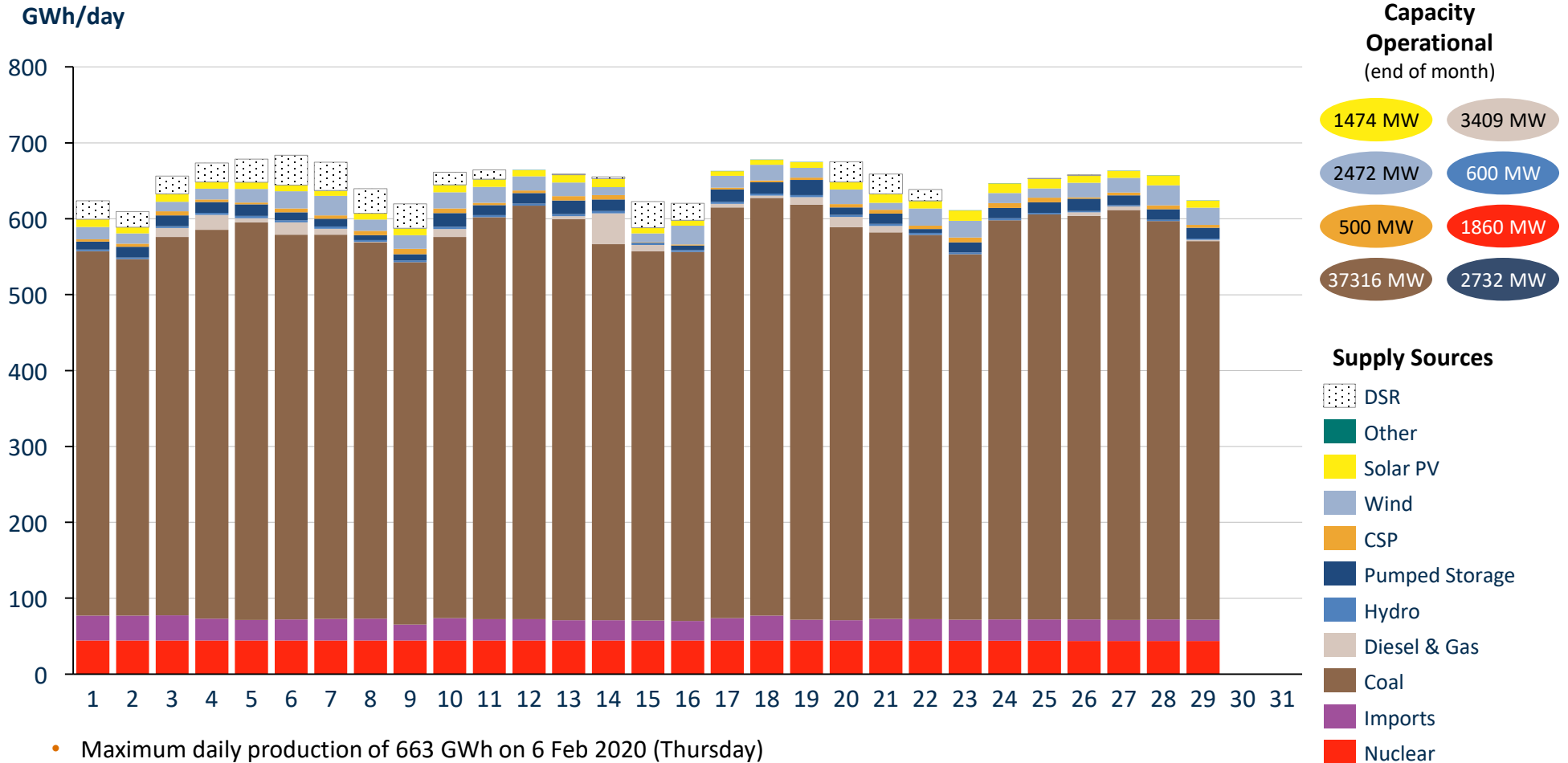


- Maximum daily production of 653 GWh on 29 Jan 2020 (Wednesday)
- Minimum daily production of 530 GWh on 1 Jan 2020 (Wednesday - National Holiday)

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

Daily electricity production of between 594-663 GWh in Feb 2020

Actual daily production from all power supply sources in South Africa for February 2020



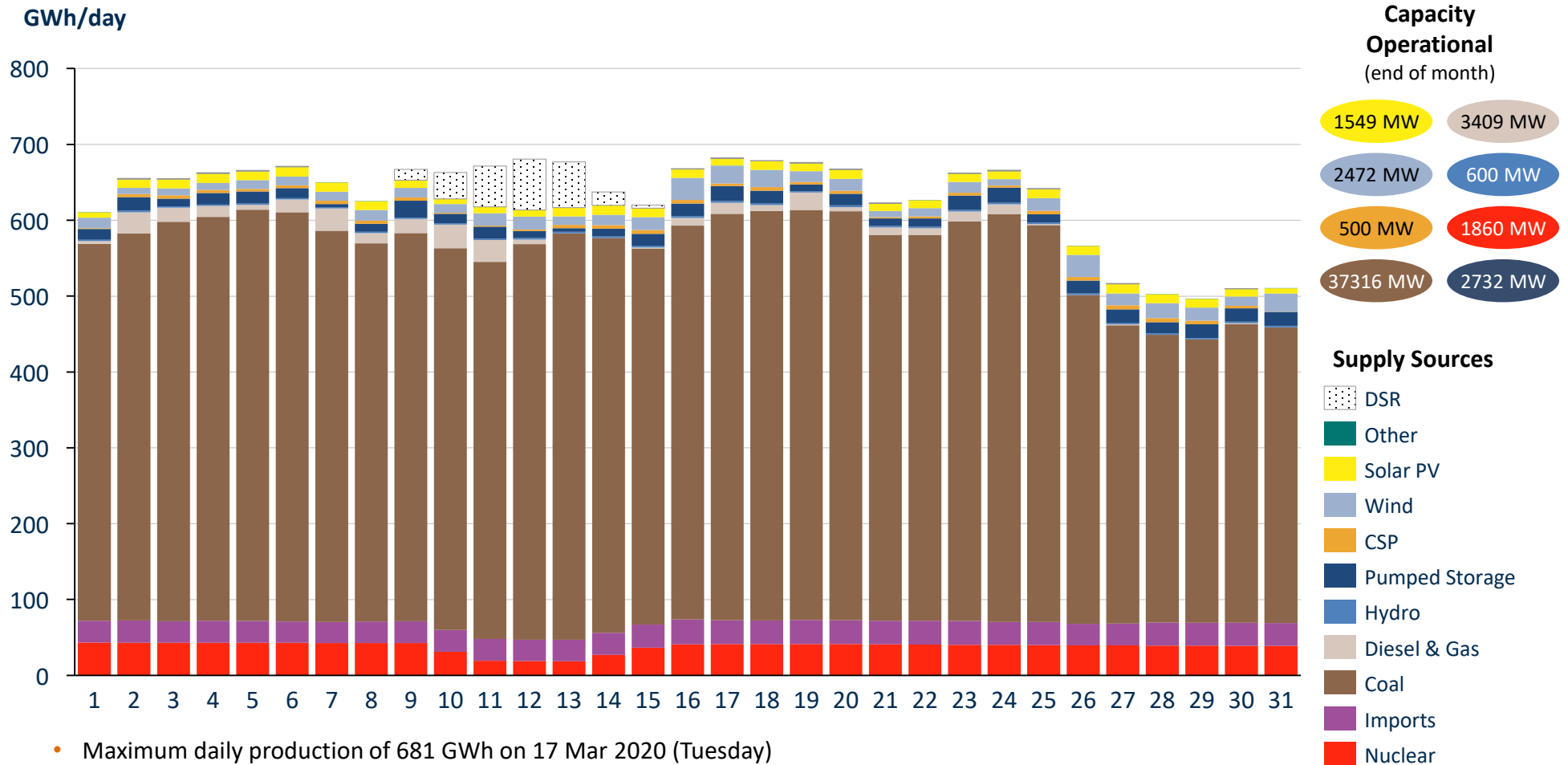
- Maximum daily production of 663 GWh on 6 Feb 2020 (Thursday)
- Minimum daily production of 594 GWh on 16 Feb 2020 (Sunday)

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



Daily electricity production of between 472-681 GWh in Mar 2020

Actual daily production from all power supply sources in South Africa for March 2020

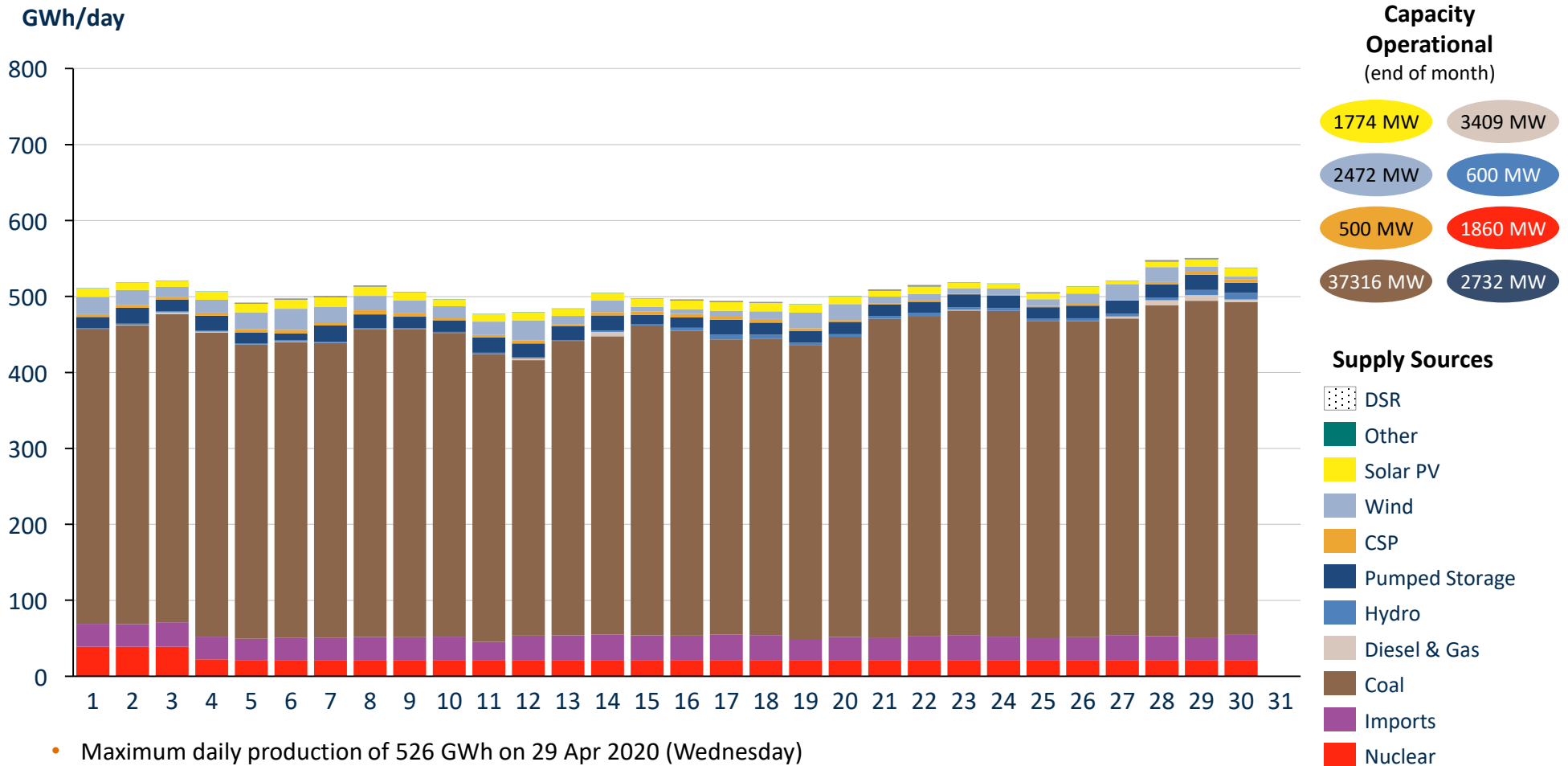


- Maximum daily production of 681 GWh on 17 Mar 2020 (Tuesday)
- Minimum daily production of 472 GWh on 29 Mar 2020 (Sunday)

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

Daily electricity production of between 457-526 GWh in Apr 2020

Actual daily production from all power supply sources in South Africa for April 2020



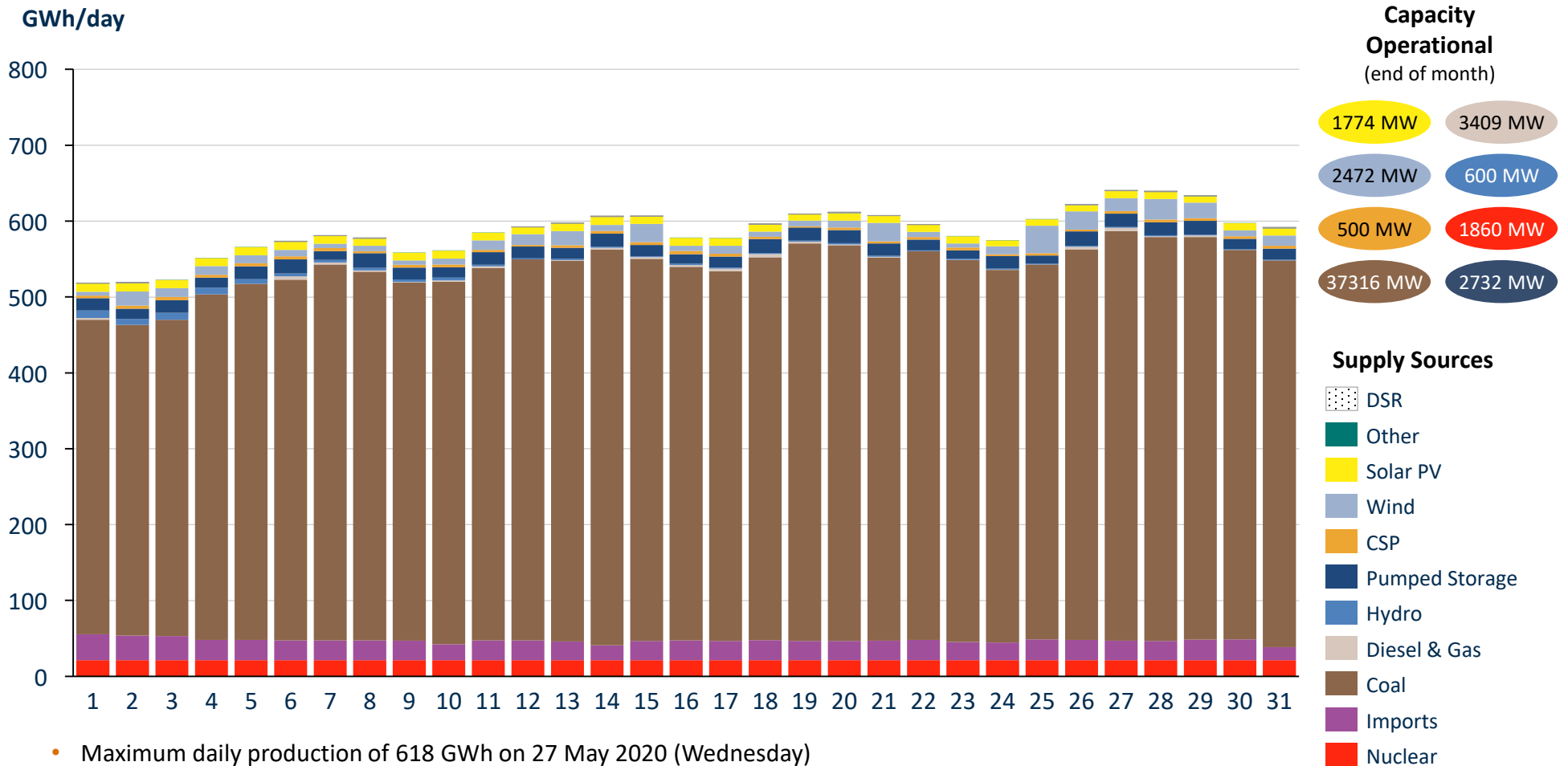
- Maximum daily production of 526 GWh on 29 Apr 2020 (Wednesday)
- Minimum daily production of 457 GWh on 11 Apr 2020 (Saturday)

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



Daily electricity production of between 497-618 GWh in May 2020

Actual daily production from all power supply sources in South Africa for May 2020



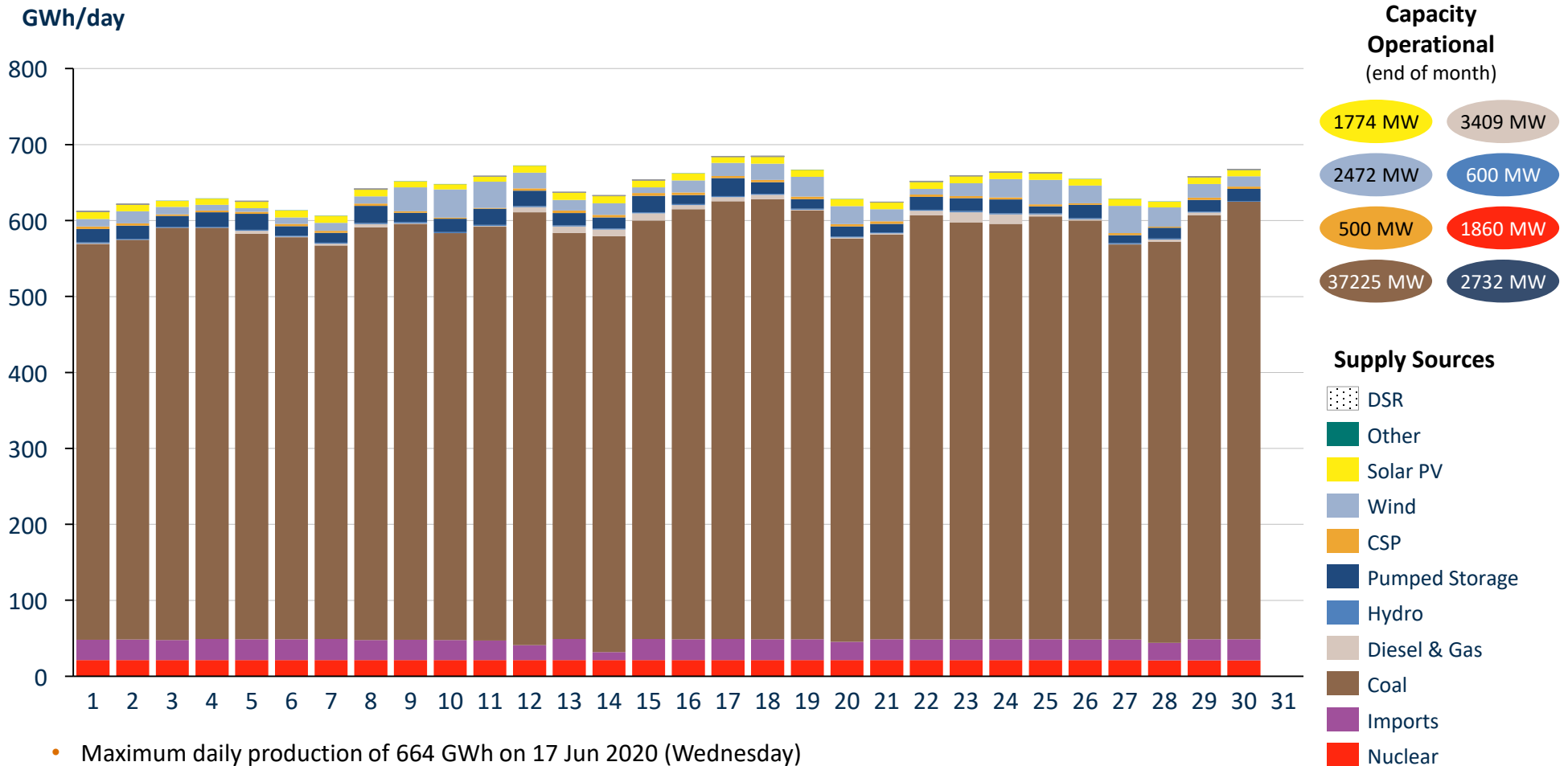
- Maximum daily production of 618 GWh on 27 May 2020 (Wednesday)
- Minimum daily production of 497 GWh on 2 May 2020 (Saturday)

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



Daily electricity production of between 583-664 GWh in Jun 2020

Actual daily production from all power supply sources in South Africa for June 2020

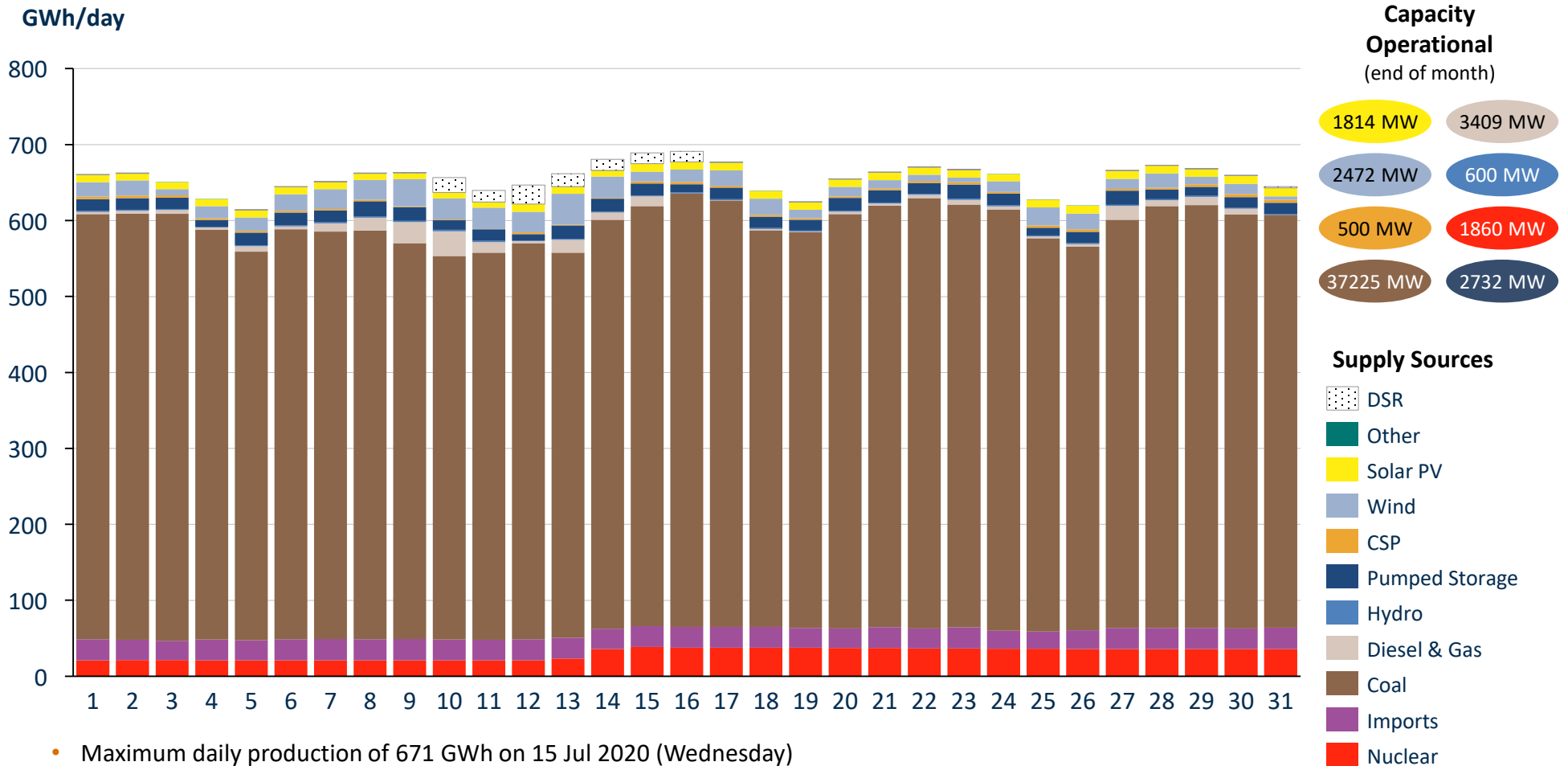


- Maximum daily production of 664 GWh on 17 Jun 2020 (Wednesday)
- Minimum daily production of 583 GWh on 7 Jun 2020 (Sunday)

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

Daily electricity production of between 591-671 GWh in Jul 2020

Actual daily production from all power supply sources in South Africa for July 2020



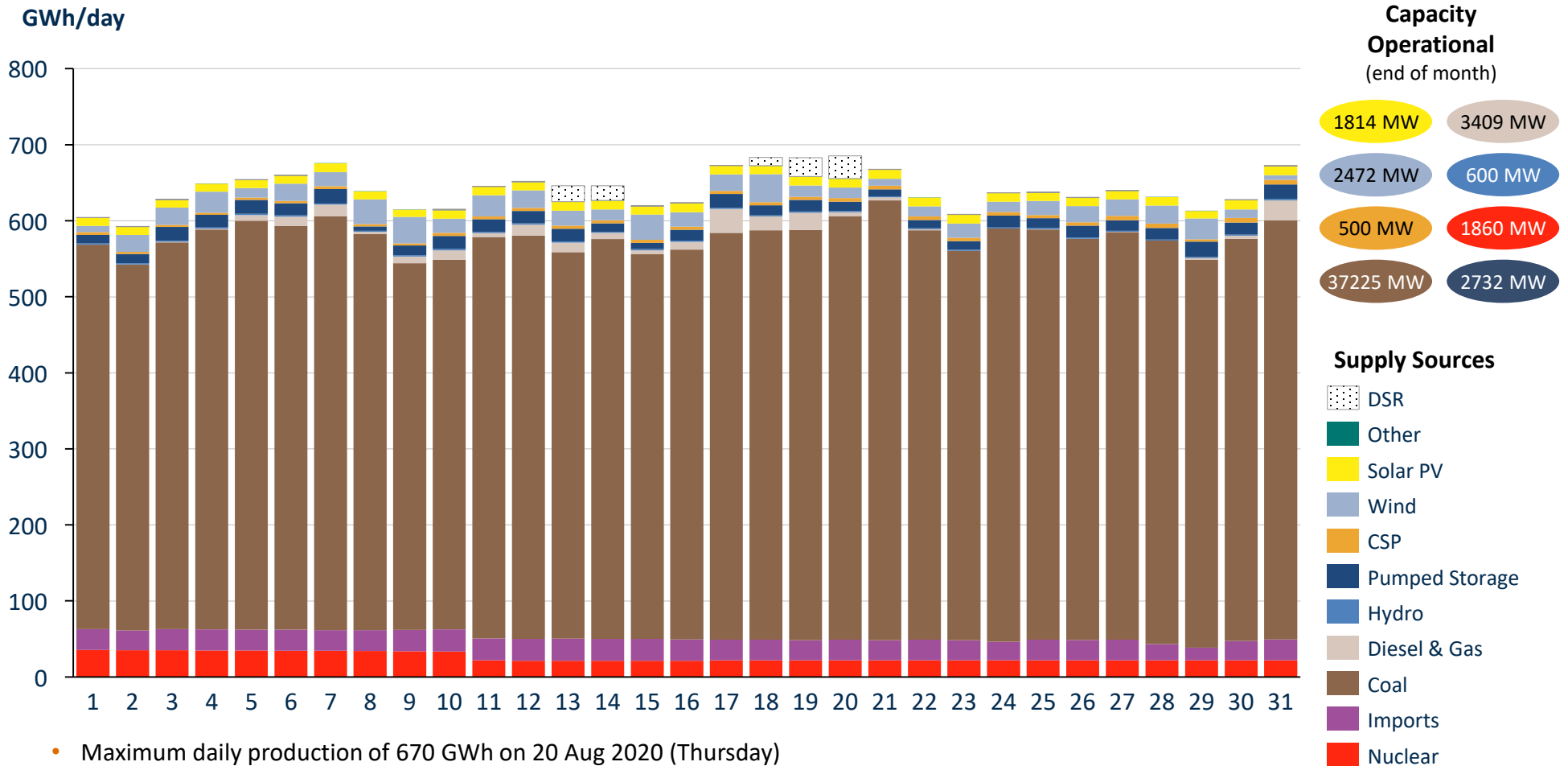
- Maximum daily production of 671 GWh on 15 Jul 2020 (Wednesday)
- Minimum daily production of 591 GWh on 5 Jul 2020 (Sunday)

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



Daily electricity production of between 576-670 GWh in Aug 2020

Actual daily production from all power supply sources in South Africa for August 2020

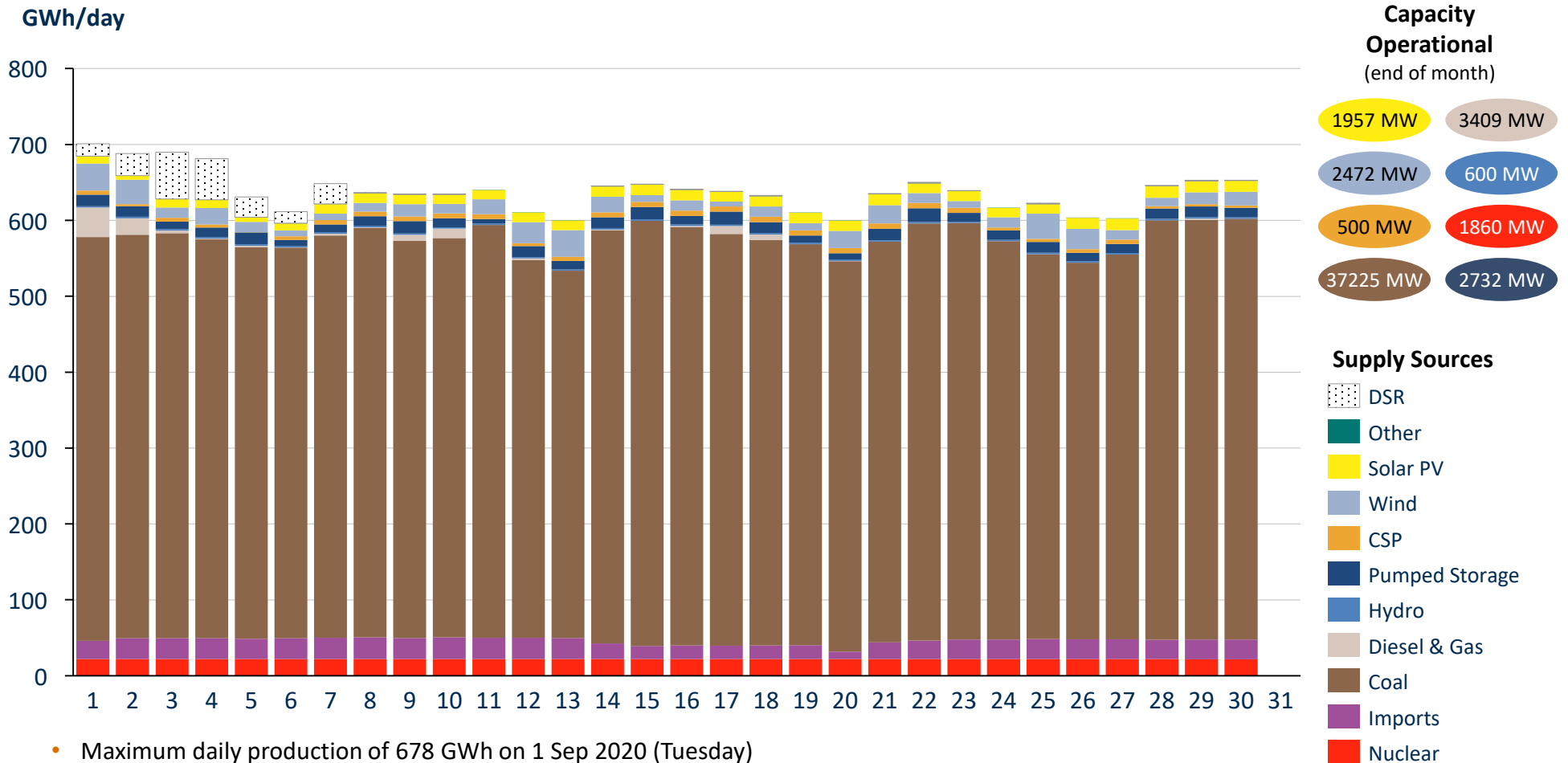


- Maximum daily production of 670 GWh on 20 Aug 2020 (Thursday)
- Minimum daily production of 576 GWh on 2 Aug 2020 (Sunday)

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

Daily electricity production of between 578-678 GWh in Sep 2020

Actual daily production from all power supply sources in South Africa for September 2020

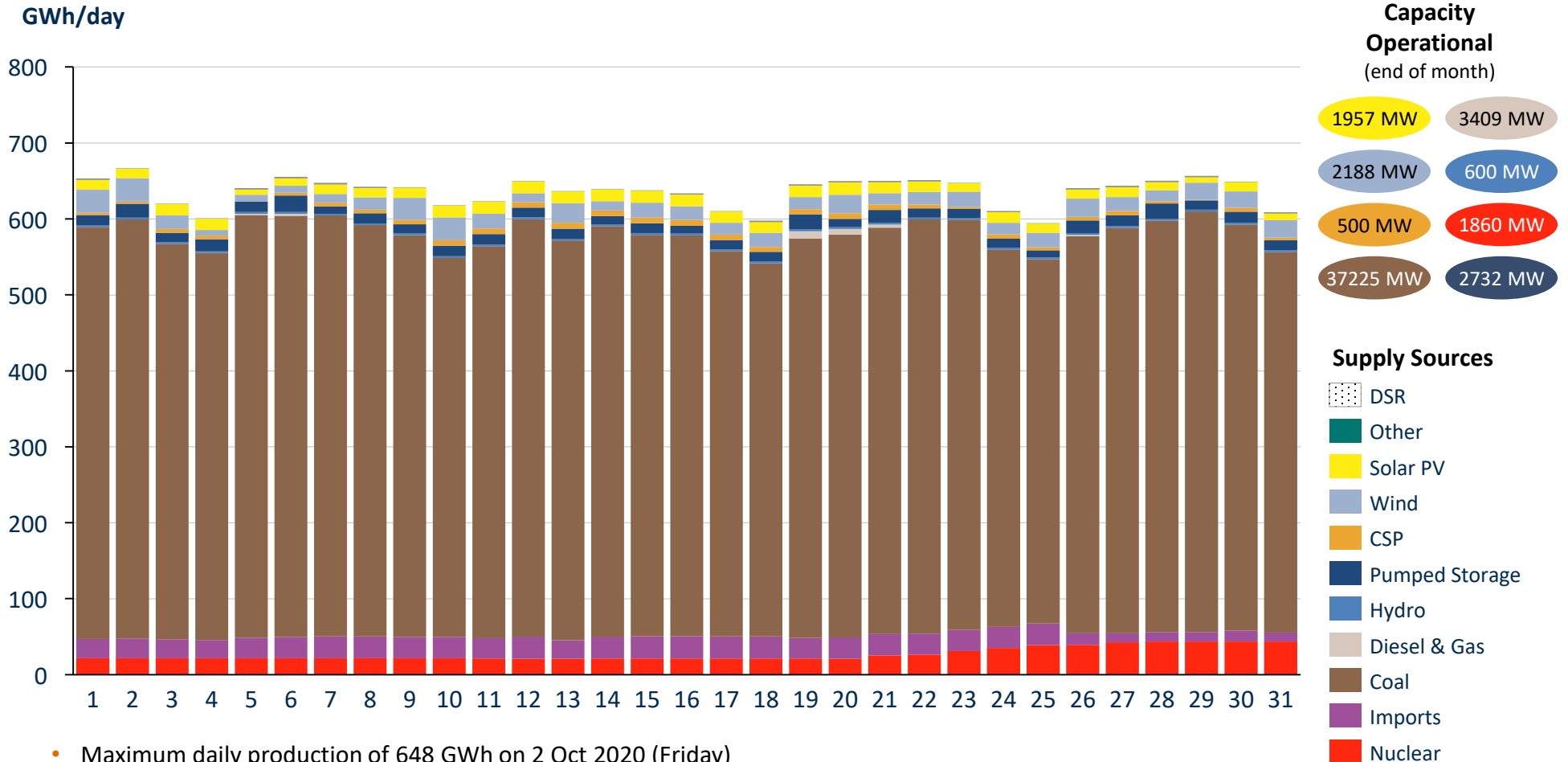


- Maximum daily production of 678 GWh on 1 Sep 2020 (Tuesday)
- Minimum daily production of 578 GWh on 20 Sep 2020 (Sunday)

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

Daily electricity production of between 574-648 GWh in Oct 2020

Actual daily production from all power supply sources in South Africa for October 2020



- Maximum daily production of 648 GWh on 2 Oct 2020 (Friday)
- Minimum daily production of 574 GWh on 25 Oct 2020 (Sunday)

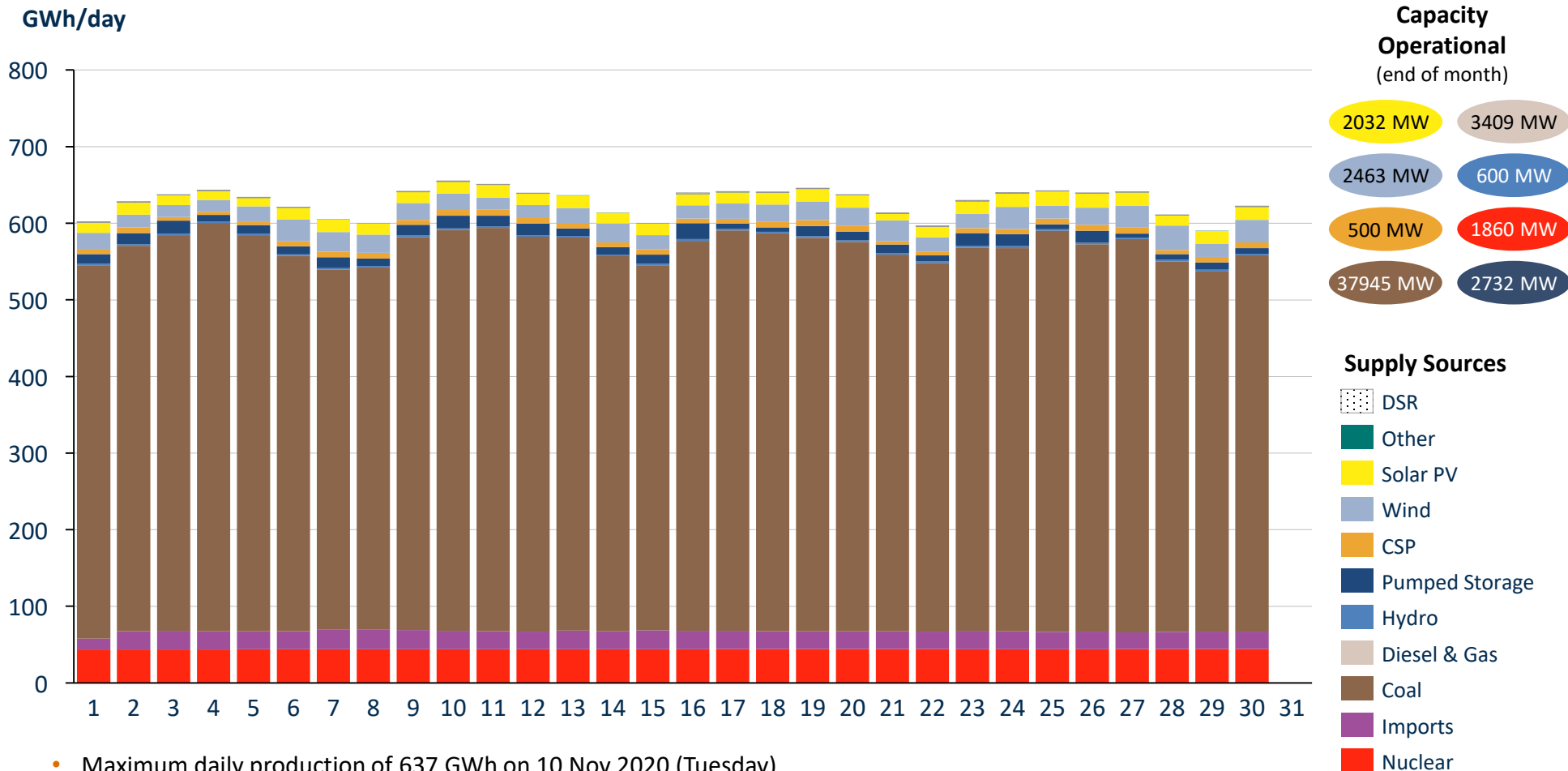
Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.

Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)

Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 574-637 GWh in Nov 2020

Actual daily production from all power supply sources in South Africa for November 2020



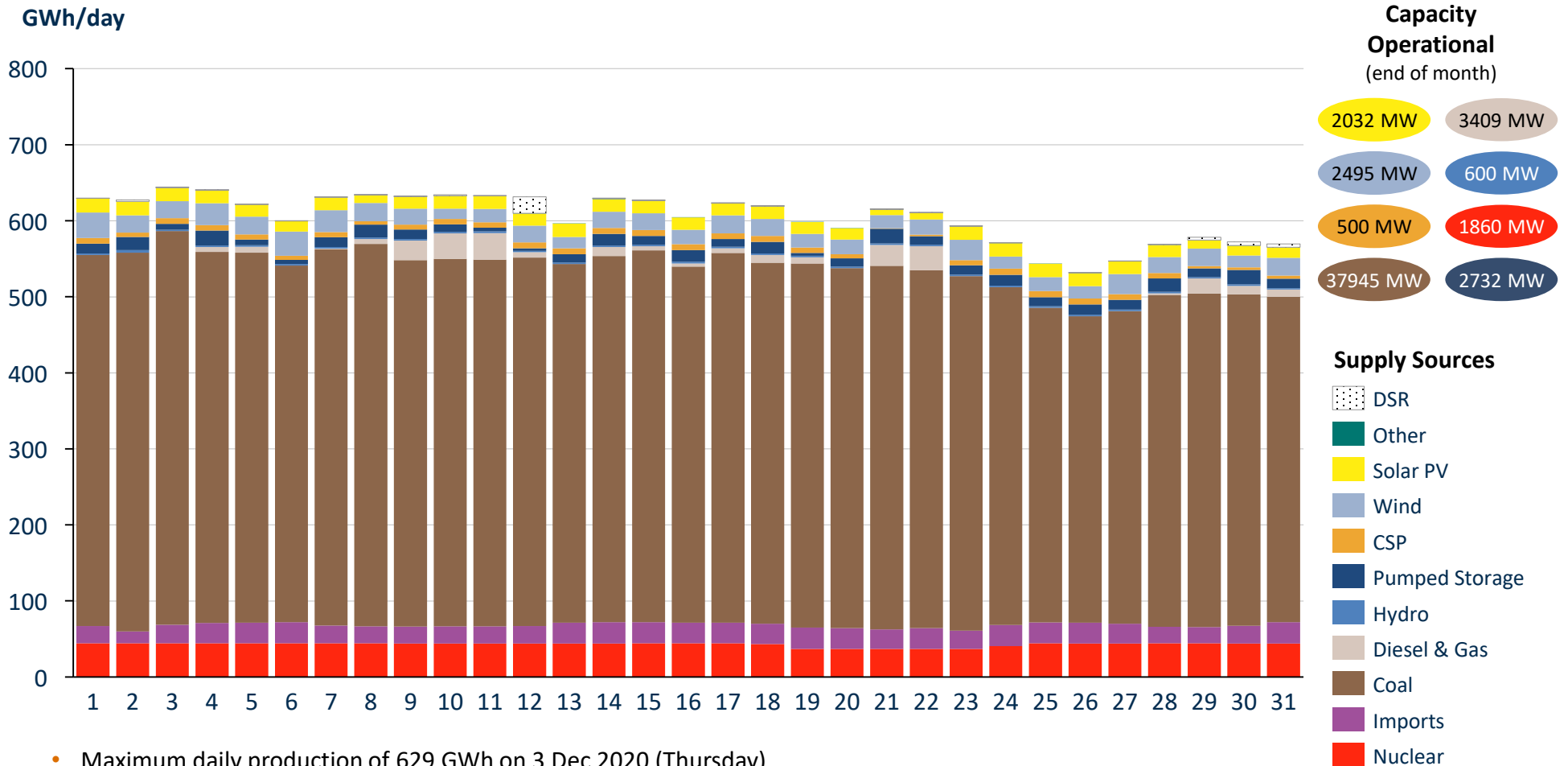
- Maximum daily production of 637 GWh on 10 Nov 2020 (Tuesday)
- Minimum daily production of 574 GWh on 29 Nov 2020 (Sunday)

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



Daily electricity production of between 514-629 GWh in Dec 2020

Actual daily production from all power supply sources in South Africa for December 2020



- Maximum daily production of 629 GWh on 3 Dec 2020 (Thursday)
- Minimum daily production of 514 GWh on 26 Dec 2020 (Saturday)

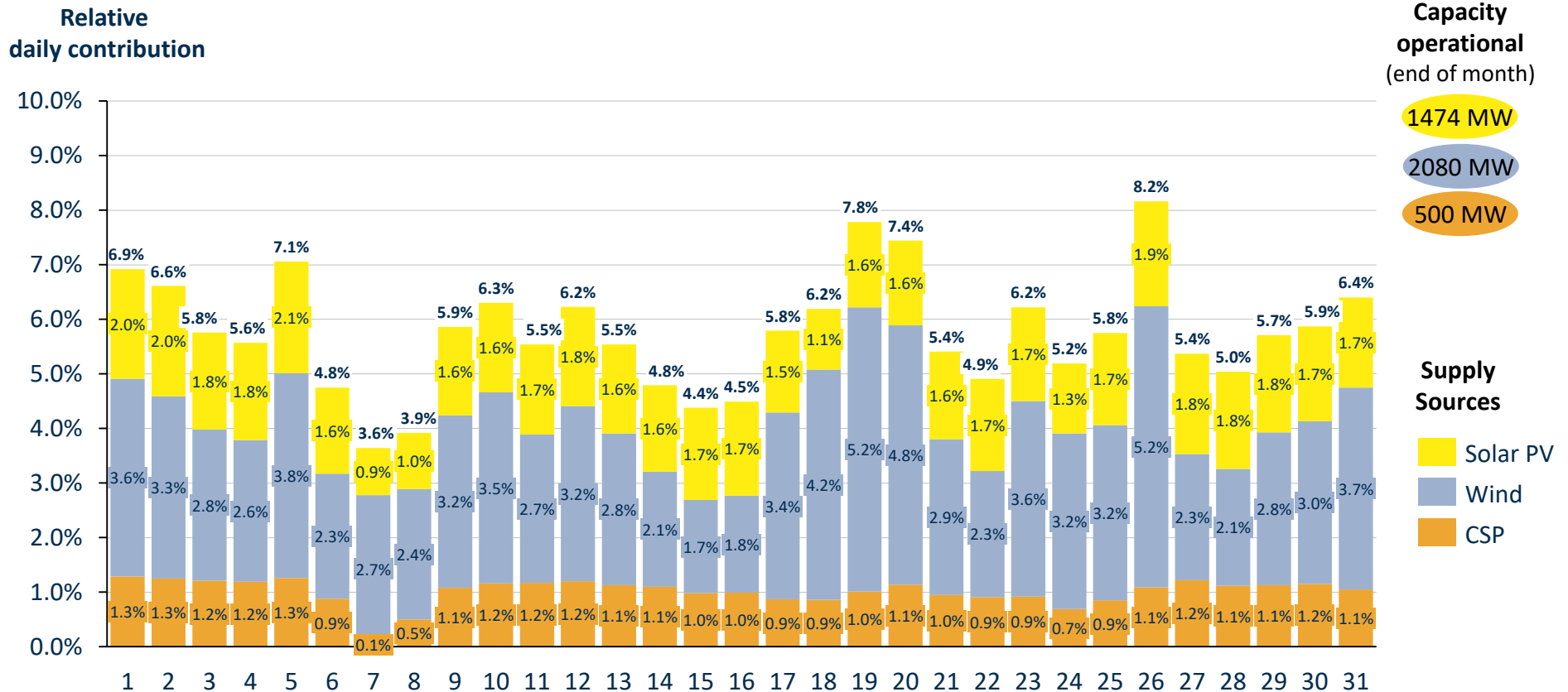
Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.

Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)

Sources: Eskom; CSIR Energy Centre analysis

Daily solar PV, wind & CSP contribution of 3.6-8.2% in Jan 2020

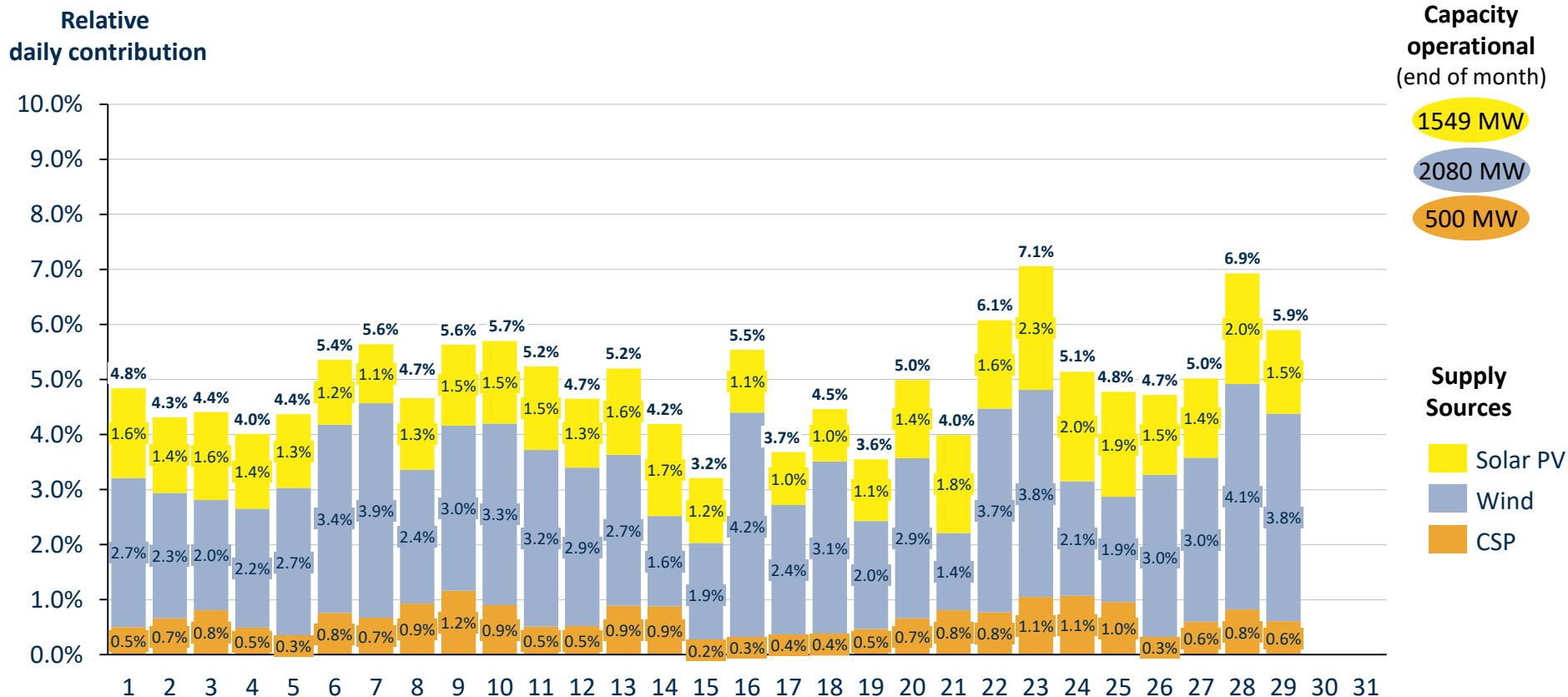
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for January 2020



- Maximum daily relative solar PV contribution of 2.0% on 5 Jan 2020 (Sunday)
- Maximum daily relative wind contribution of 5.2% on 19 Jan 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.3% on 1 Jan 2020 (Wednesday-National Holiday)

Daily solar PV, wind & CSP contribution of 3.2-7.1% in Feb 2020

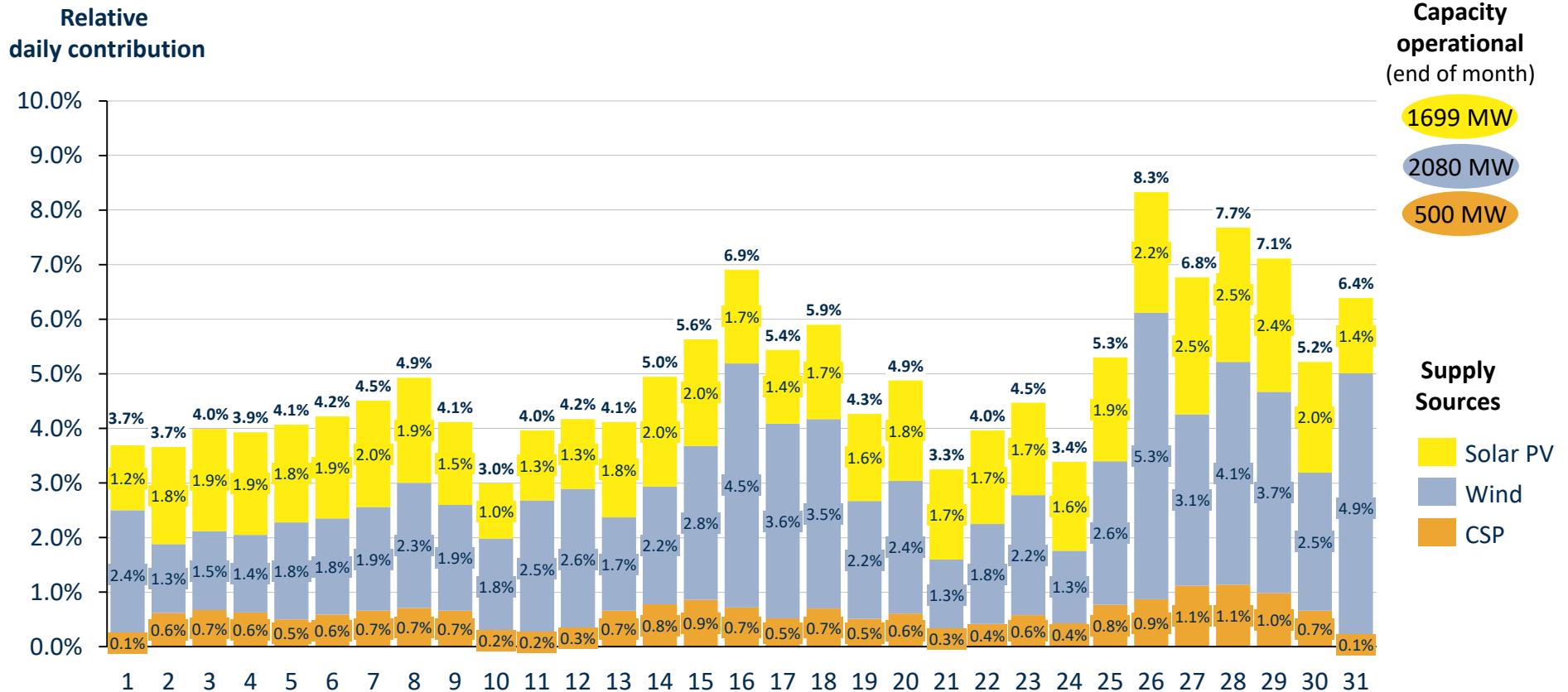
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for February 2020



- Maximum daily relative solar PV contribution of 2.3% on 23 Feb 2020 (Sunday)
- Maximum daily relative wind contribution of 4.2% on 16 Feb 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.2% on 9 Feb 2020 (Sunday)

Daily solar PV, wind & CSP contribution of 3.0-8.3% in Mar 2020

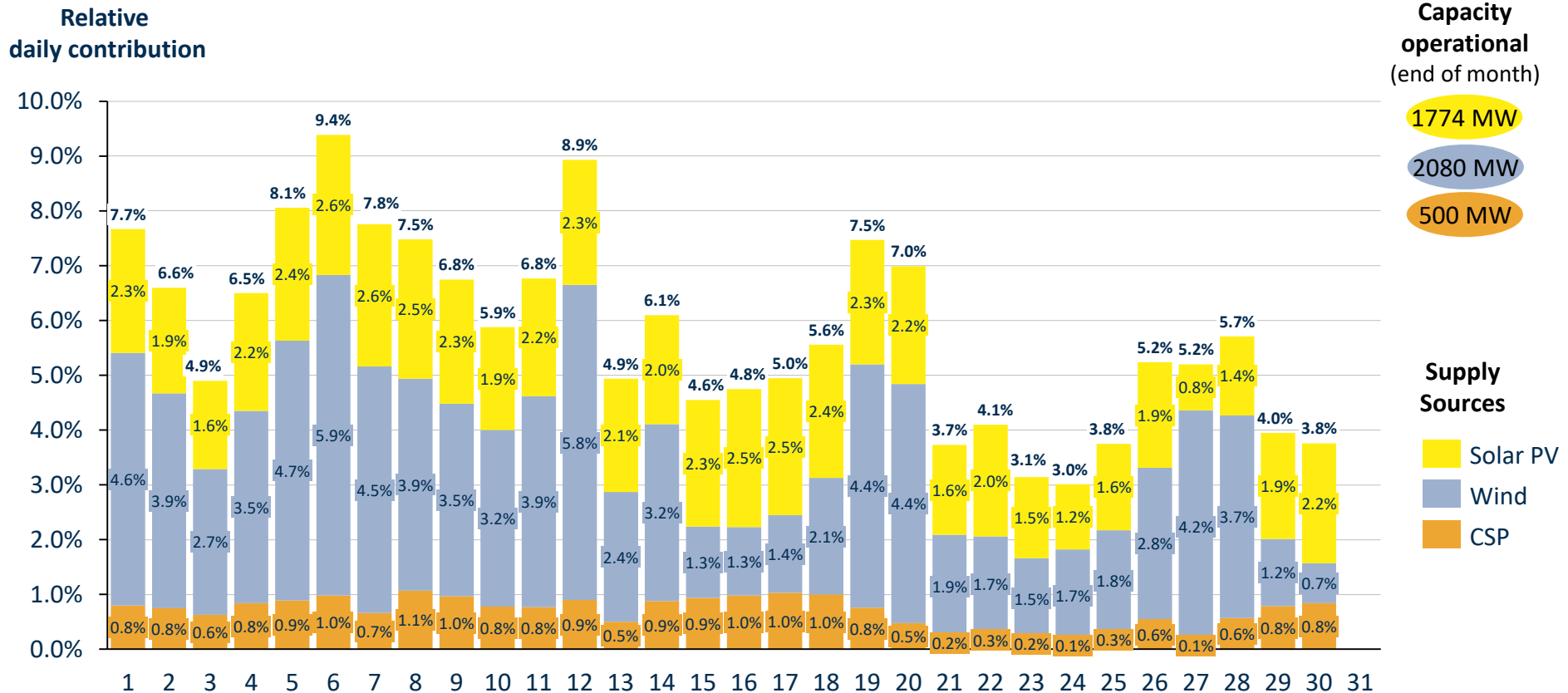
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for March 2020



- Maximum daily relative solar PV contribution of 2.5% on 27 Mar 2020 (Friday)
- Maximum daily relative wind contribution of 5.3% on 26 Mar 2020 (Thursday)
- Maximum daily relative CSP contribution of 1.1% on 28 Mar 2020 (Saturday)

Daily solar PV, wind & CSP contribution of 3.0-9.4% in Apr 2020

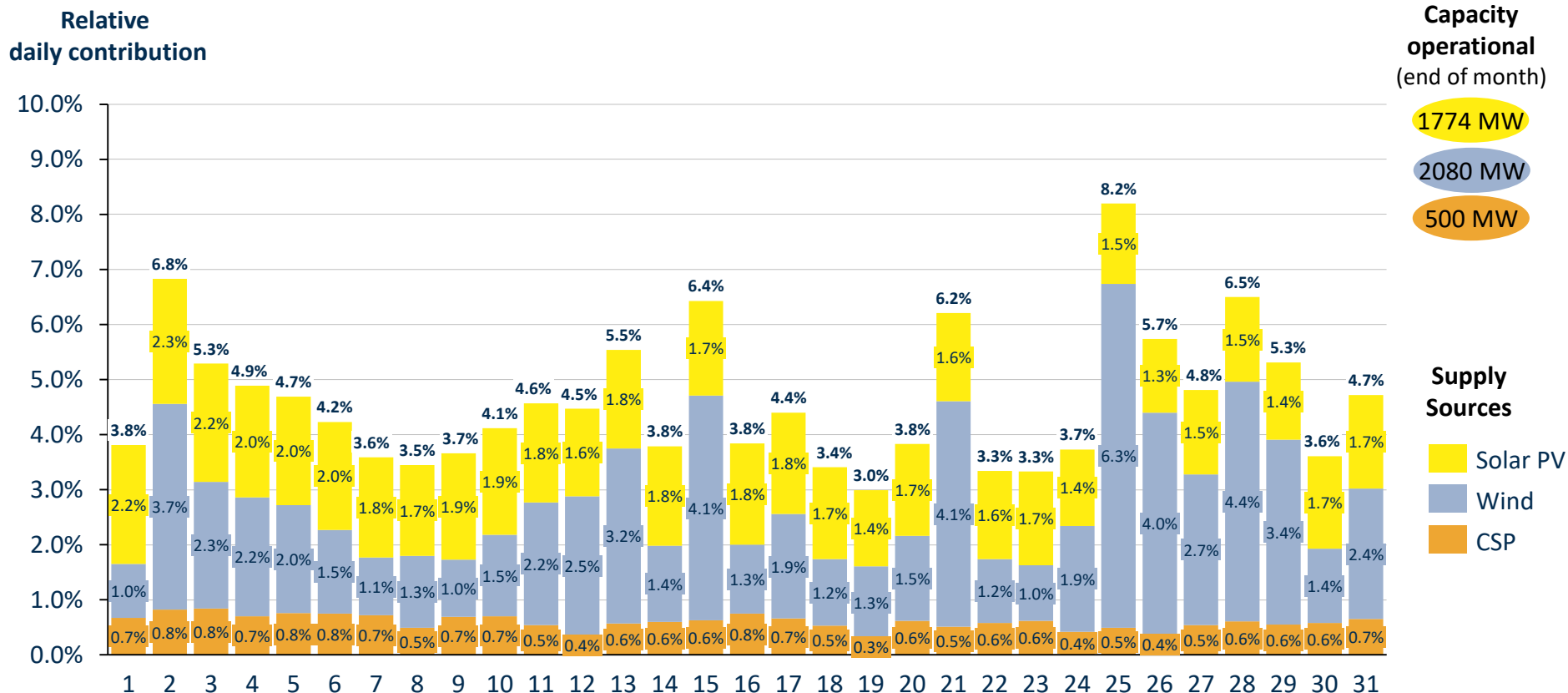
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for April 2020



- Maximum daily relative solar PV contribution of 2.6% on 7 Apr 2020 (Tuesday)
- Maximum daily relative wind contribution of 5.9% on 6 Apr 2020 (Monday)
- Maximum daily relative CSP contribution of 1.1% on 8 Apr 2020 (Wednesday)

Daily solar PV, wind & CSP contribution of 3.0-8.2% in May 2020

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

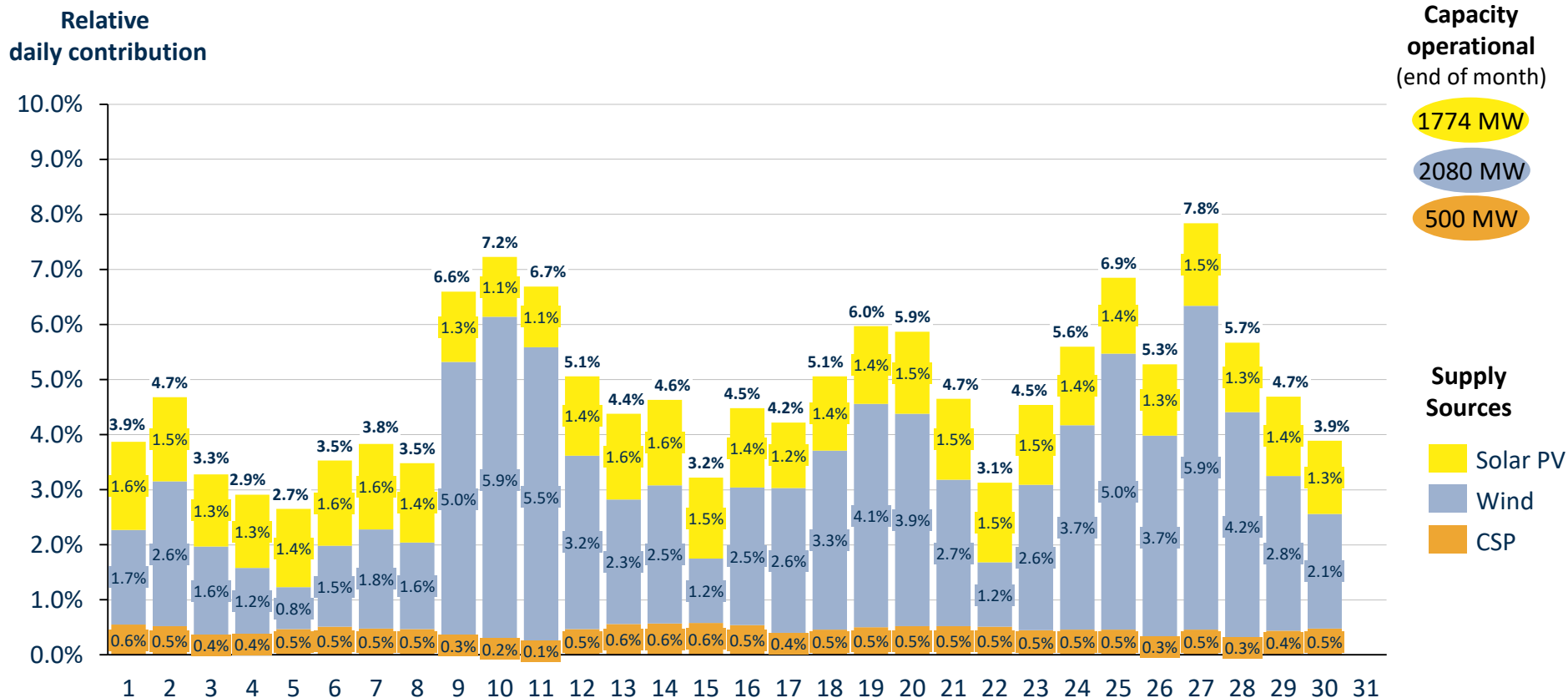


- Maximum daily relative solar PV contribution of 2.3% on 2 May 2020 (Saturday)
- Maximum daily relative wind contribution of 6.3% on 25 May 2020 (Monday)
- Maximum daily relative CSP contribution of 0.8% on 3 May 2020 (Sunday)



Daily solar PV, wind & CSP contribution of 2.7-7.8% in Jun 2020

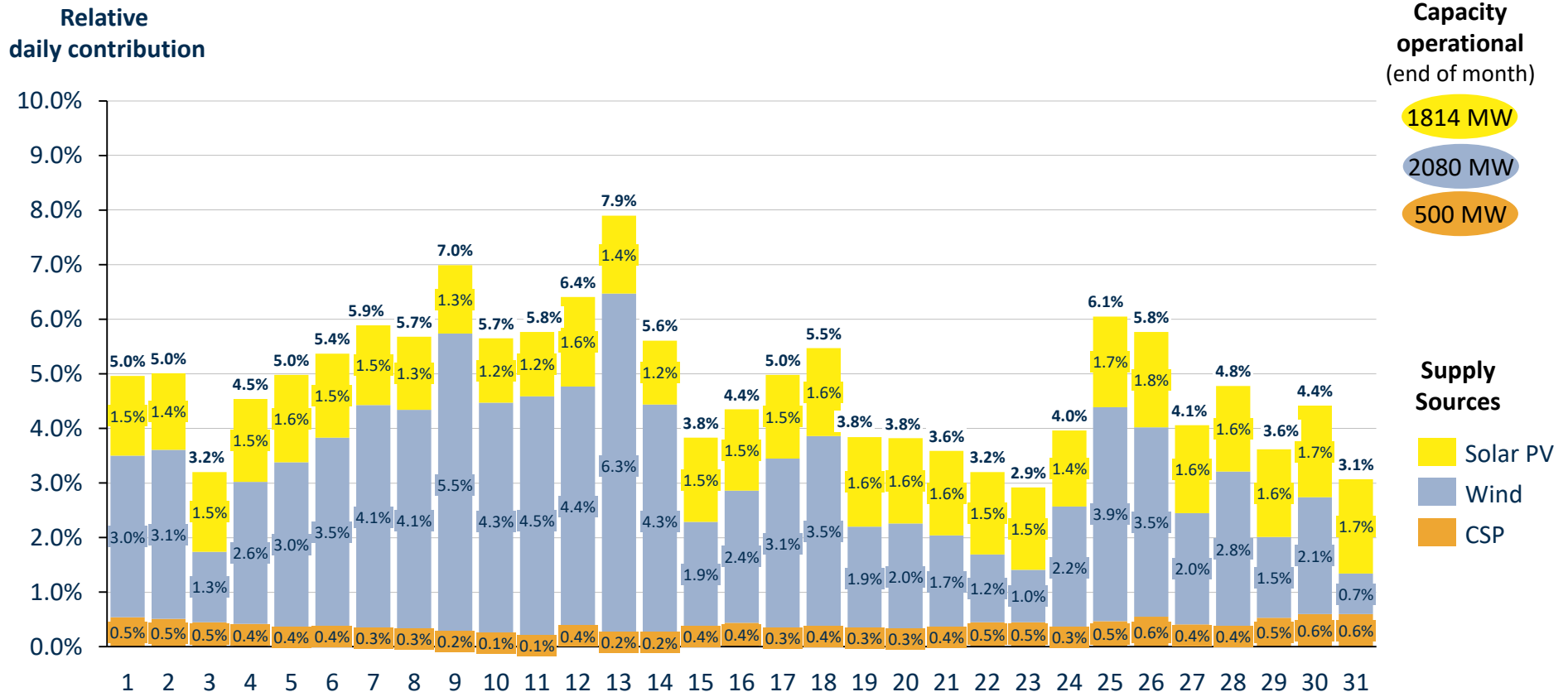
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for June 2020



- Maximum daily relative solar PV contribution of 1.6% on 1 Jun 2020 (Monday)
- Maximum daily relative wind contribution of 5.9% on 10 Jun 2020 (Wednesday)
- Maximum daily relative CSP contribution of 0.6% on 15 Jun 2020 (Monday)

Daily solar PV, wind & CSP contribution of 2.9-7.9% in Jul 2020

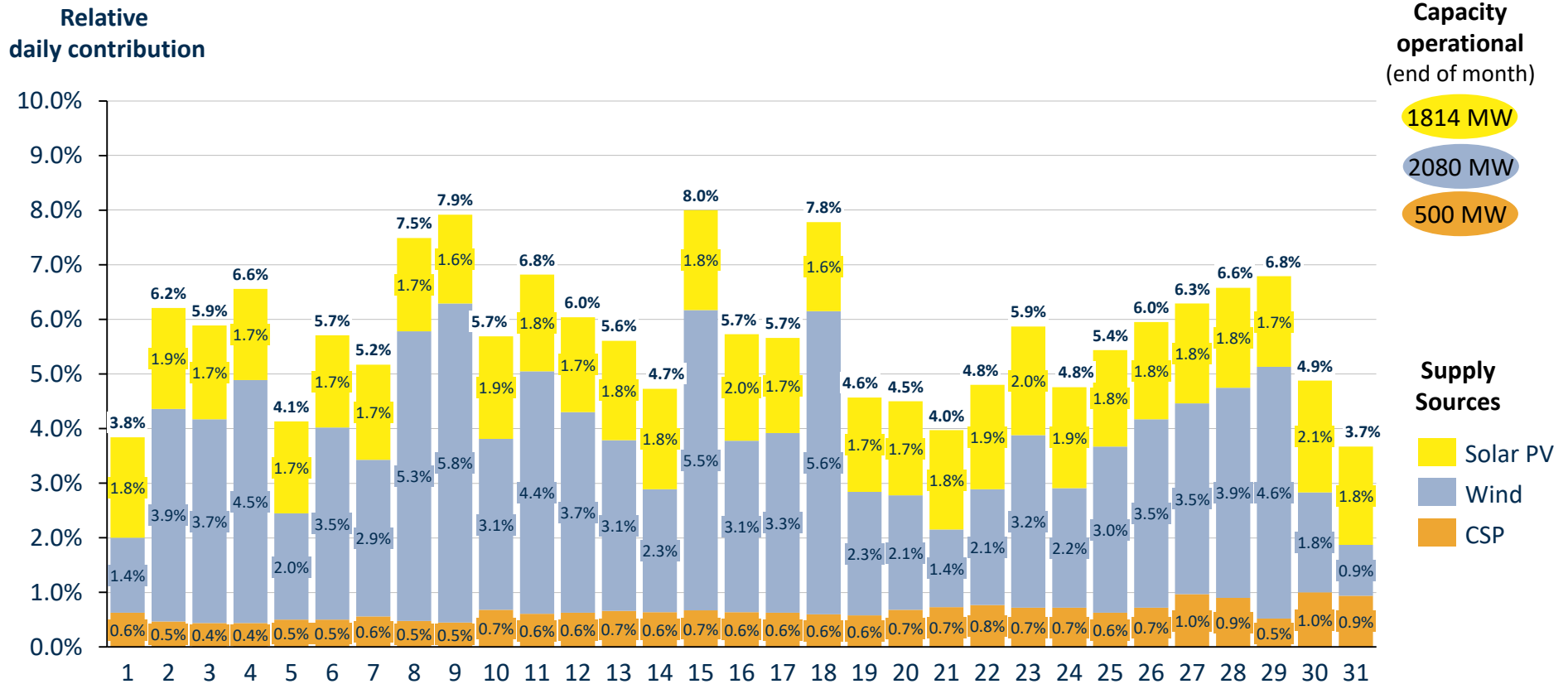
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for July 2020



- Maximum daily relative solar PV contribution of 1.8% on 26 Jul 2020 (Sunday)
- Maximum daily relative wind contribution of 6.3% on 13 Jul 2020 (Monday)
- Maximum daily relative CSP contribution of 0.6% on 31 Jul 2020 (Friday)

Daily solar PV, wind & CSP contribution of 3.7-8.0% in Aug 2020

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

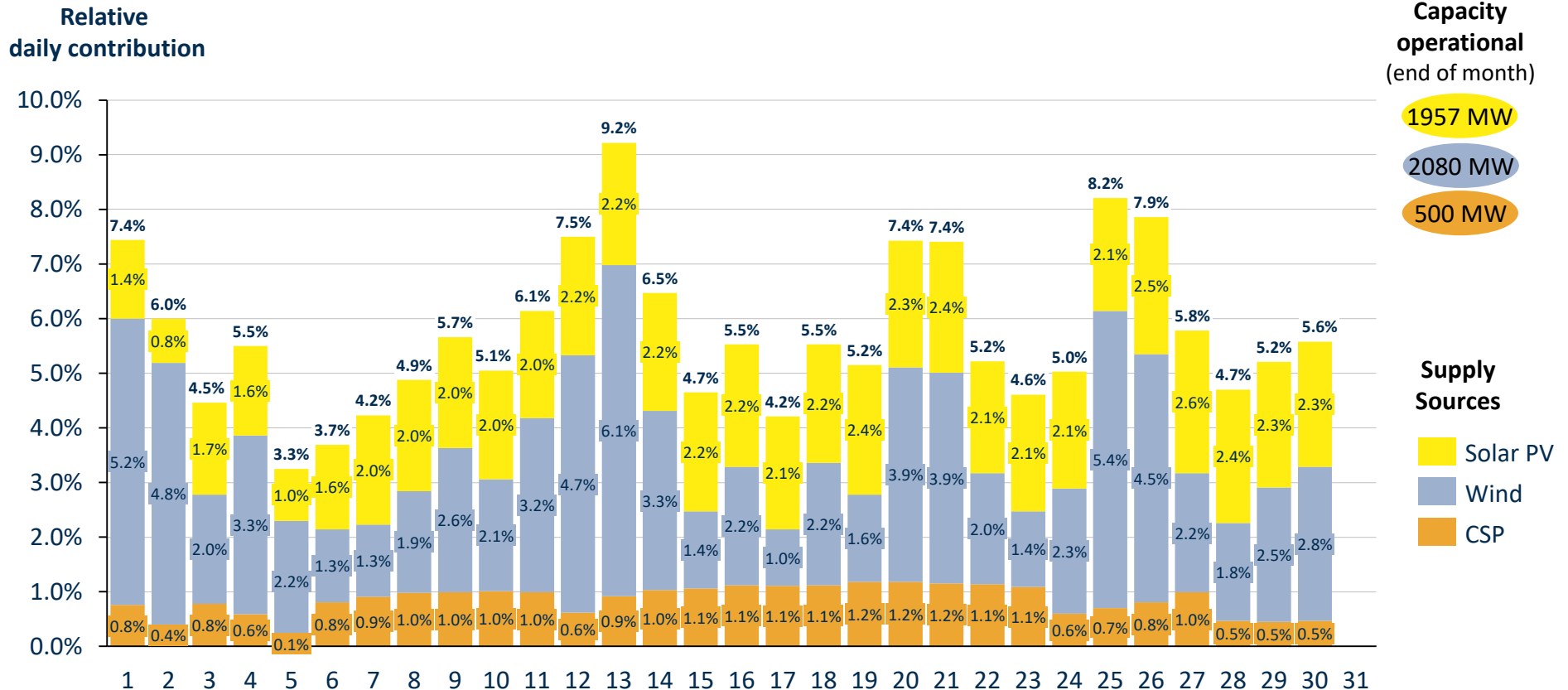


- Maximum daily relative solar PV contribution of 2.0% on 30 Aug 2020 (Sunday)
- Maximum daily relative wind contribution of 5.8% on 9 Aug 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.0% on 30 Aug 2020 (Sunday)



Daily solar PV, wind & CSP contribution of 3.3-9.2% in Sep 2020

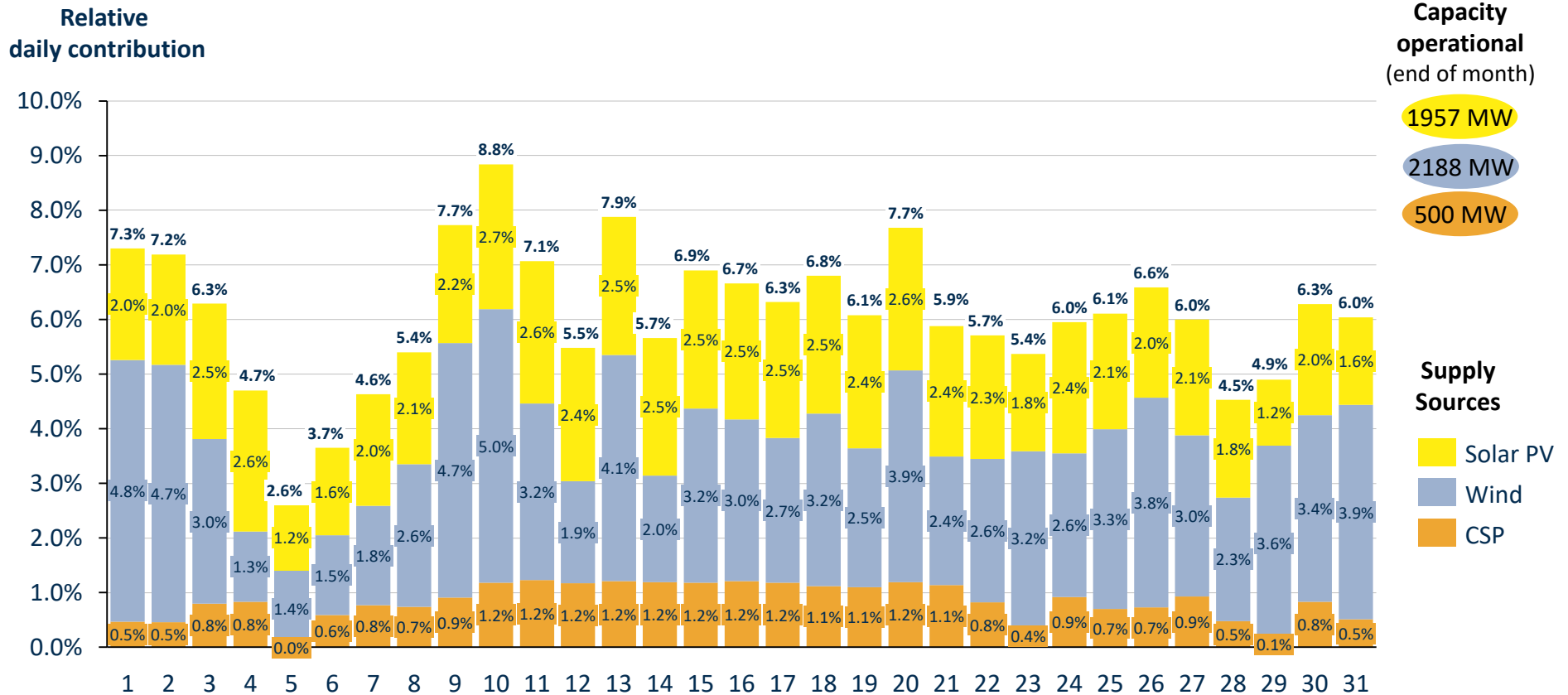
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for September 2020



- Maximum daily relative solar PV contribution of 2.6% on 27 Sep 2020 (Sunday)
- Maximum daily relative wind contribution of 6.1% on 13 Sep 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.2% on 19 Sep 2020 (Saturday)

Daily solar PV, wind & CSP contribution of 2.6-8.8% in Oct 2020

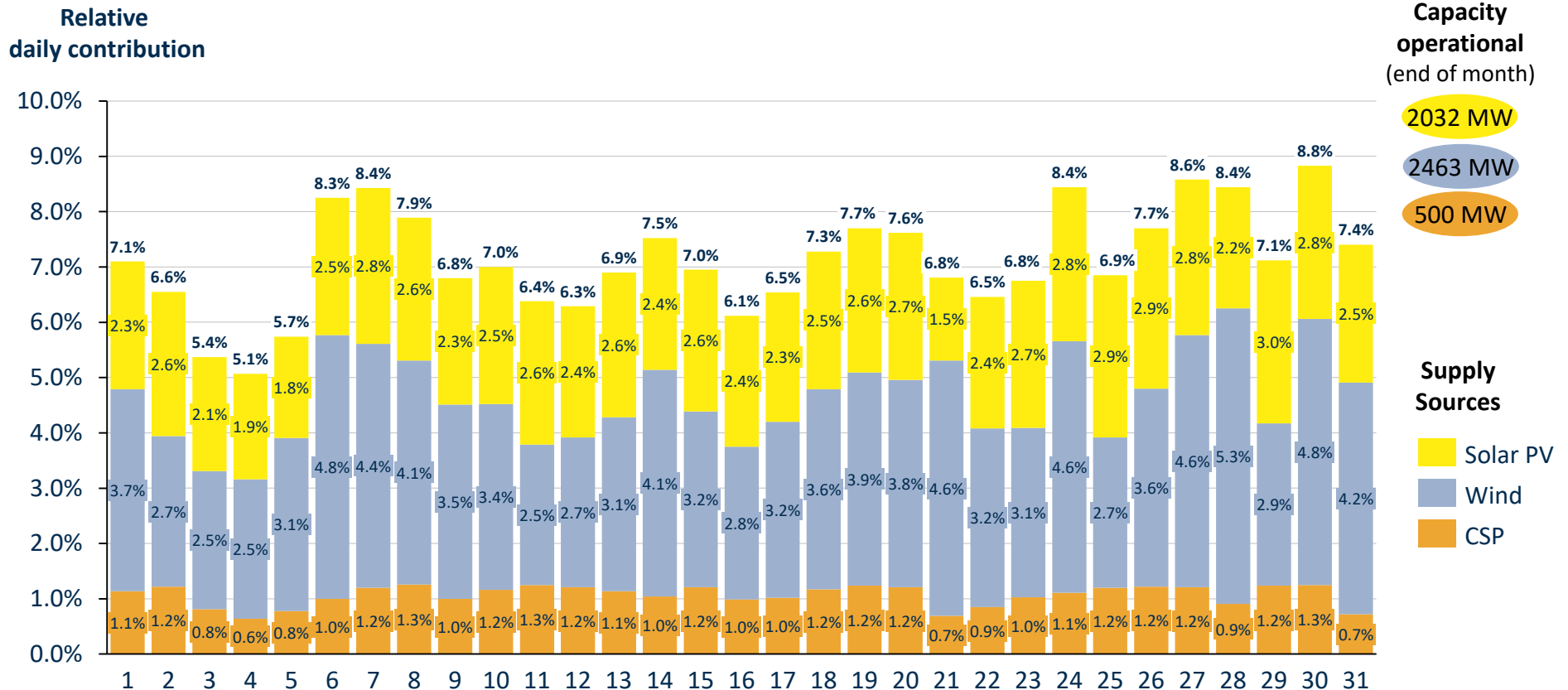
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for October 2020



- Maximum daily relative solar PV contribution of 2.7% on 10 Oct 2020 (Saturday)
- Maximum daily relative wind contribution of 5.0% on 10 Oct 2020 (Saturday)
- Maximum daily relative CSP contribution of 1.2% on 11 Oct 2020 (Sunday)

Daily solar PV, wind & CSP contribution of 5.1-8.8% in Nov 2020

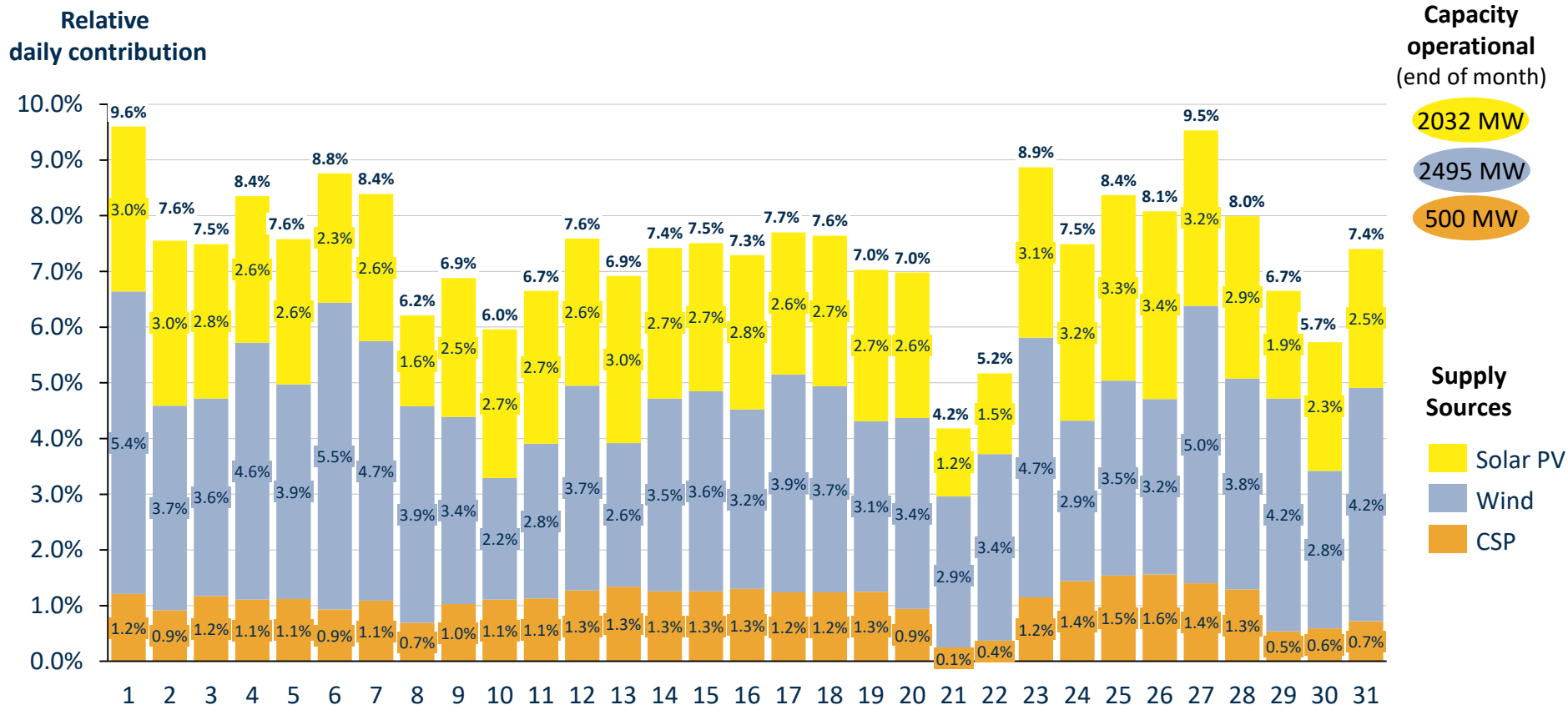
Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for November 2020



- Maximum daily relative solar PV contribution of 2.9% on 29 Nov 2020 (Sunday)
- Maximum daily relative wind contribution of 5.3% on 28 Nov 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.3% on 8 Nov 2020 (Sunday)

Daily solar PV, wind & CSP contribution of 4.2-9.5% in Dec 2020

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



- Maximum daily relative solar PV contribution of 3.4% on 26 Dec 2020 (Saturday)
- Maximum daily relative wind contribution of 5.5% on 6 Dec 2020 (Sunday)
- Maximum daily relative CSP contribution of 1.6% on 26 Dec 2020 (Saturday)

Agenda

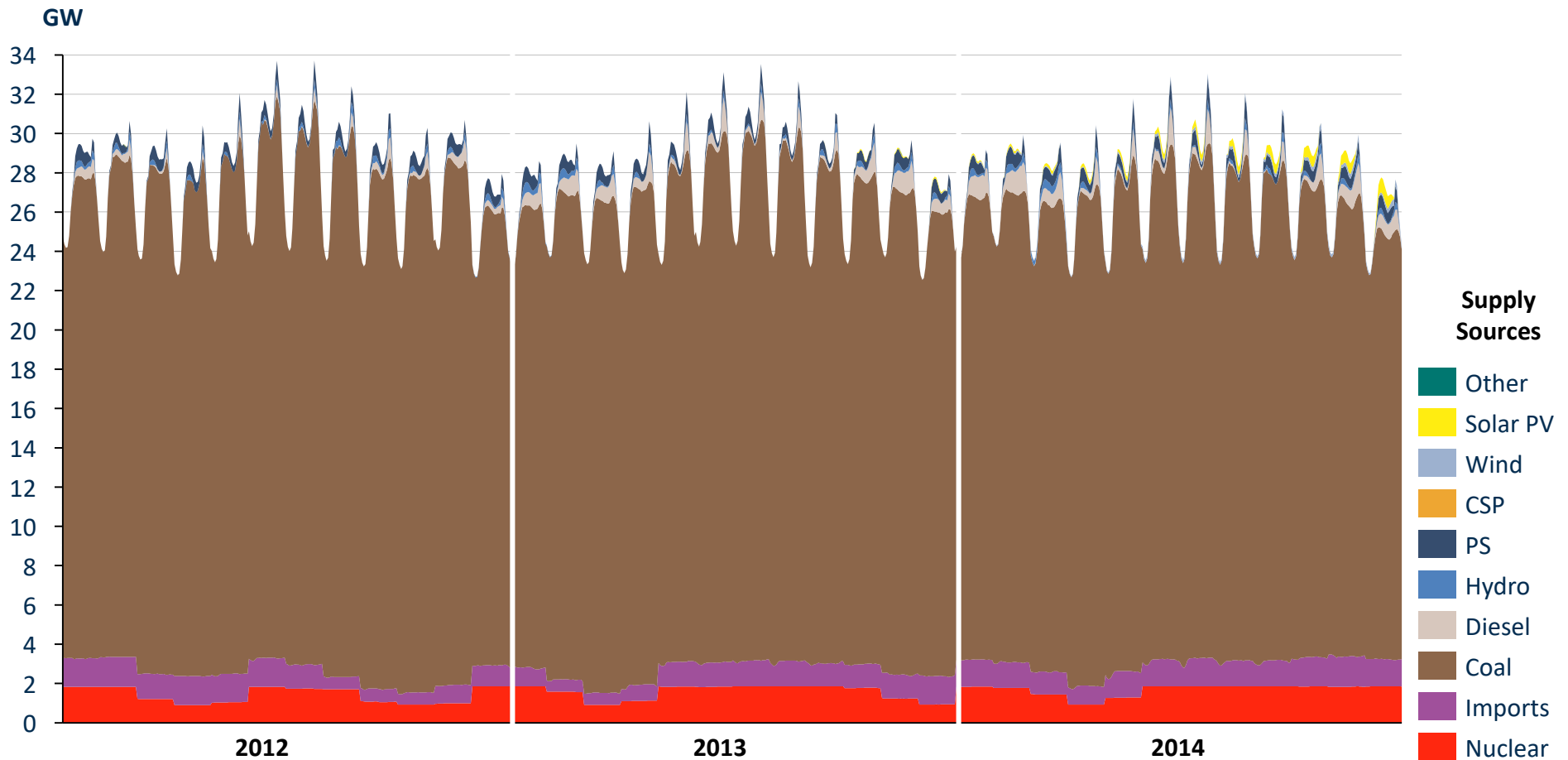
- 1 Overview actual electricity production (2020)
- 2 Monthly electricity production (2020)
- 3 Weekly electricity production (2020)
- 4 Daily electricity production (2020)

- 5 [Hourly electricity production \(2020\)](#)

- 6 Actual load shedding in 2020
- 7 Other power system statistics

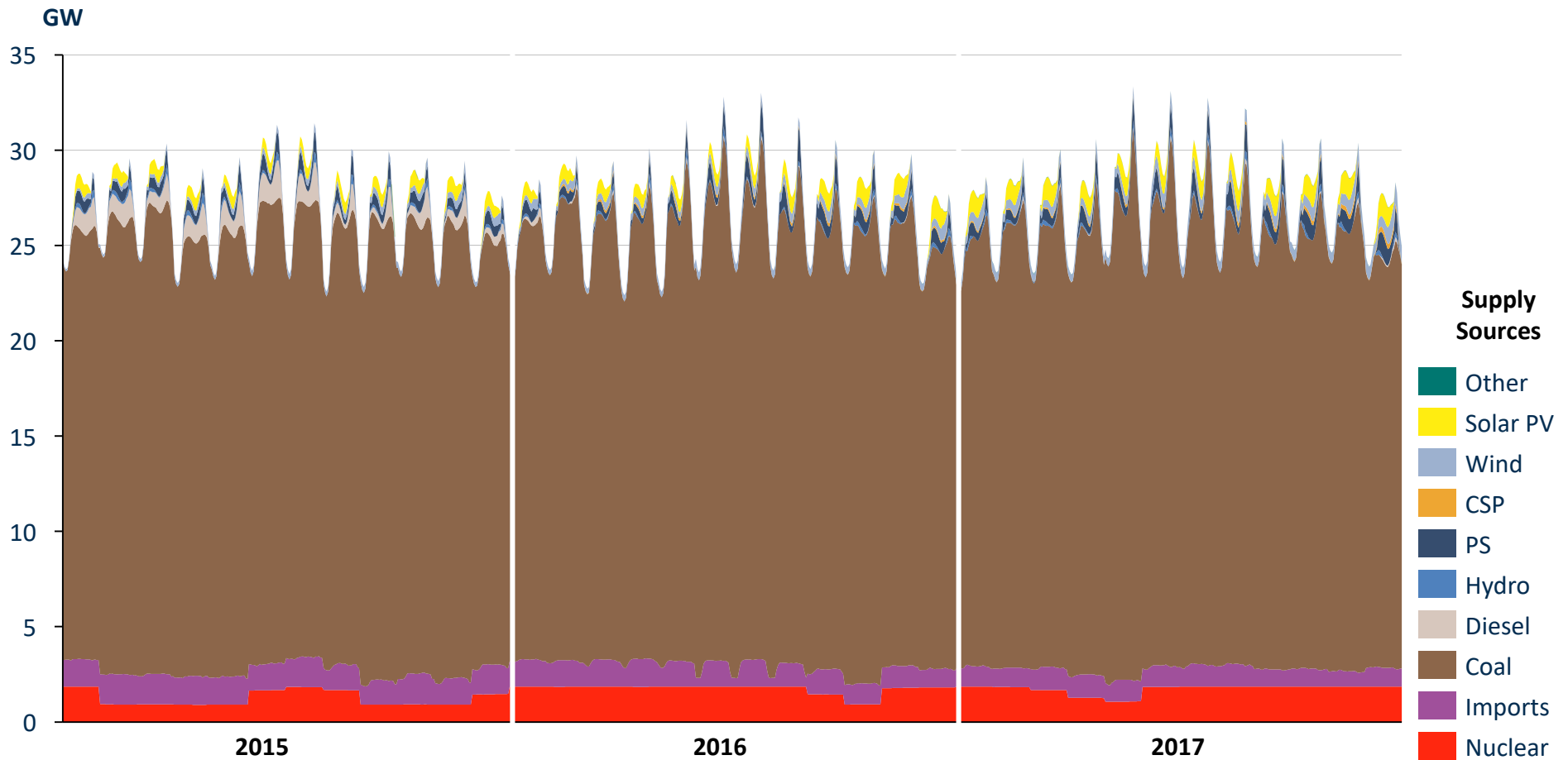
Diurnal Courses of electricity supply sources in RSA

Actual monthly average diurnal courses of total power supply in RSA Jan 2012-Dec 2014



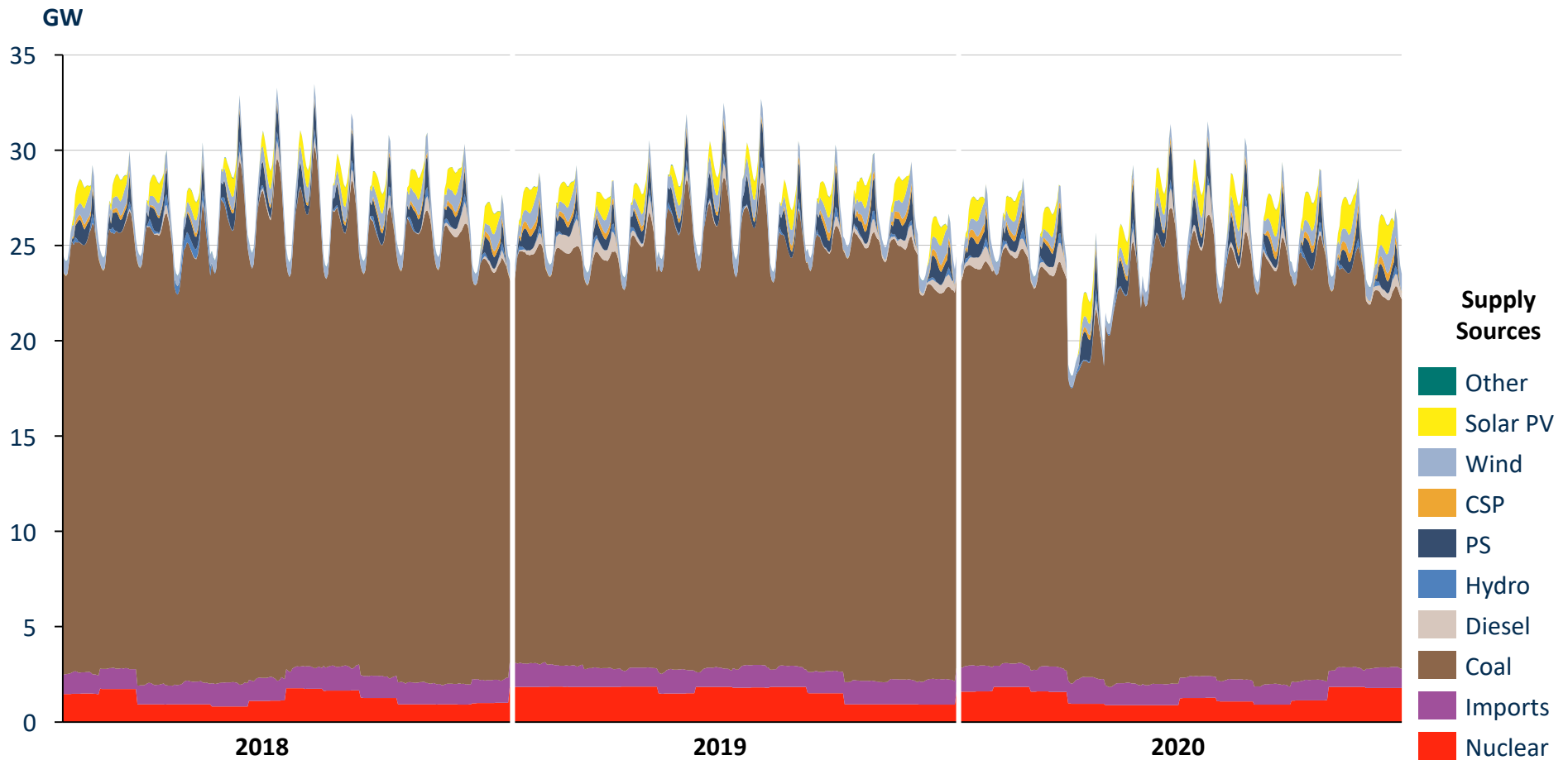
Diurnal Courses of electricity supply sources in RSA

Actual monthly average diurnal courses of total power supply in RSA Jan 2015-Dec 2017



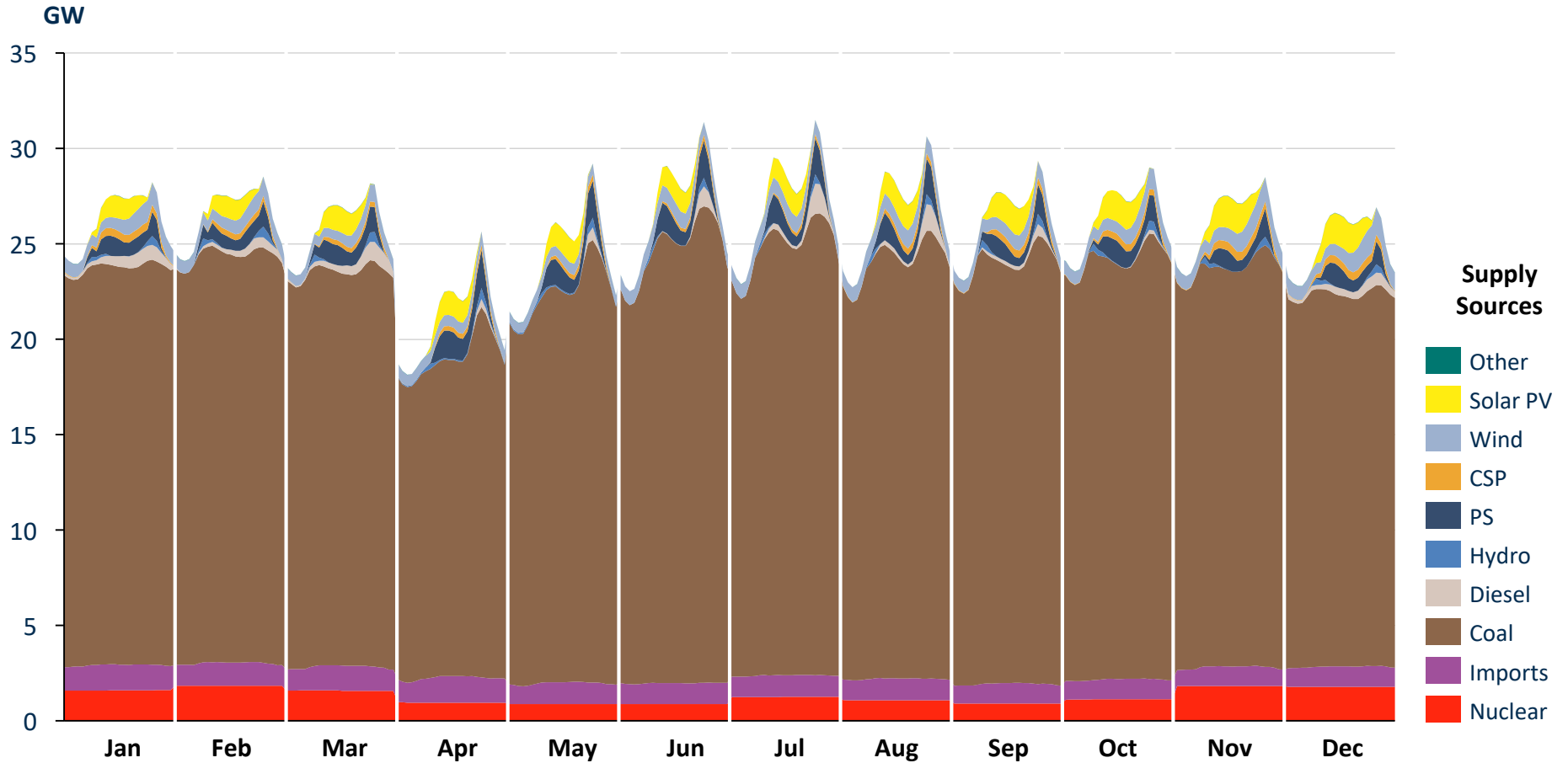
Diurnal Courses of electricity supply sources in RSA

Actual monthly average diurnal courses of total power supply in RSA from Jan 2018-Dec 2020



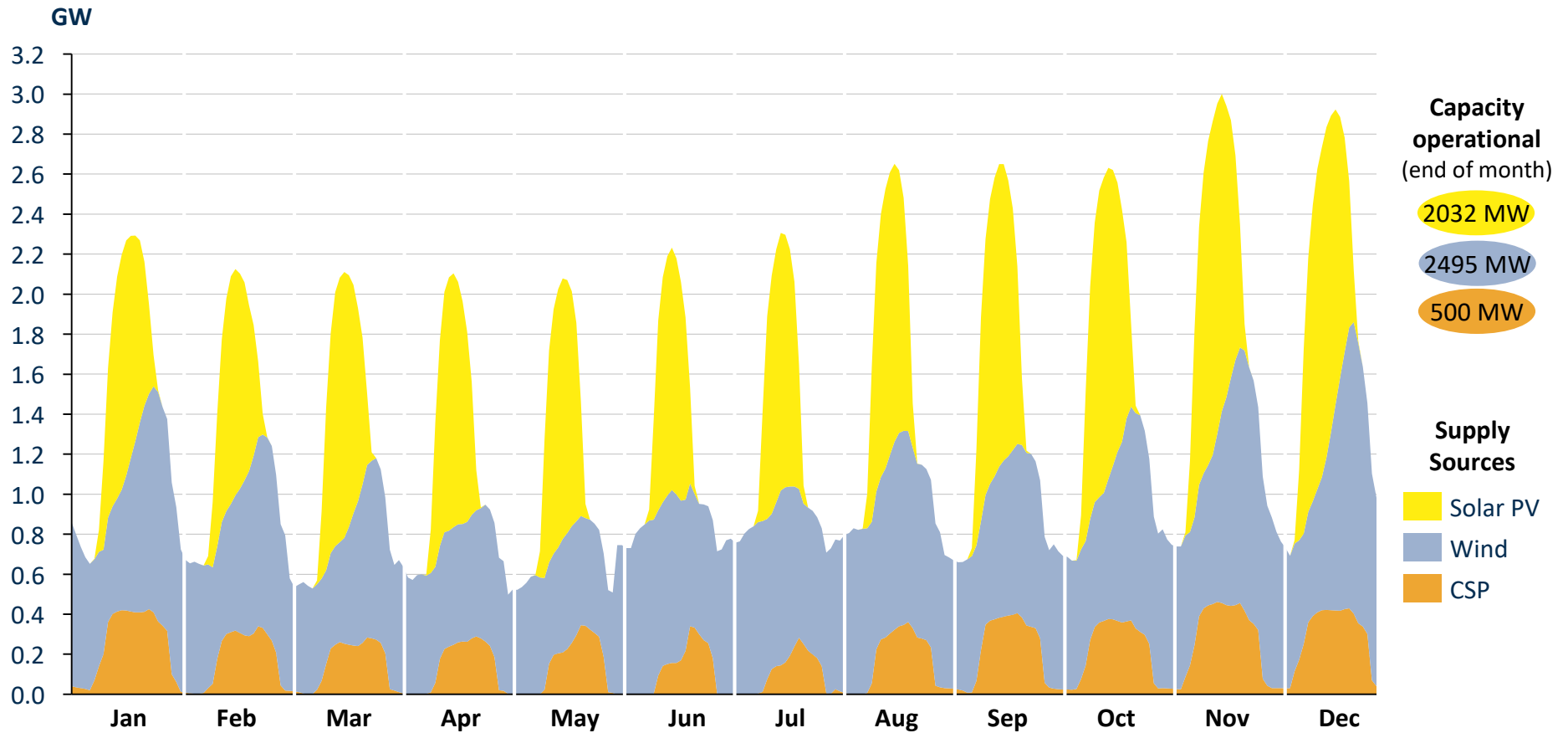
Diurnal Courses of electricity supply sources in RSA

Actual monthly average diurnal courses of the total power supply in RSA from Jan-Dec 2020



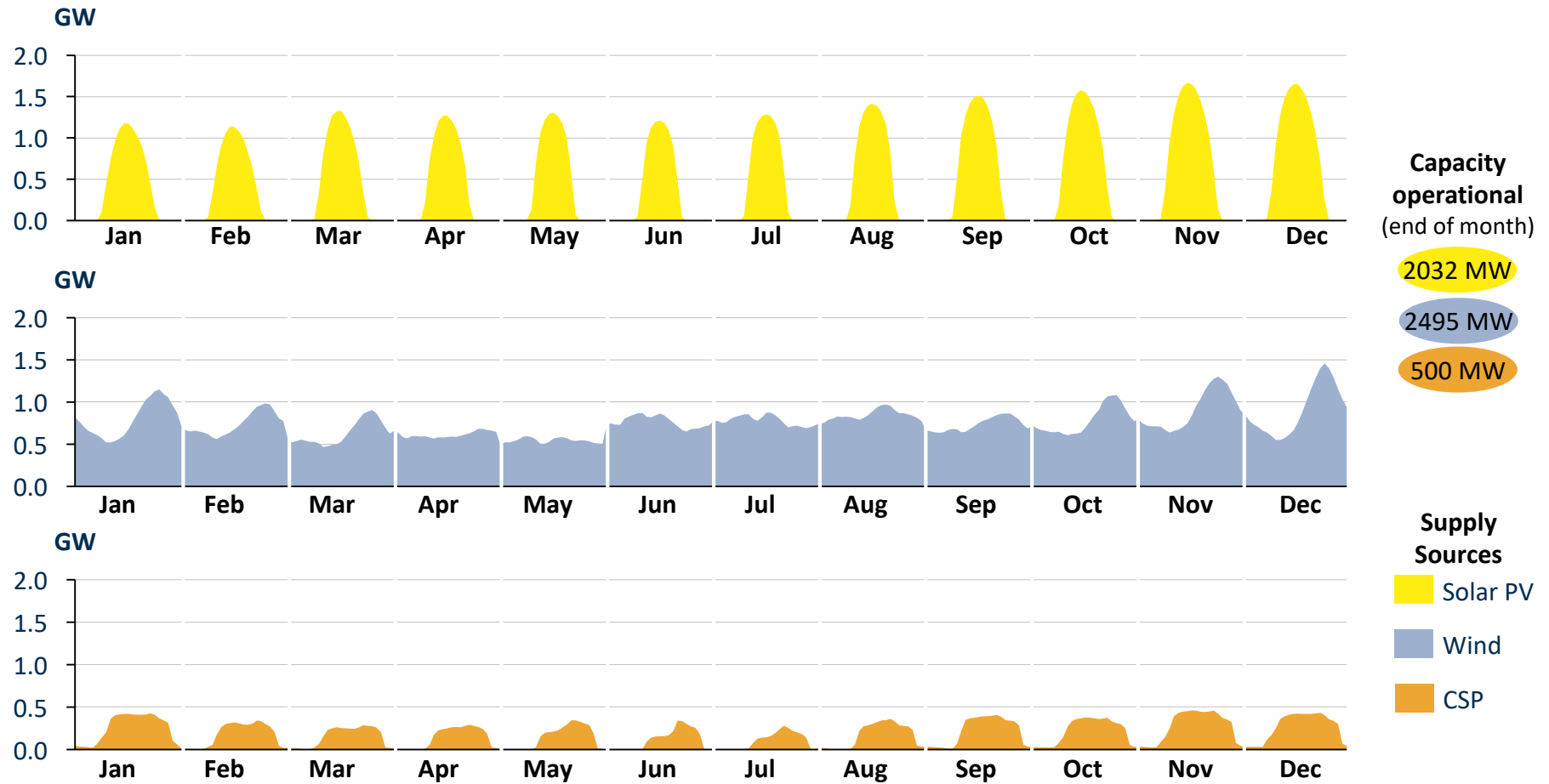
Diurnal Courses for renewable energy supply

Actual monthly average diurnal courses of solar PV, wind and CSP in RSA for the months from Jan-Dec 2020



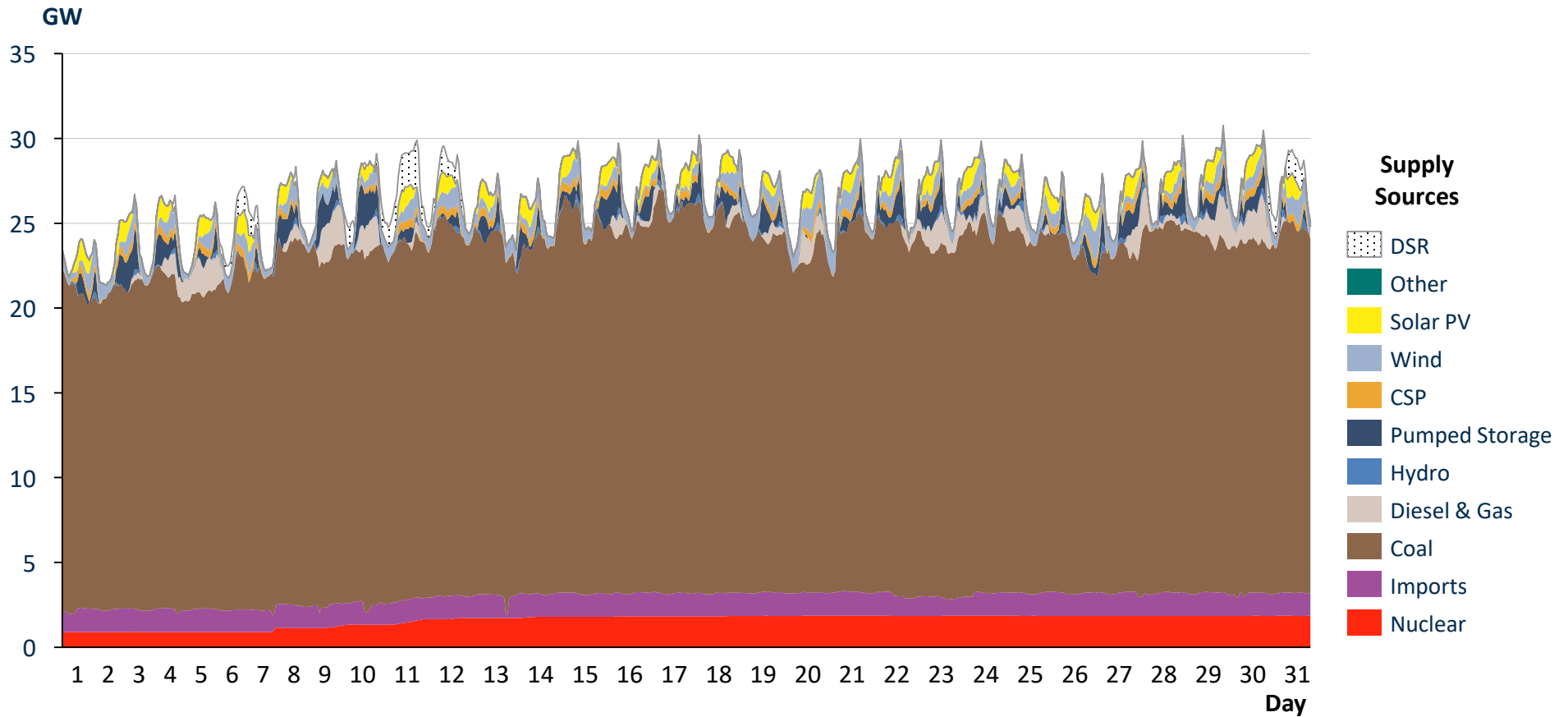
Diurnal Courses for renewable energy supply

Actual monthly average diurnal courses of solar PV, wind & CSP in RSA from Jan-Dec 2020



Hourly electricity production in Jan 2020

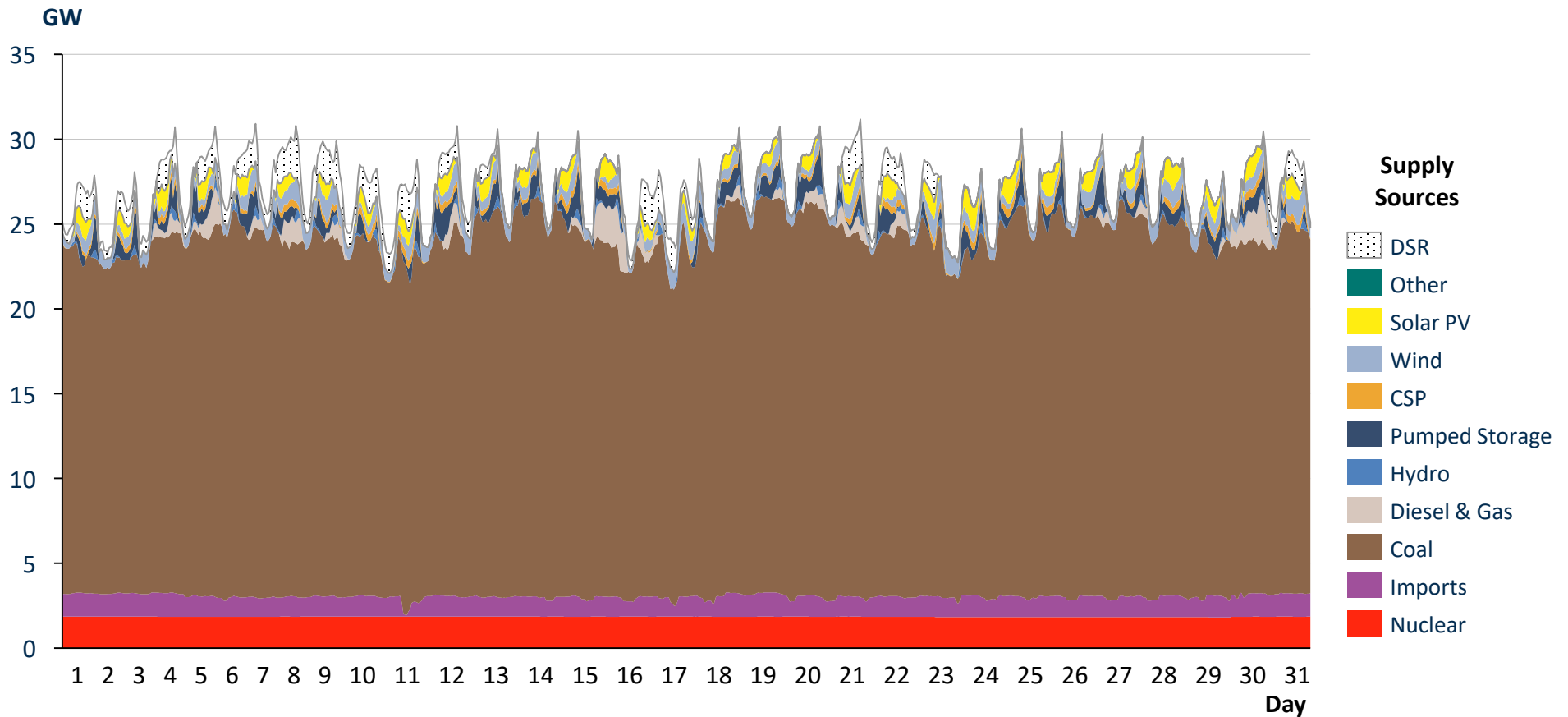
Actual hourly production from all power supply sources in RSA for January 2020



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

Hourly electricity production in Feb 2020

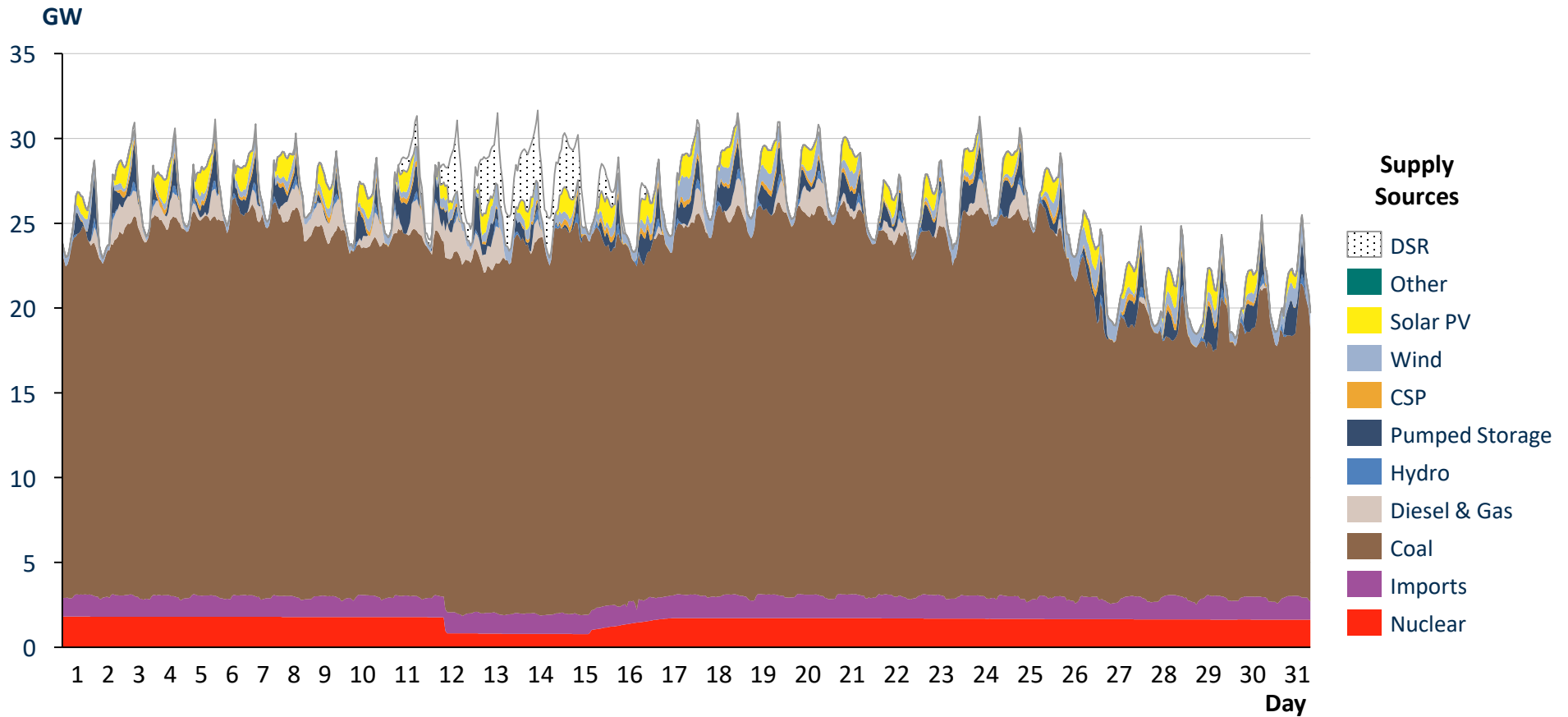
Actual hourly production from all power supply sources in RSA for February 2020



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

Hourly electricity production in Mar 2020

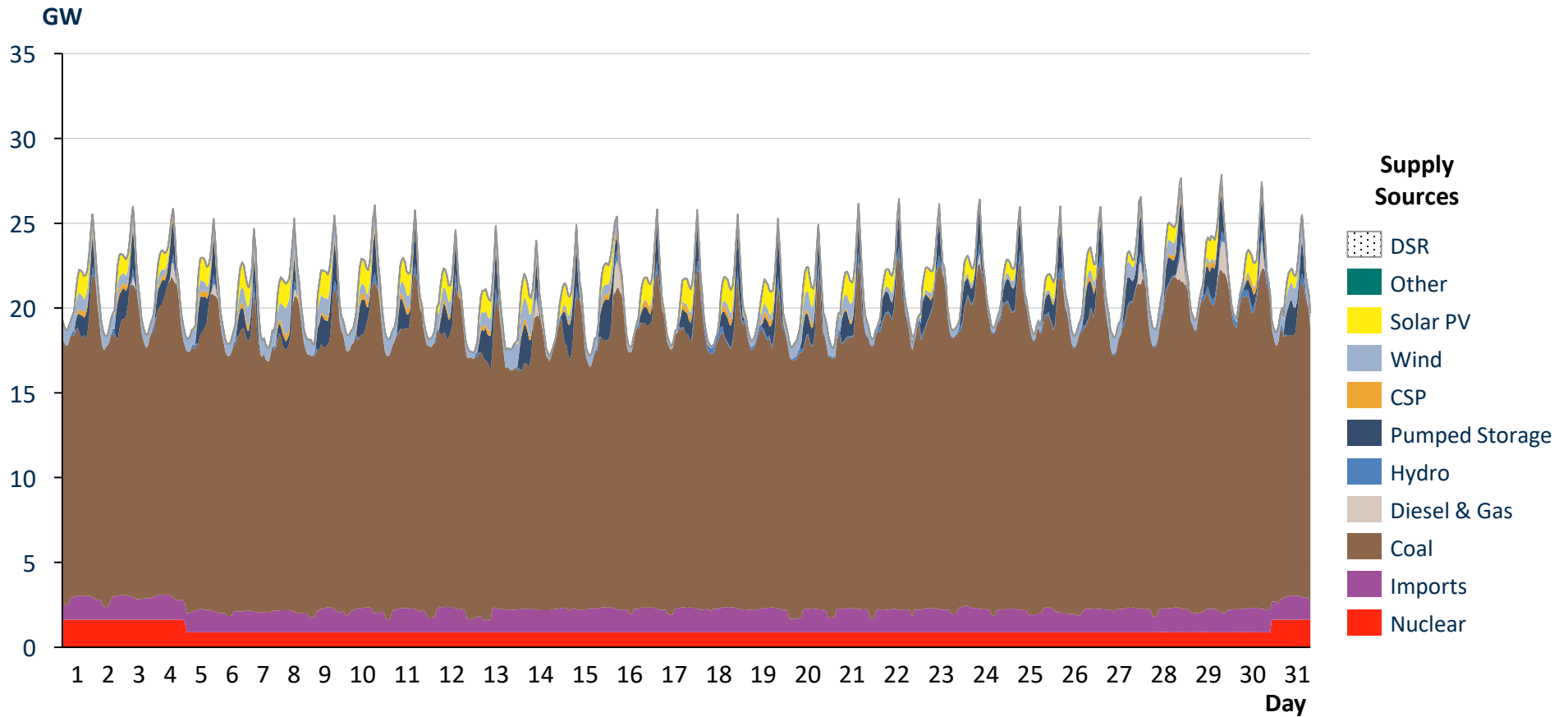
Actual hourly production from all power supply sources in RSA for March 2020



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

Hourly electricity production in Apr 2020

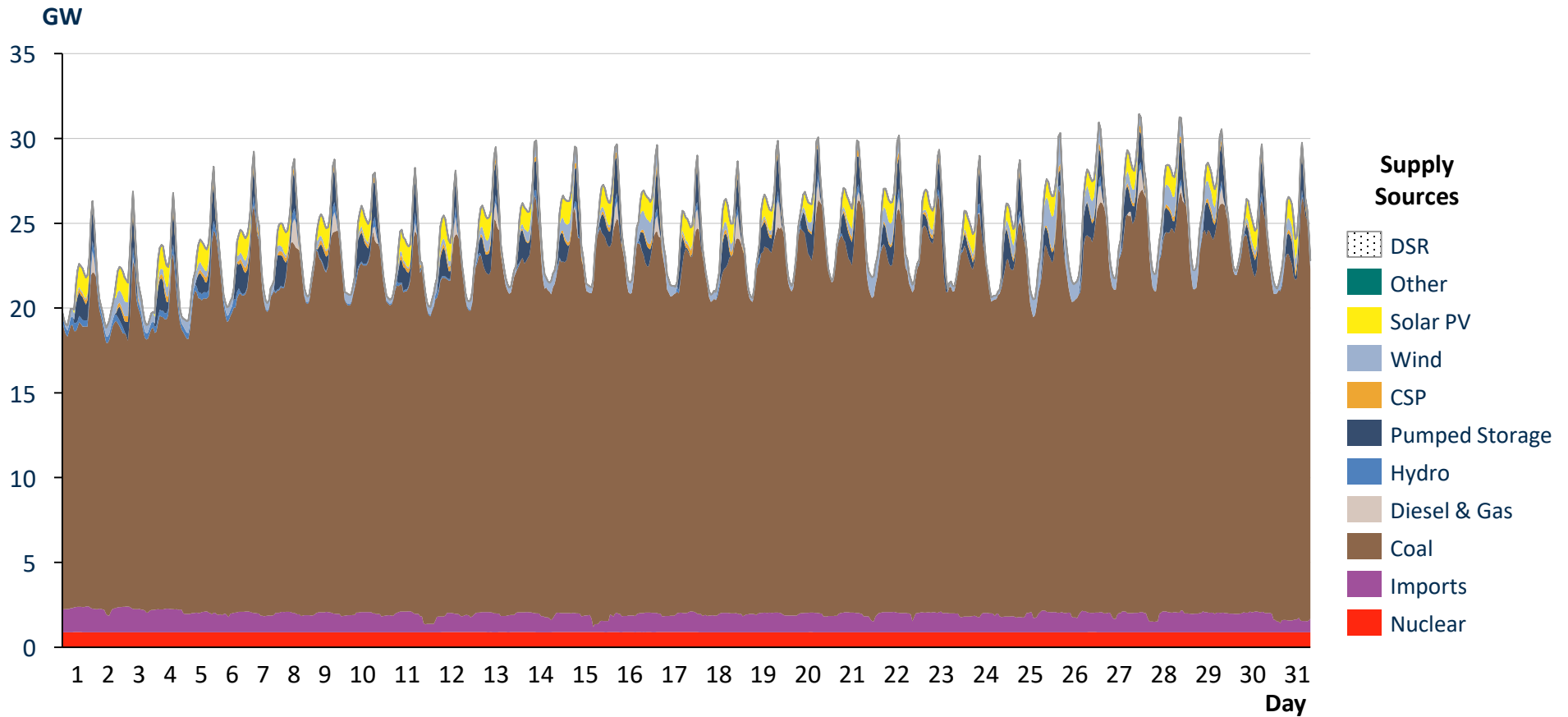
Actual hourly production from all power supply sources in RSA for April 2020



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

Hourly electricity production in May 2020

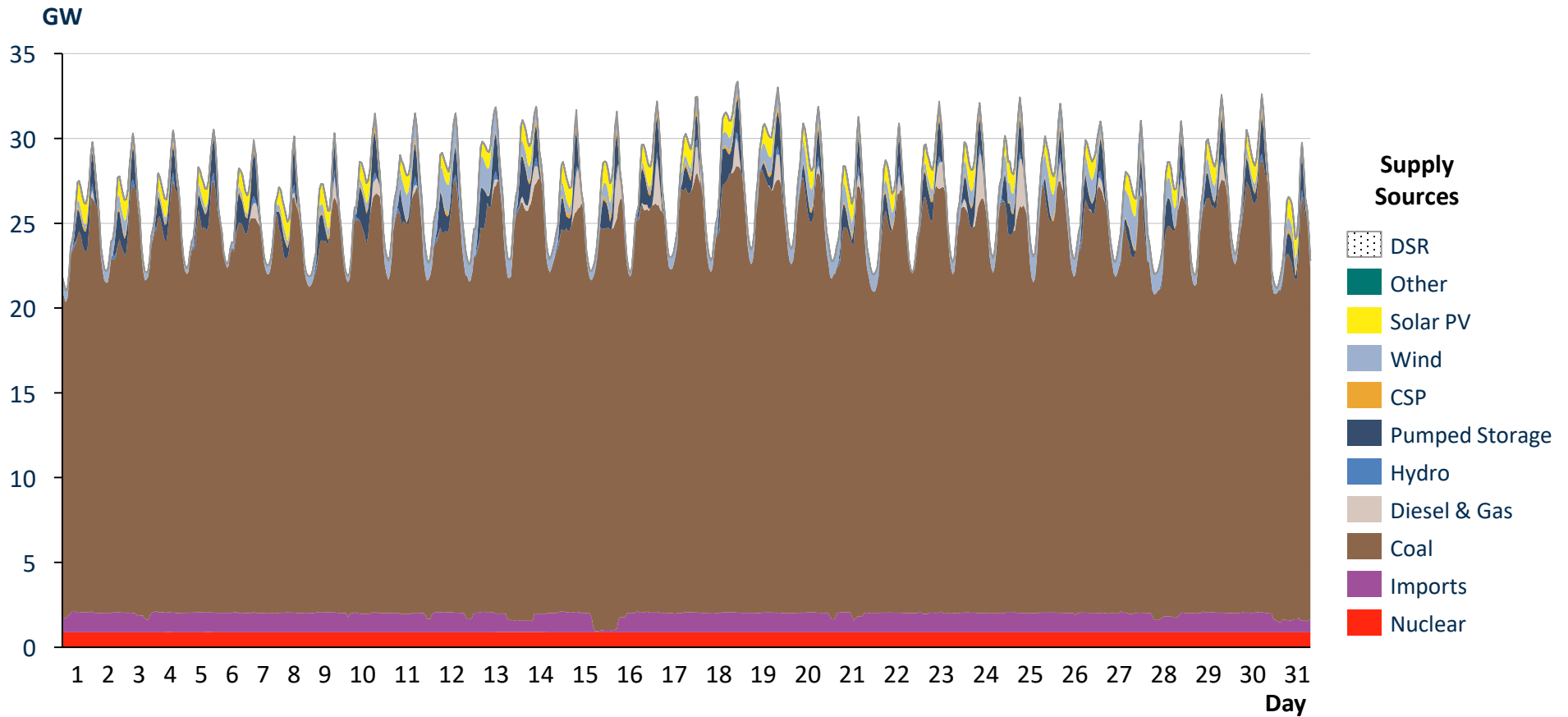
Actual hourly production from all power supply sources in RSA for May 2020



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

Hourly electricity production in Jun 2020

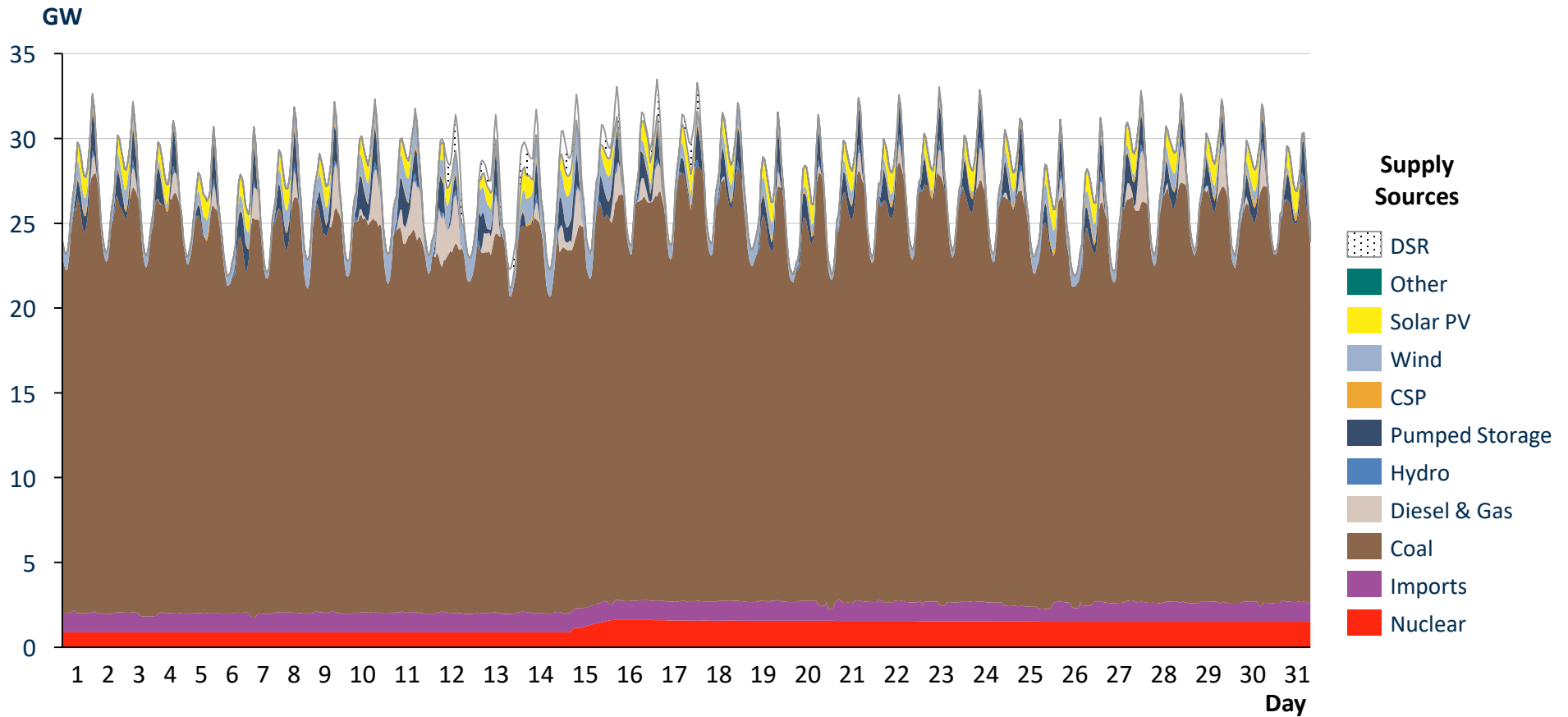
Actual hourly production from all power supply sources in RSA for June 2020



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

Hourly electricity production in Jul 2020

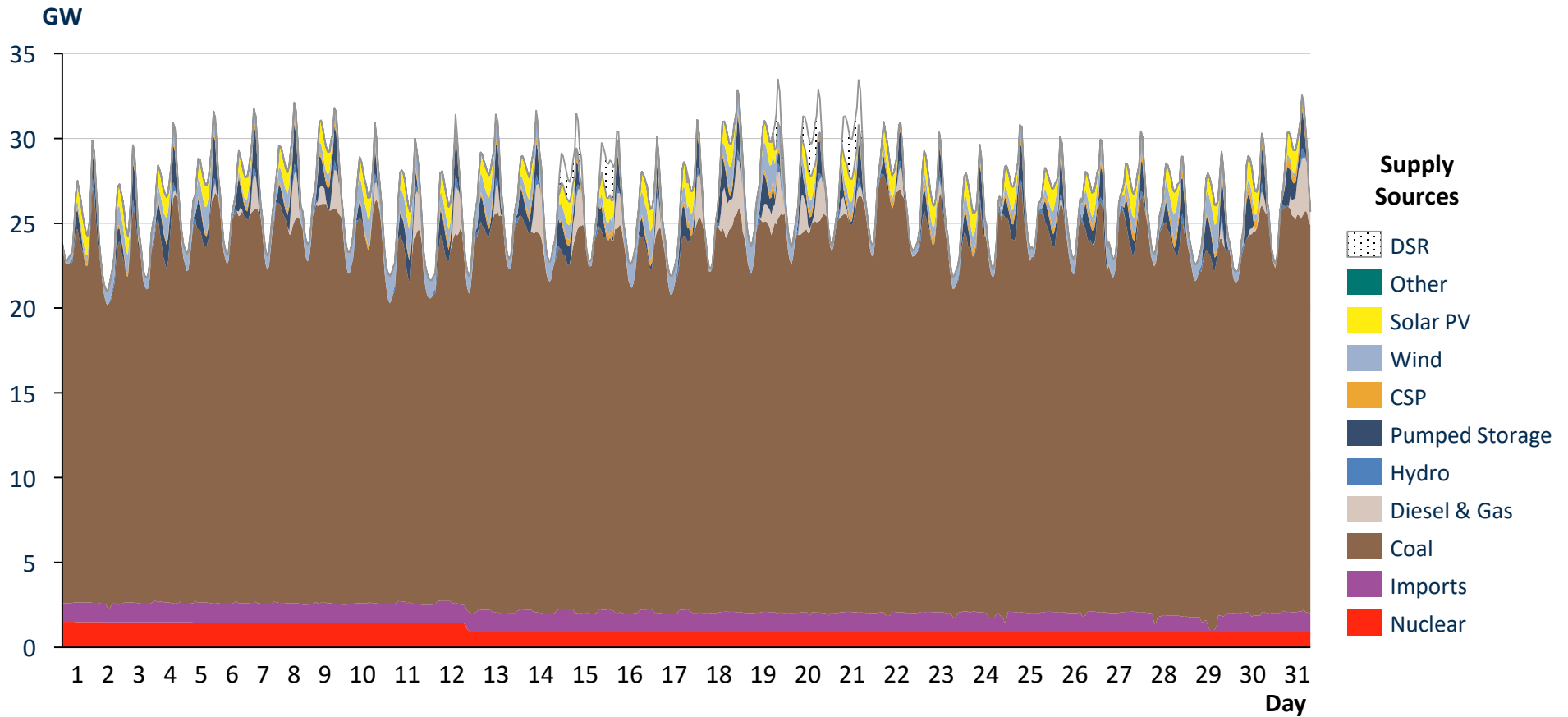
Actual hourly production from all power supply sources in RSA for July 2020



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

Hourly electricity production in Aug 2020

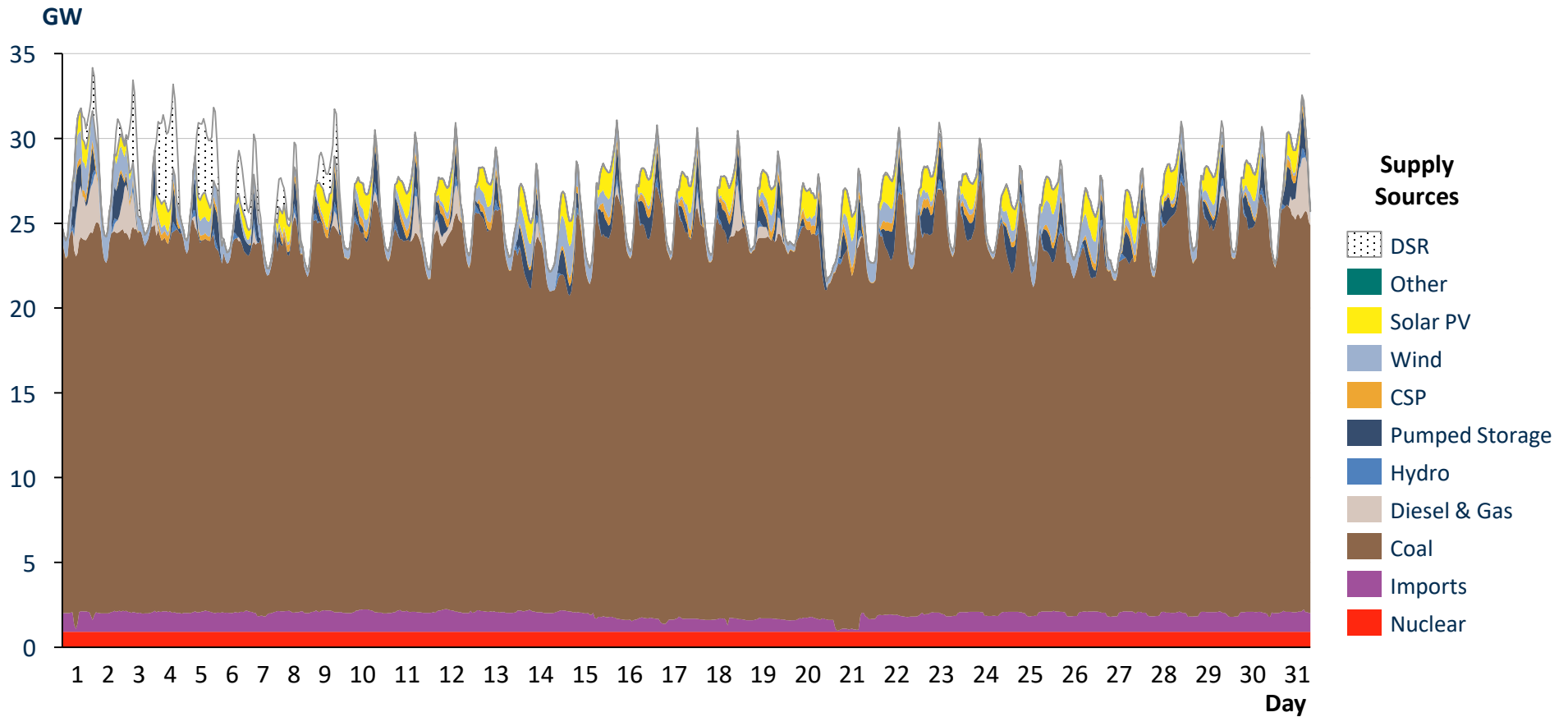
Actual hourly production from all power supply sources in RSA for August 2020



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

Hourly electricity production in Sep 2020

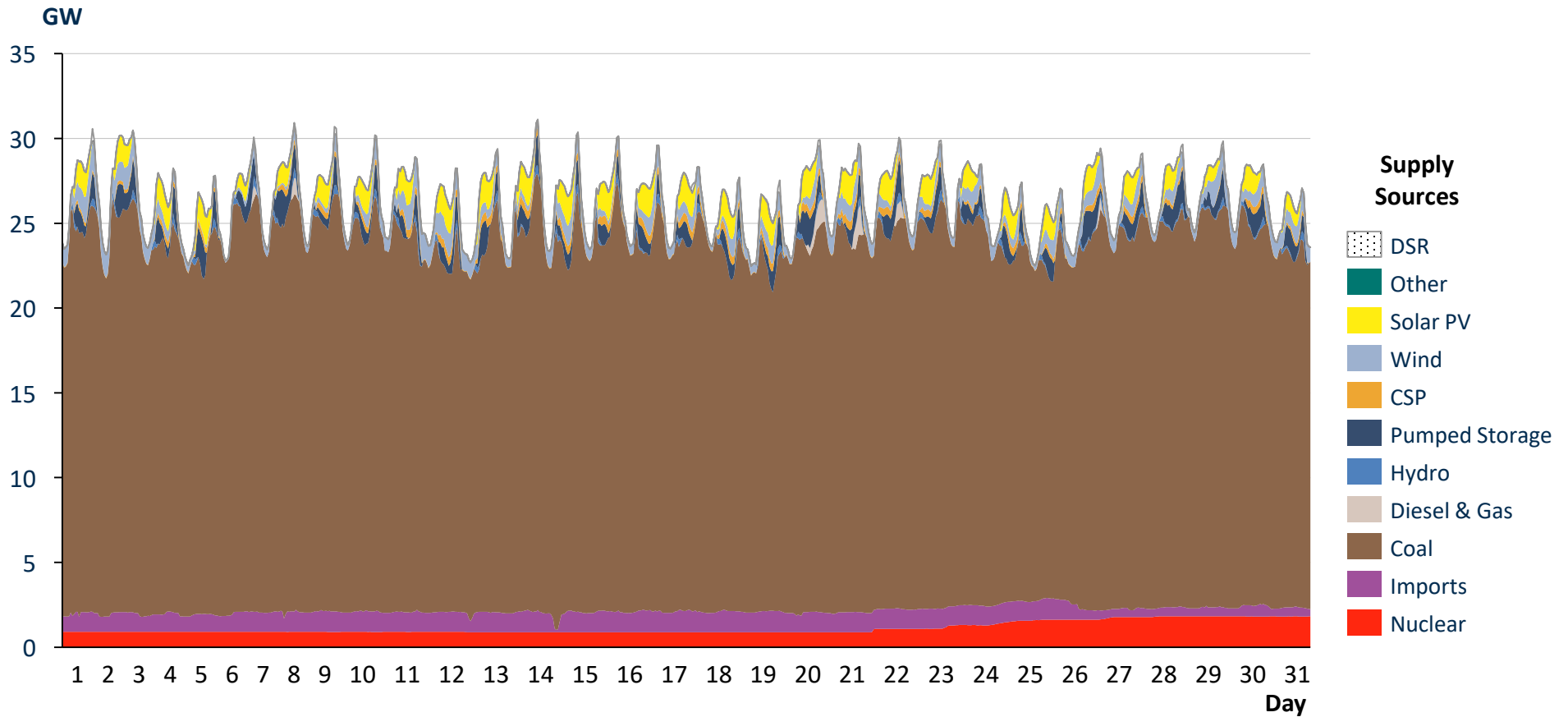
Actual hourly production from all power supply sources in RSA for September 2020



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

Hourly electricity production in Oct 2020

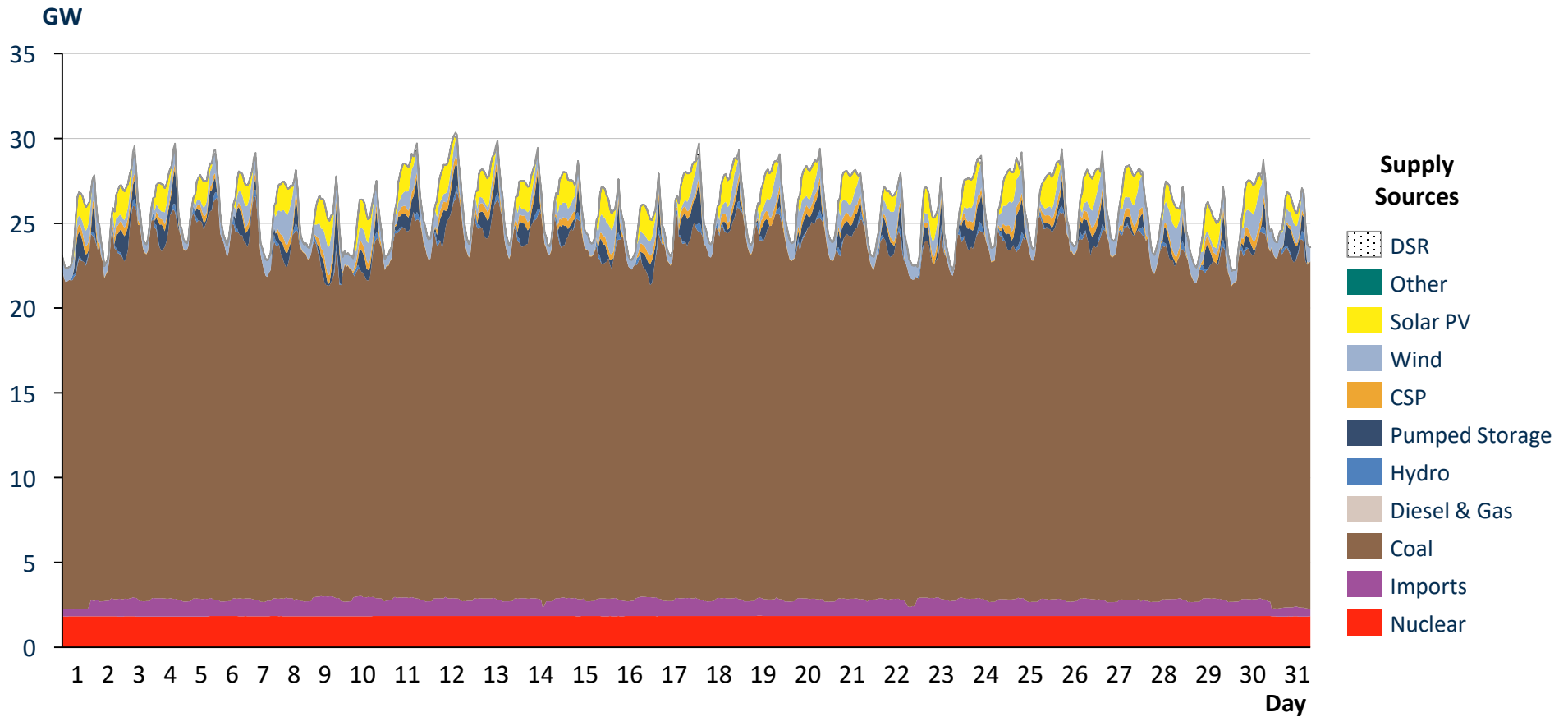
Actual hourly production from all power supply sources in RSA for October 2020



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

Hourly electricity production in Nov 2020

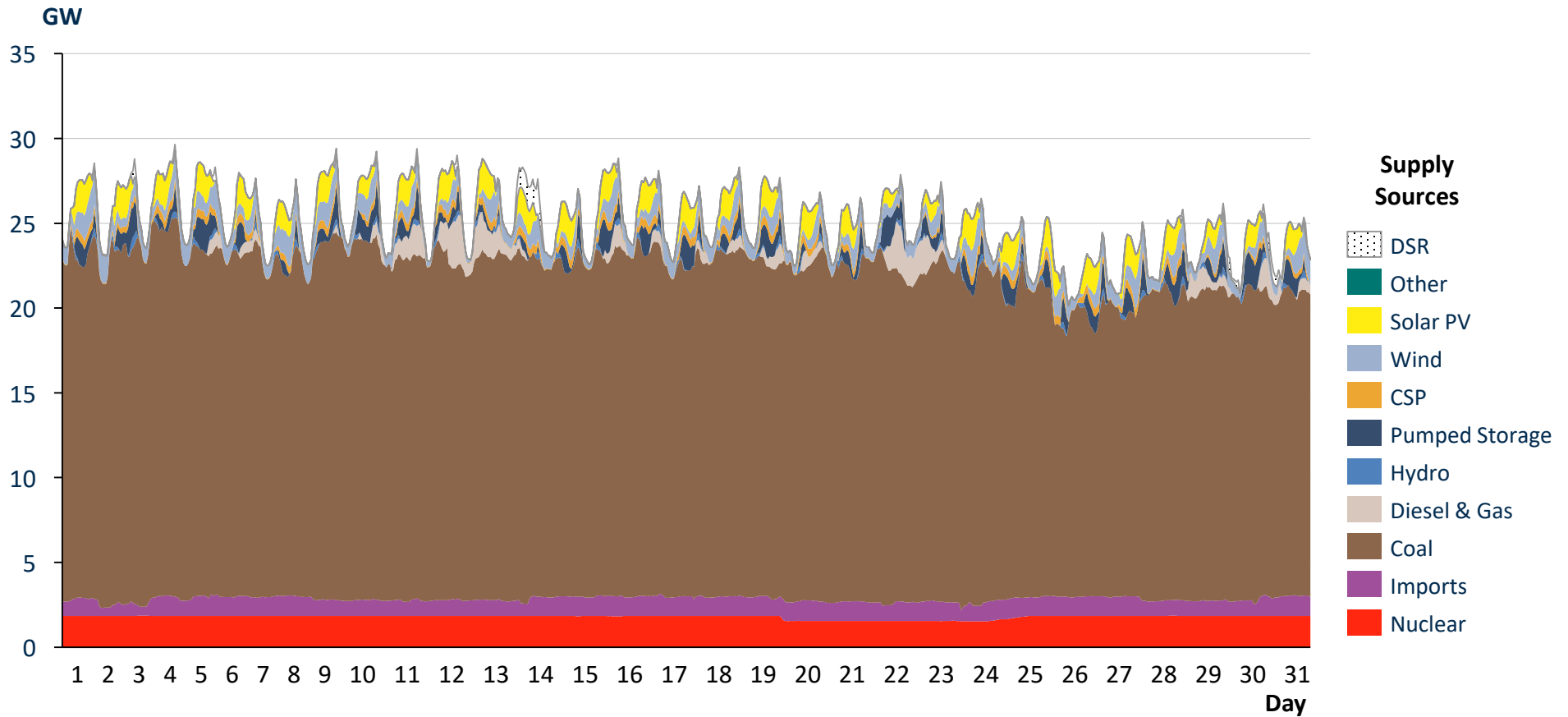
Actual hourly production from all power supply sources in RSA for November 2020



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

Hourly electricity production in Dec 2020

Actual hourly production from all power supply sources in RSA for December 2020

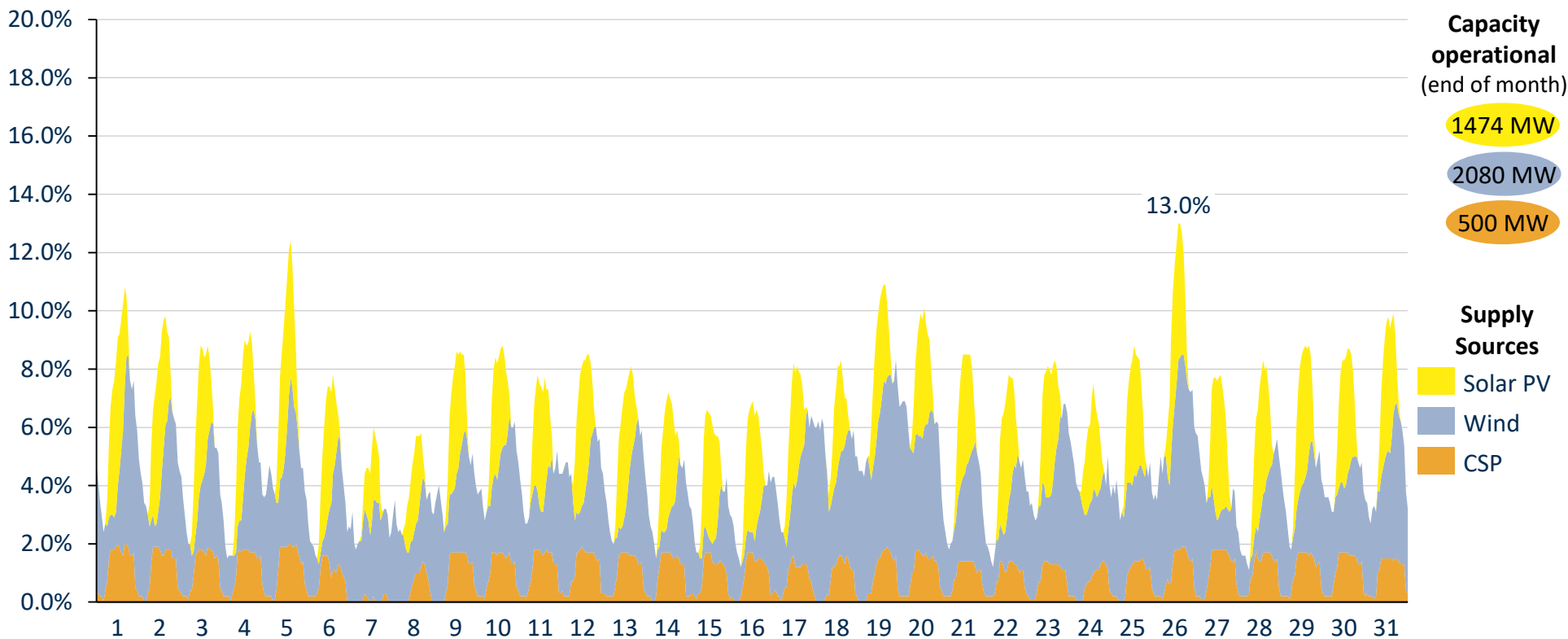


Note: Design as per Fraunhofer ISE. Daily production includes generation for pumping load. Wind includes Sere.
Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS)
Sources: Eskom; CSIR Energy Centre analysis

Hourly solar PV, wind & CSP contribution of 1.1-13.0% in Jan 2020

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

Relative hourly contribution

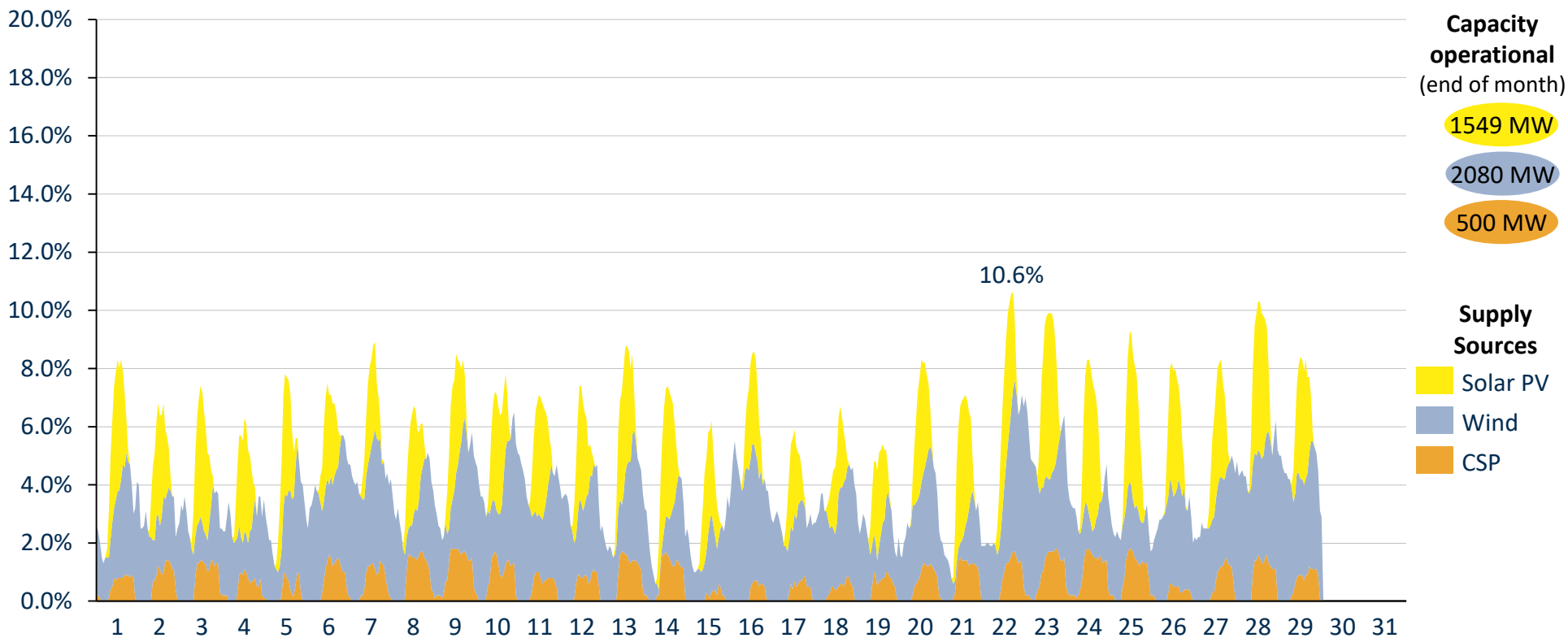


- Solar PV maximum relative contribution of 5.2% between 11h00 and 12h00 on 5 Jan 2020
- Wind maximum relative contribution of 6.9% between 22h00 and 23h00 on 19 Jan 2020
- CSP maximum relative contribution of 2.0% between 14h00 and 15h00 on 5 Jan 2020

Hourly solar PV, wind & CSP contribution of 0.6-10.6% in Feb 2020

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

Relative hourly contribution

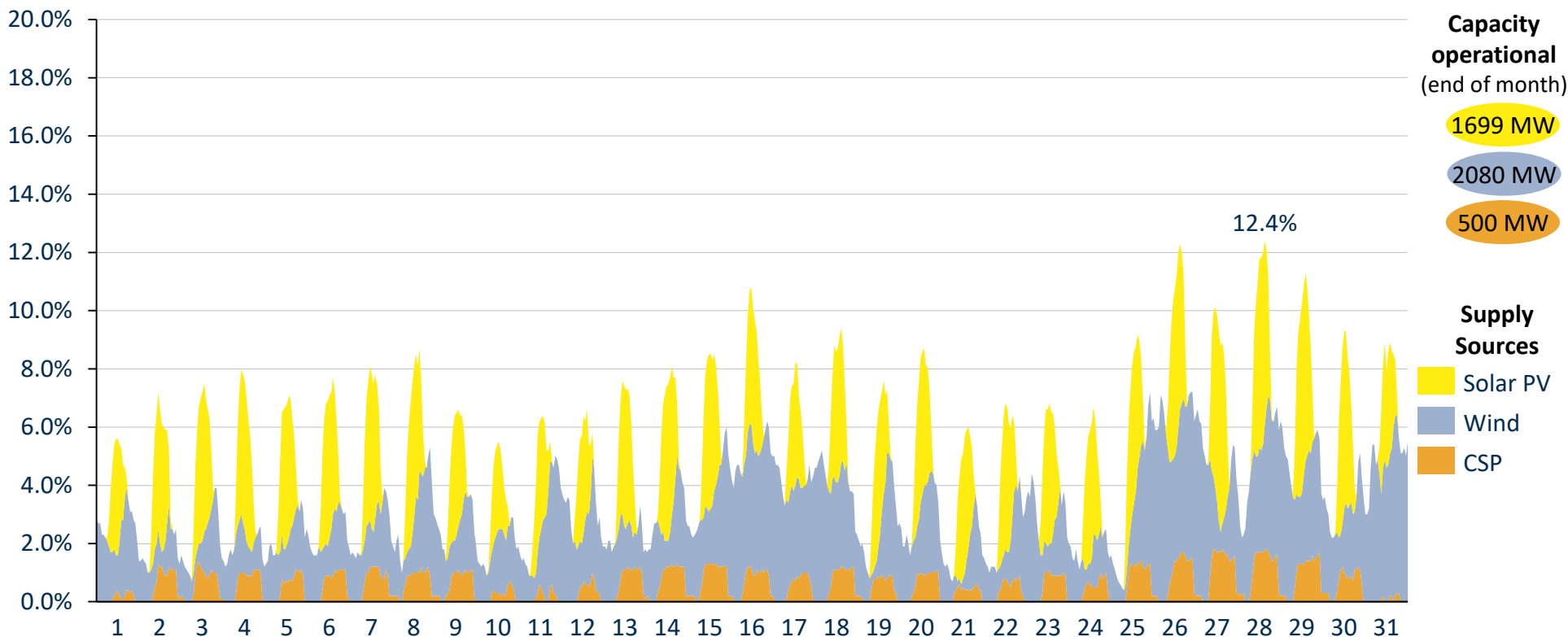


- Maximum solar PV relative contribution of 5.7% between 13h00 and 14h00 on 23 Feb 2020
- Maximum wind relative contribution of 6.8% between 23h00 and 00h00 on 23 Feb 2020
- Maximum CSP relative contribution of 1.8% between 13h00 and 14h00 on 23 Feb 2020

Hourly solar PV, wind & CSP contribution of 0.5-12.3% in Mar 2020

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

Relative hourly contribution

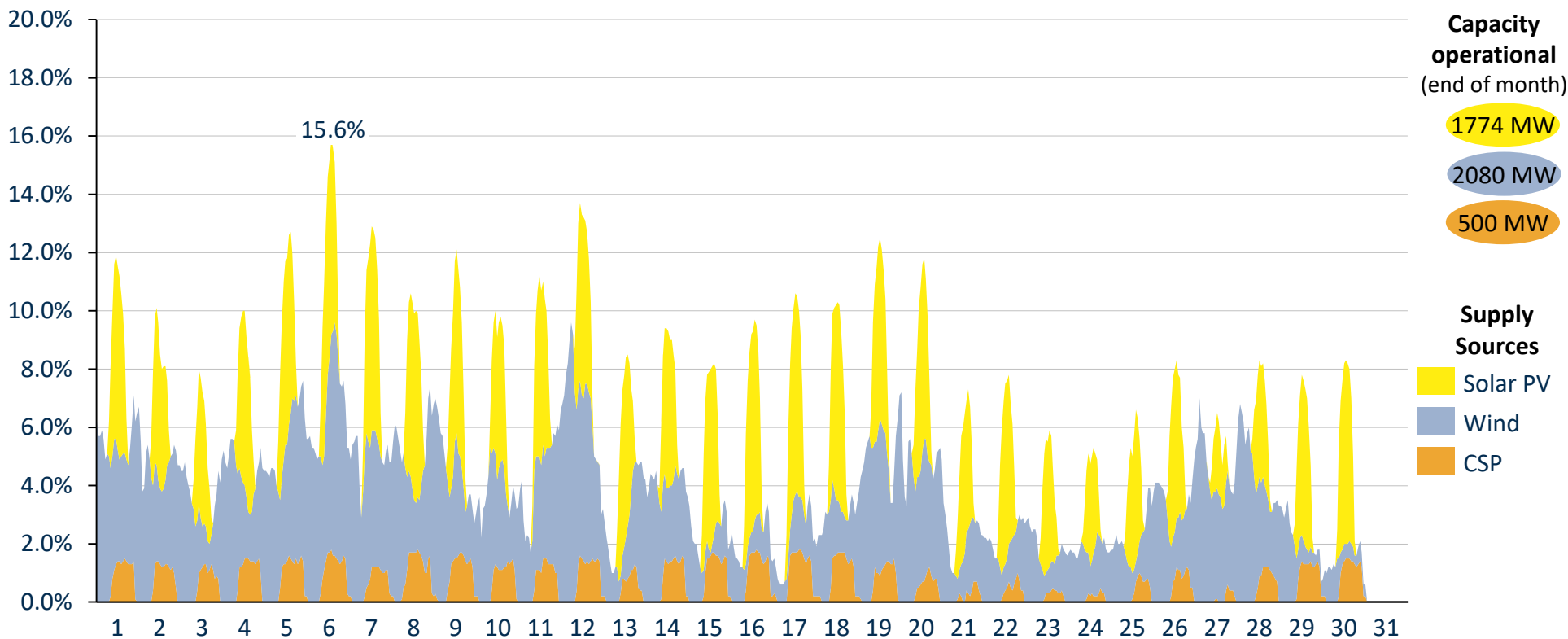


- Maximum solar PV relative contribution of 6.6% between 12h00 and 13h00 on 28 Mar 2020
- Maximum wind relative contribution of 7.1% between 03h00 and 04h00 on 26 Mar 2020
- Maximum CSP relative contribution of 1.8% between 15h00 and 16h00 on 28 Mar 2020

Hourly solar PV, wind & CSP contribution of 0.6-15.9% in Apr 2020

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

Relative hourly contribution

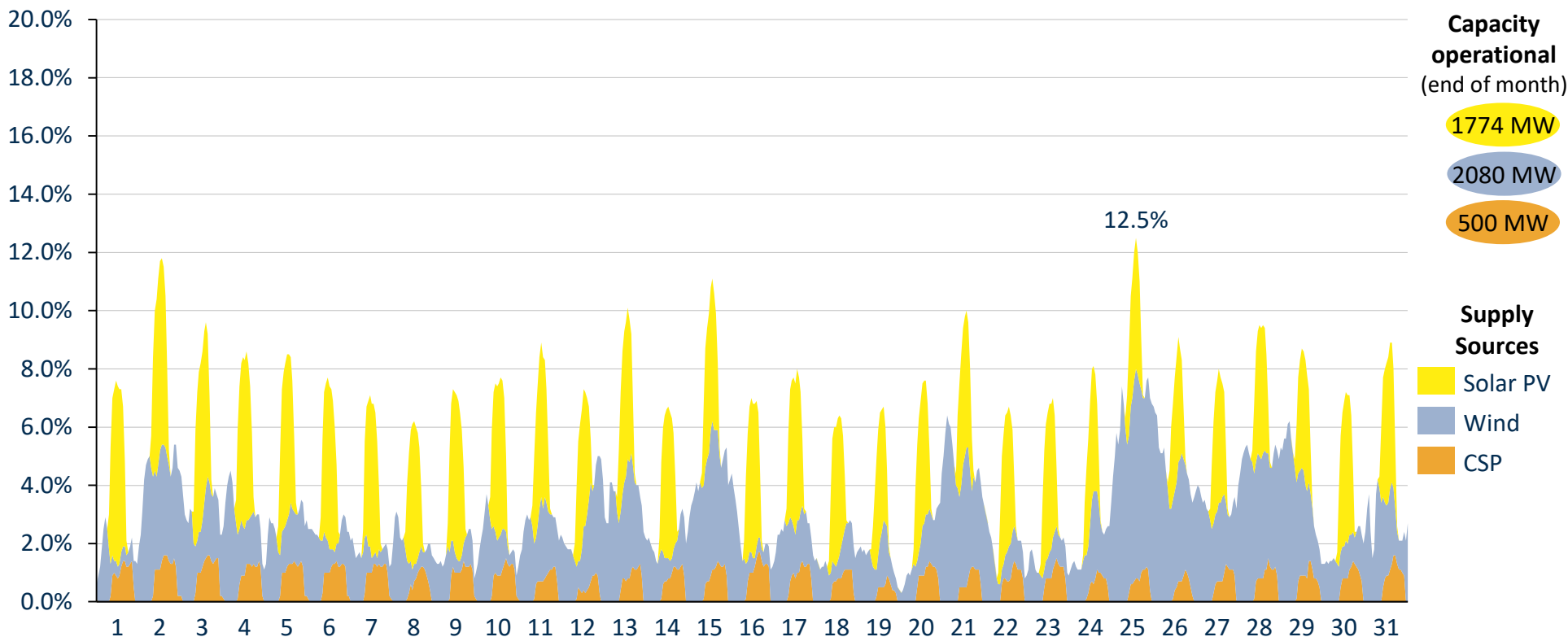


- Maximum solar PV relative contribution of 7.0% between 12h00 and 13h00 on 7 Apr 2020
- Maximum wind relative contribution of 9.6% between 05h00 and 06h00 on 12 Apr 2020
- Maximum CSP relative contribution of 1.8% between 15h00 and 16h00 on 17 Apr 2020

Hourly solar PV, wind & CSP contribution of 0.3-12.5% in May 2020

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

Relative hourly contribution

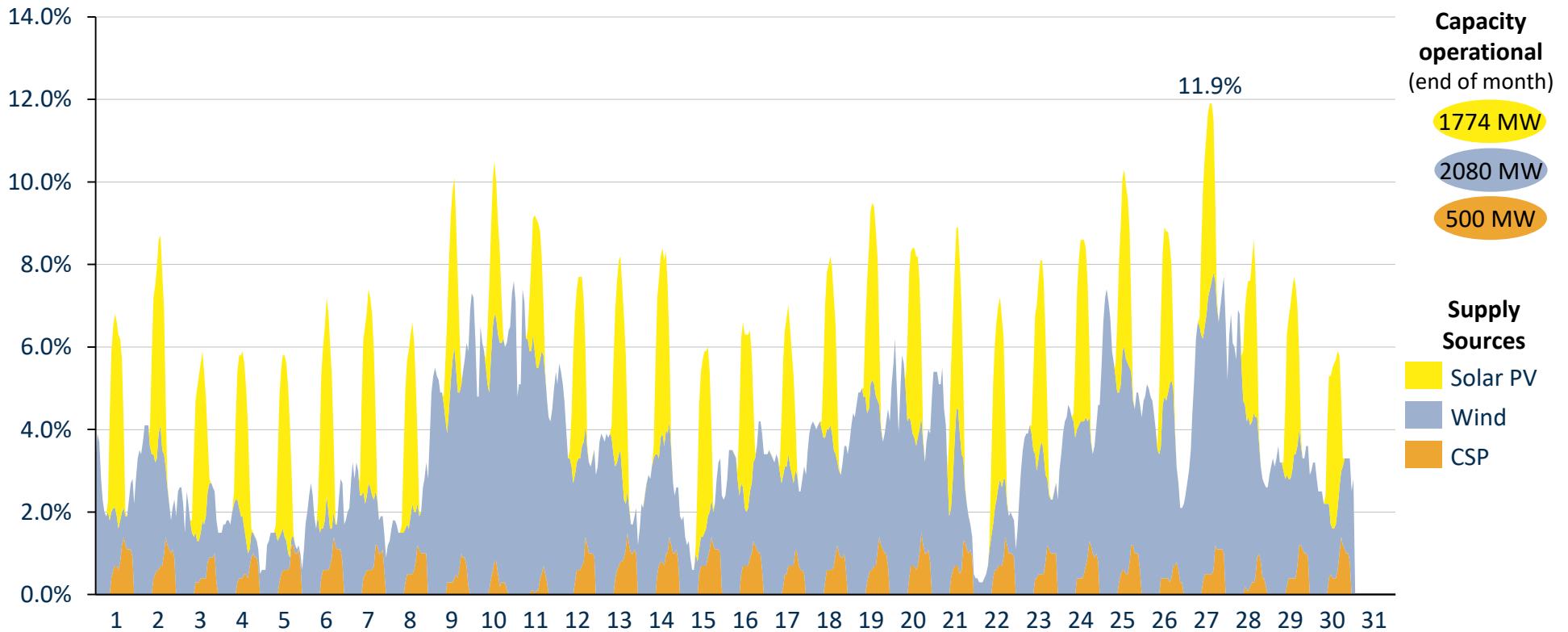


- Maximum solar PV relative contribution of 6.5% between 12h00 and 13h00 on 2 May 2020
- Maximum wind relative contribution of 7.4% between 05h00 and 06h00 on 25 May 2020
- Maximum CSP relative contribution of 1.7% between 16h00 and 17h00 on 16 May 2020

Hourly solar PV, wind & CSP contribution of 0.3-12.0% in Jun 2020

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

Relative hourly contribution

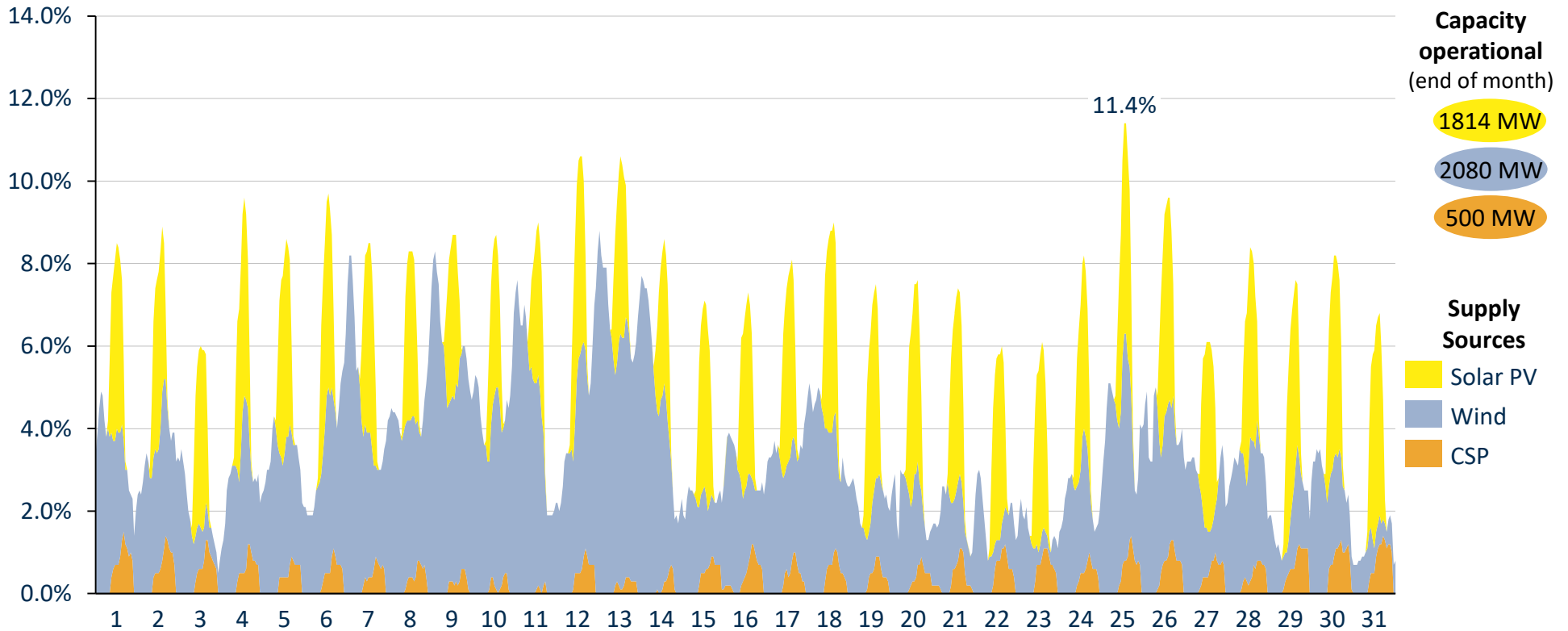


- Maximum solar PV relative contribution of 4.8% between 12h00 and 13h00 on 6 Jun 2020
- Maximum wind relative contribution of 7.6% between 23h00 and 00h00 on 11 Jun 2020
- Maximum CSP relative contribution of 1.5% between 16h00 and 17h00 on 20 Jun 2020

Hourly solar PV, wind & CSP contribution of 0.5-11.4% in Jul 2020

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

Relative hourly contribution

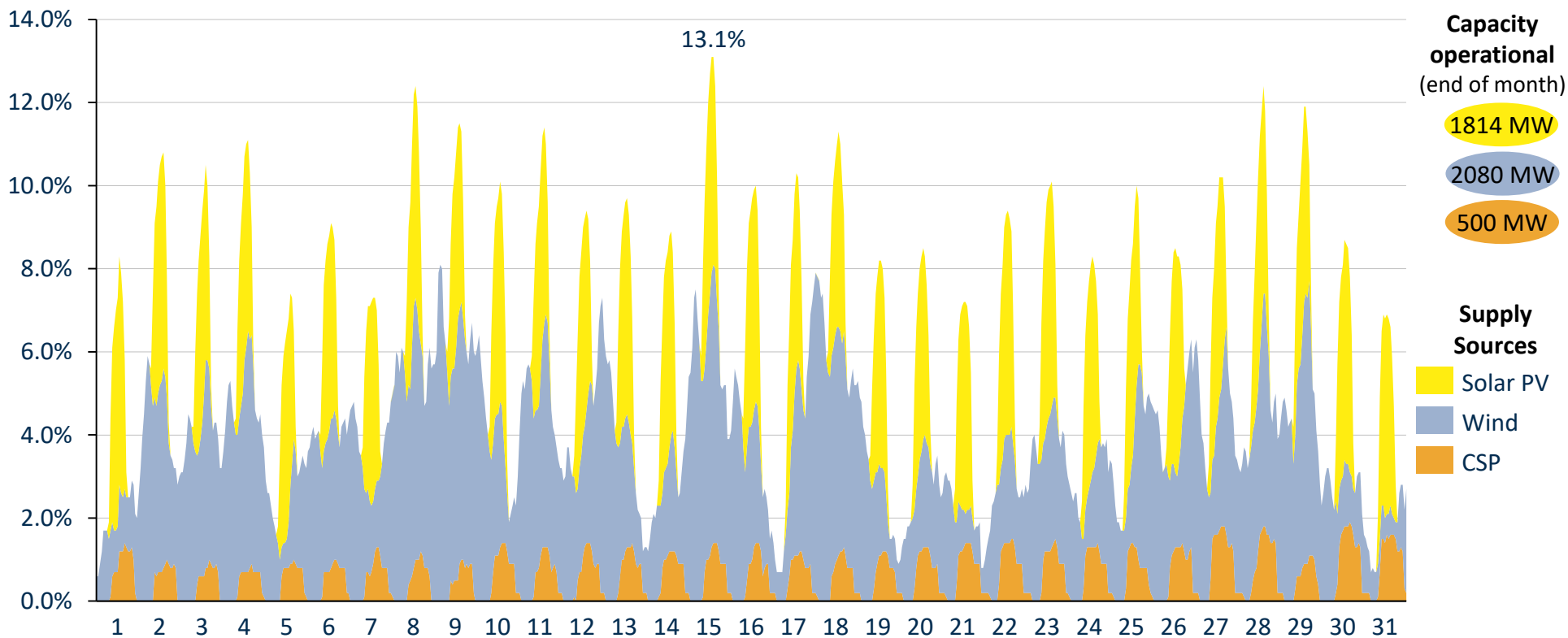


- Maximum solar PV relative contribution of 5.1% between 13h00 and 14h00 on 25 Jul 2020
- Maximum wind relative contribution of 8.8% between 00h00 and 01h00 on 13 Jul 2020
- Maximum CSP relative contribution of 1.5% between 16h00 and 17h00 on 1 Jul 2020

Hourly solar PV, wind & CSP contribution of 0.6-13.1% in Aug 2020

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

Relative hourly contribution

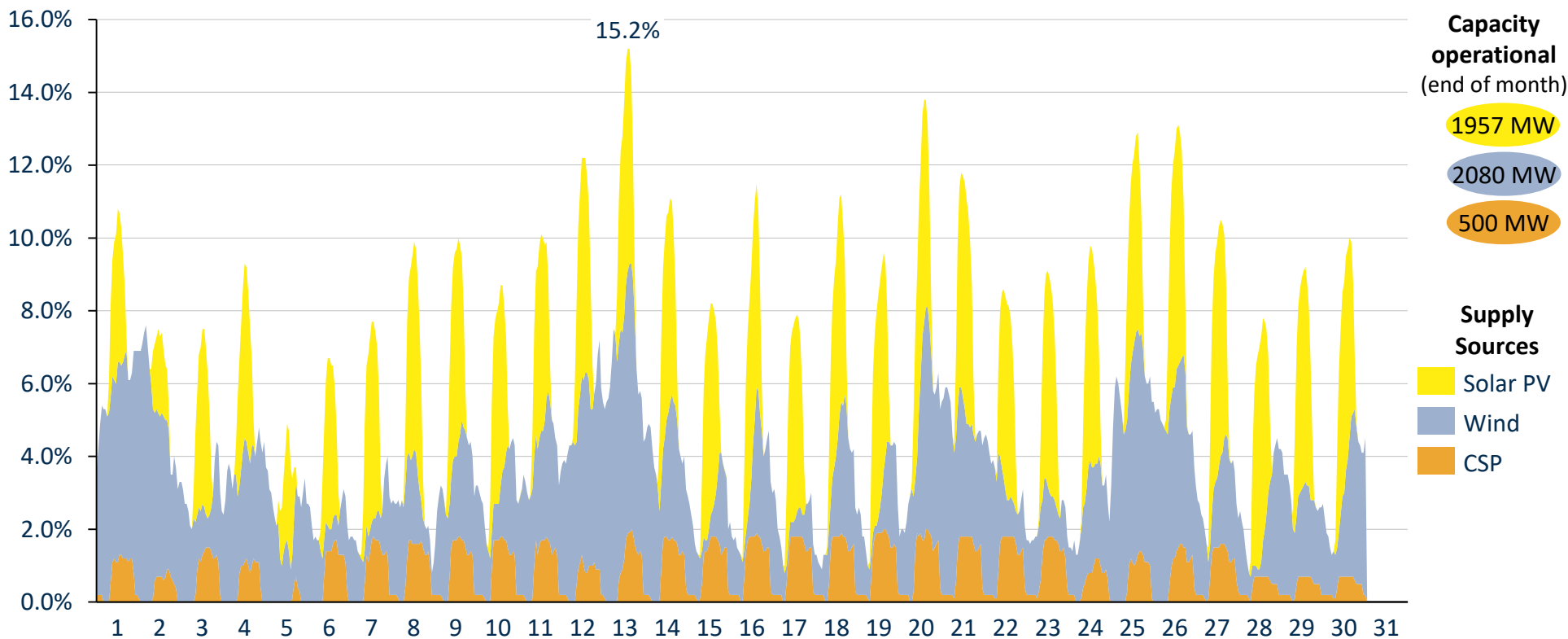


- Maximum solar PV relative contribution of 5.5% between 13h00 and 14h00 on 23 Aug 2020
- Maximum wind relative contribution of 8.1% between 03h00 and 04h00 on 9 Aug 2020
- Maximum CSP relative contribution of 1.9% between 15h00 and 16h00 on 30 Aug 2020

Hourly solar PV, wind & CSP contribution of 0.8-15.2% in Sep 2020

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

Relative hourly contribution



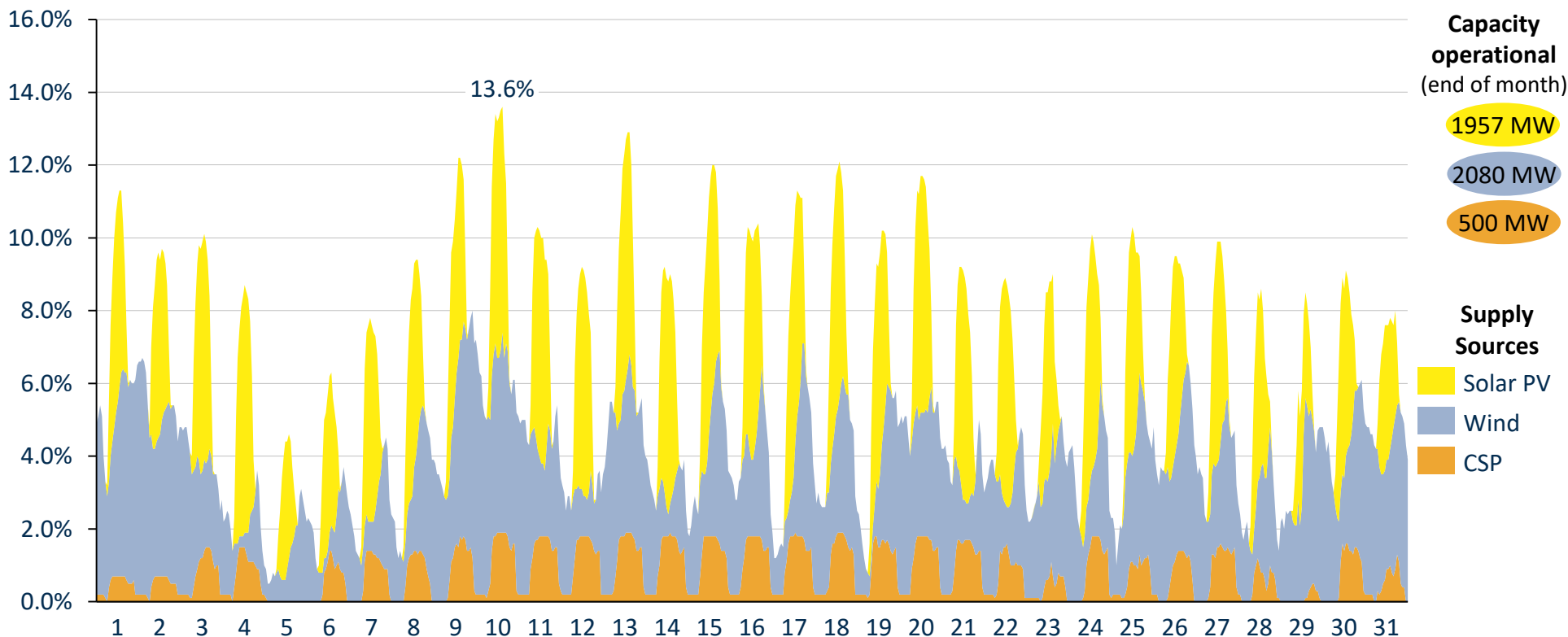
- Maximum solar PV relative contribution of 6.6% between 12h00 and 13h00 on 26 Sep 2020
- Maximum wind relative contribution of 7.6% between 04h00 and 05h00 on 2 Sep 2020
- Maximum CSP relative contribution of 2.0% between 14h00 and 15h00 on 20 Sep 2020

Sources: Eskom; CSIR Energy Centre analysis

Hourly solar PV, wind & CSP contribution of 0.5-13.7% in Oct 2020

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

Relative hourly contribution



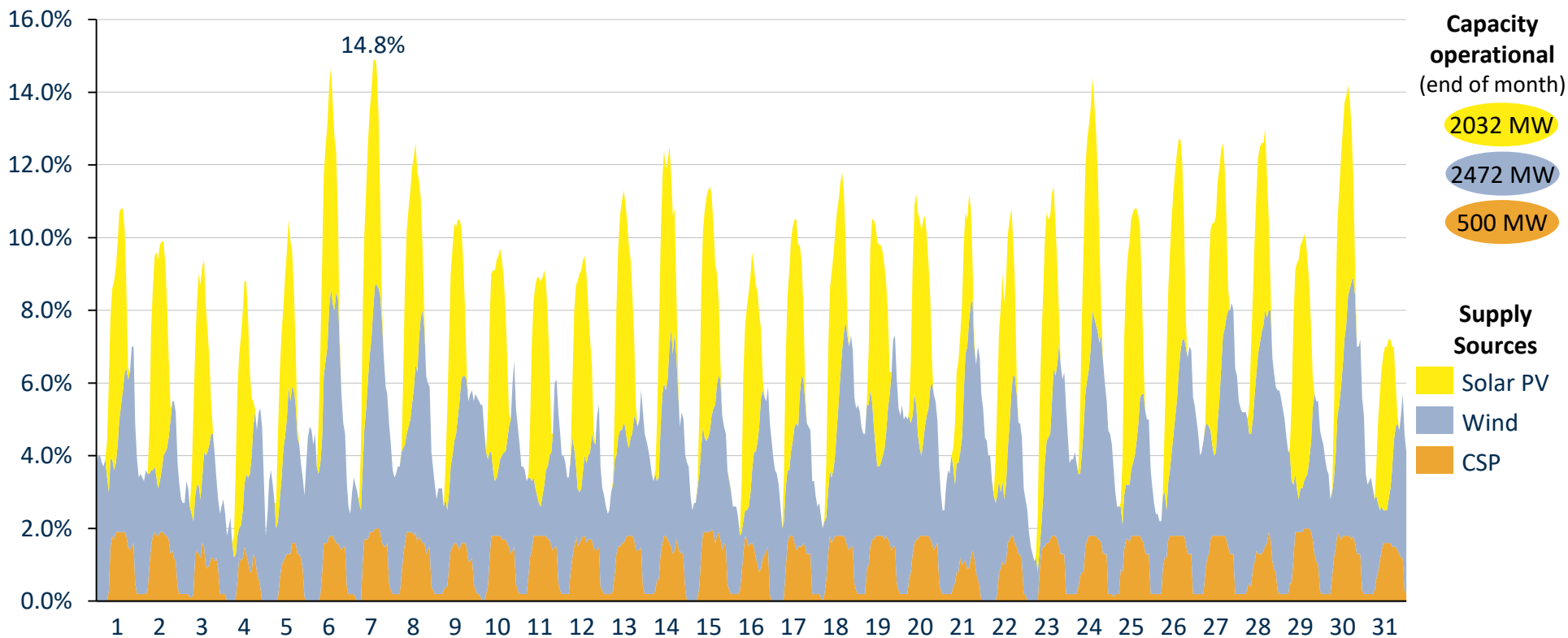
- Maximum solar PV relative contribution of 6.8% between 12h00 and 13h00 on 4 Oct 2020
- Maximum wind relative contribution of 7.0% between 23h00 and 00h00 on 10 Oct 2020
- Maximum CSP relative contribution of 1.9% between 15h00 and 16h00 on 10 Oct 2020

Sources: Eskom; CSIR Energy Centre analysis

Hourly solar PV, wind & CSP contribution of 1.1-15.2% in Nov 2020

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

Relative hourly contribution

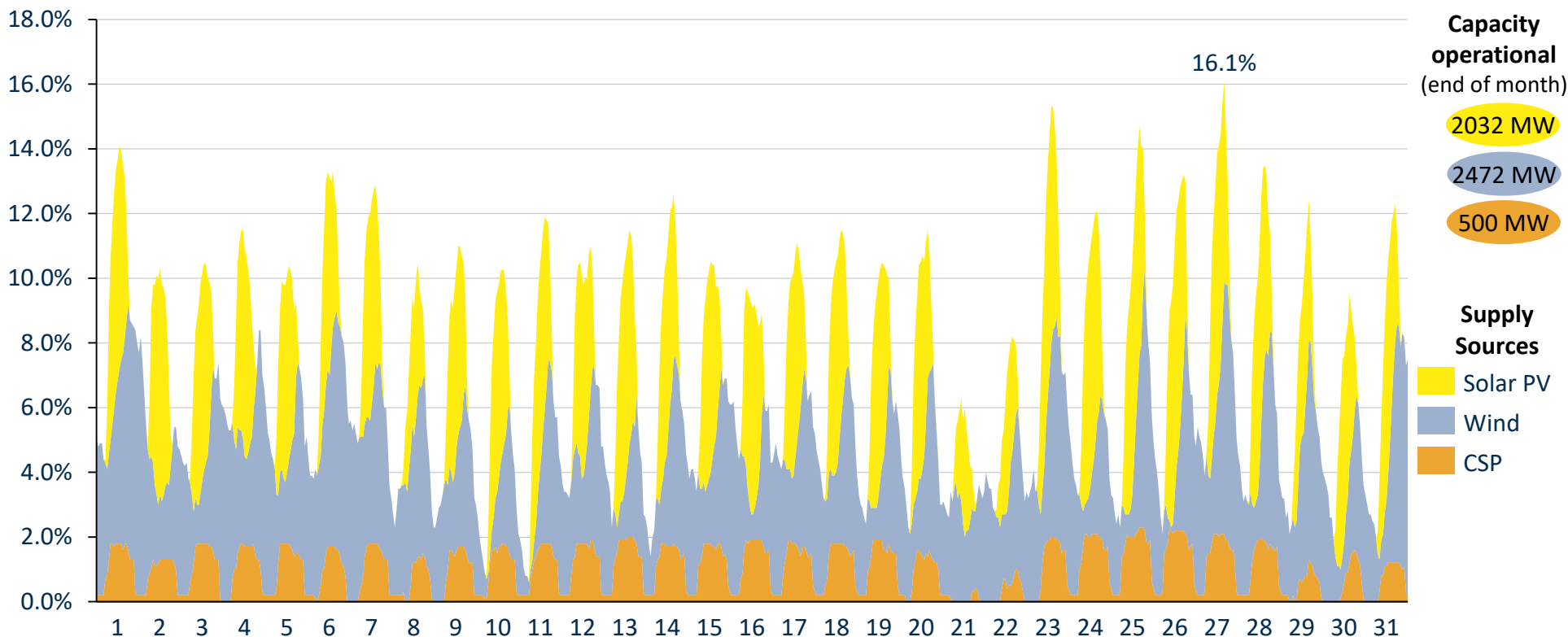


- Maximum solar PV relative contribution of 6.9% between 12h00 and 13h00 on 25 Nov 2020
- Maximum wind relative contribution of 7.1% between 16h00 and 17h00 on 30 Nov 2020
- Maximum CSP relative contribution of 2.0% between 15h00 and 16h00 on 29 Nov 2020

Hourly solar PV, wind & CSP contribution of 0.7-16.0% in Dec 2020

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

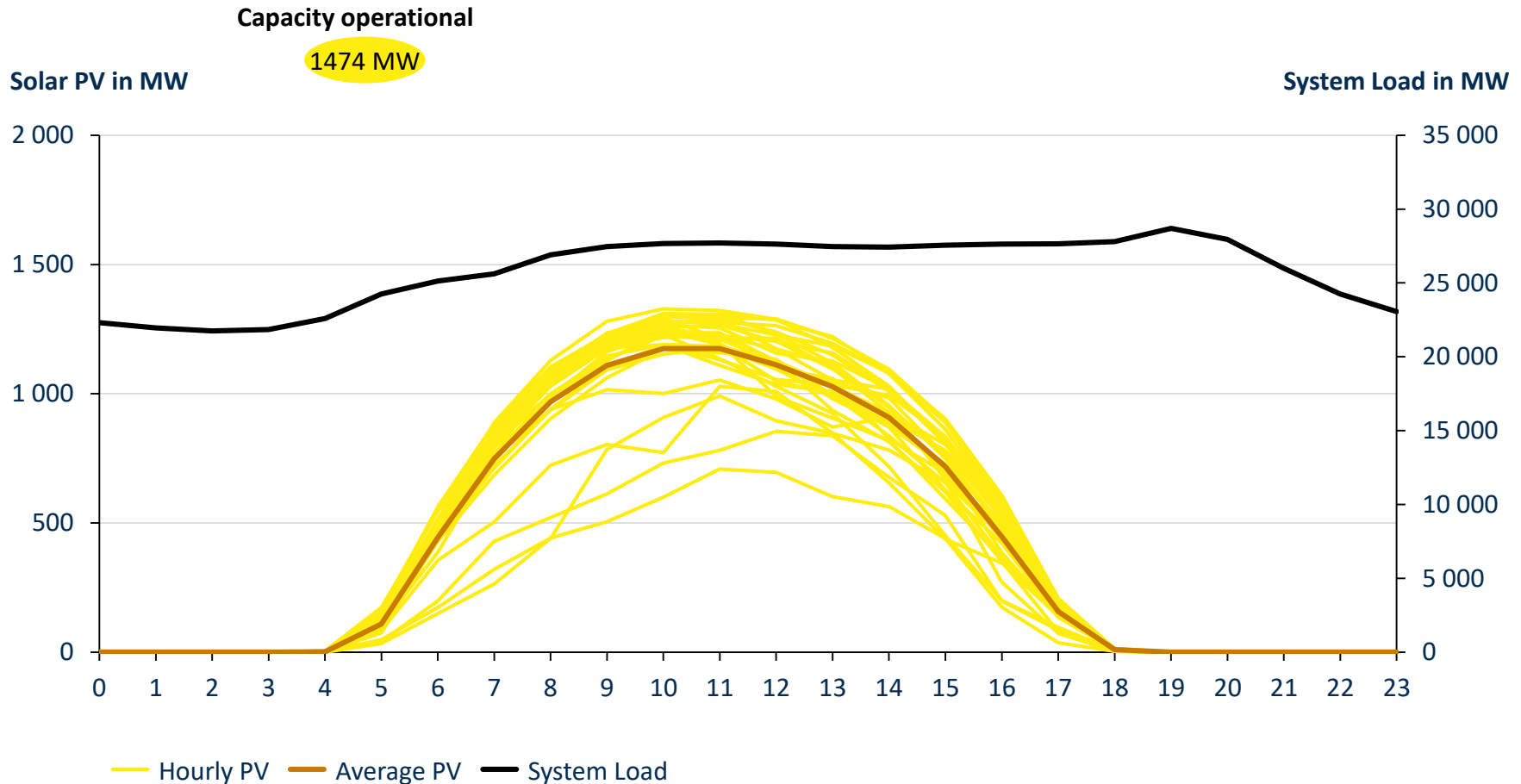
Relative hourly contribution



- Maximum solar PV relative contribution of 7.9% between 12h00 and 13h00 on 26 Dec 2020
- Maximum wind relative contribution of 8.1% between 18h00 and 19h00 on 25 Dec 2020
- Maximum CSP relative contribution of 2.3% between 16h00 and 17h00 on 25 Dec 2020

Solar PV supply in Jan 2020 was very stable

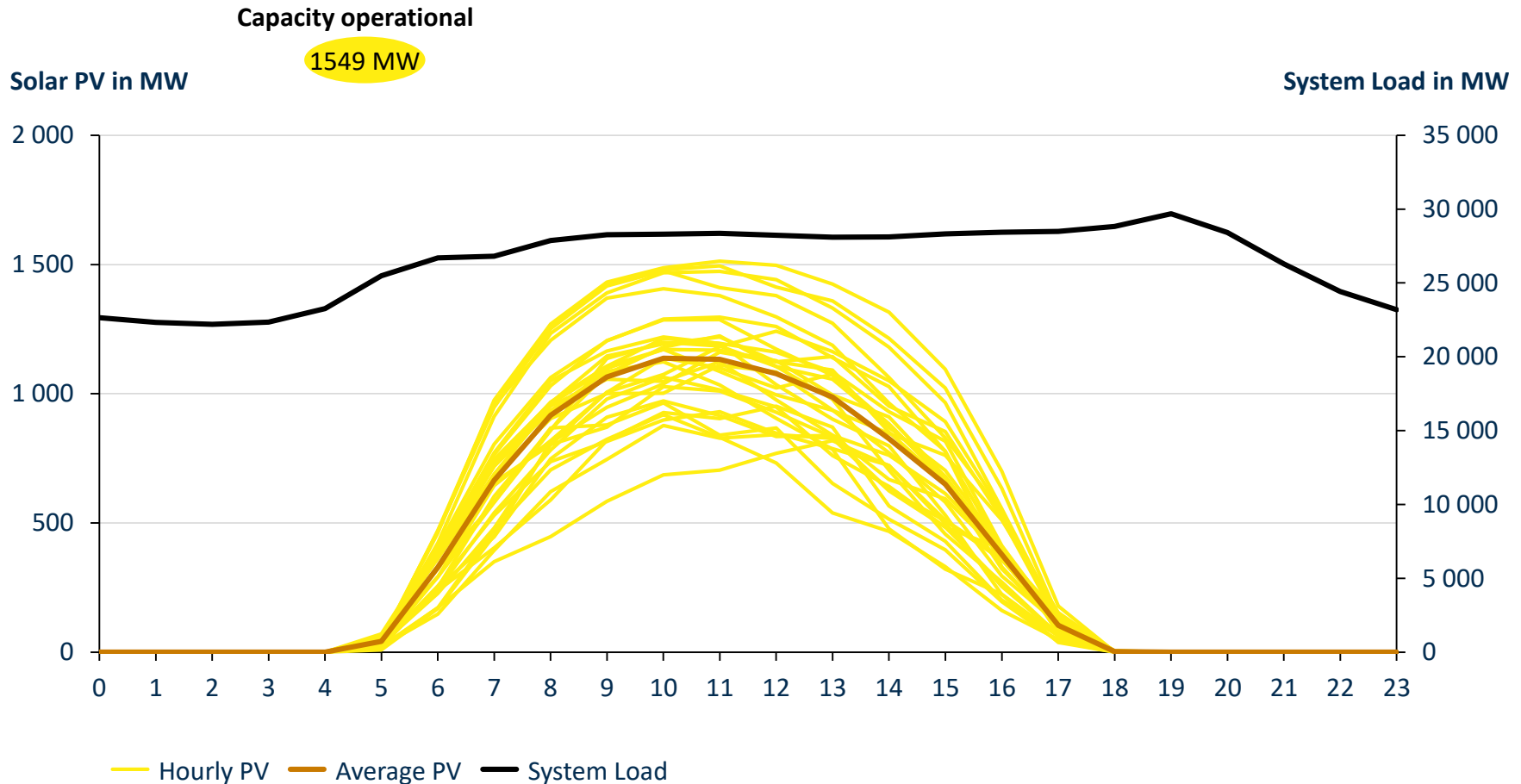
Hourly solar PV production for all 31 days of January 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Feb 2020 was very stable

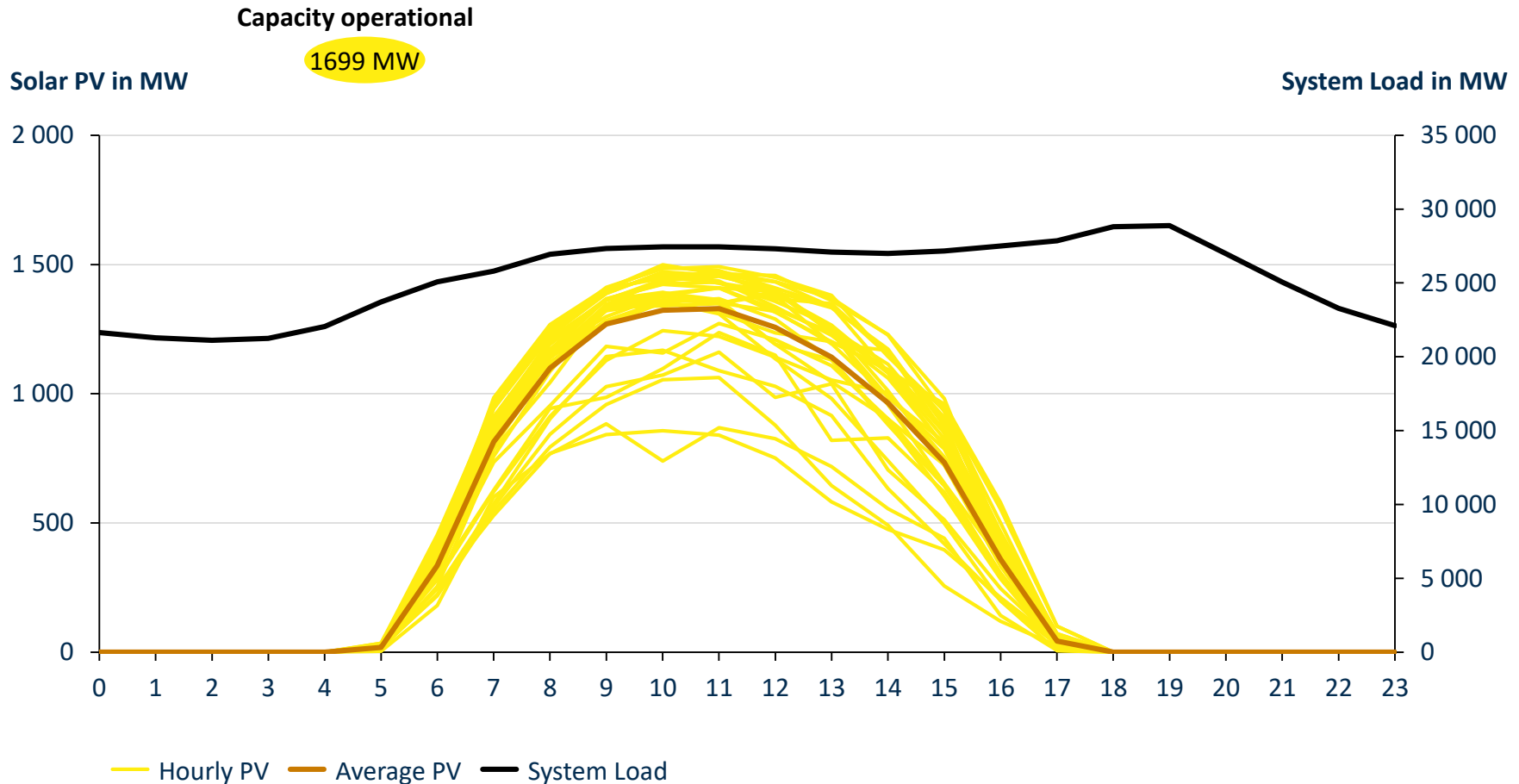
Hourly solar PV production for all 29 days of February 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Mar 2020 was very stable

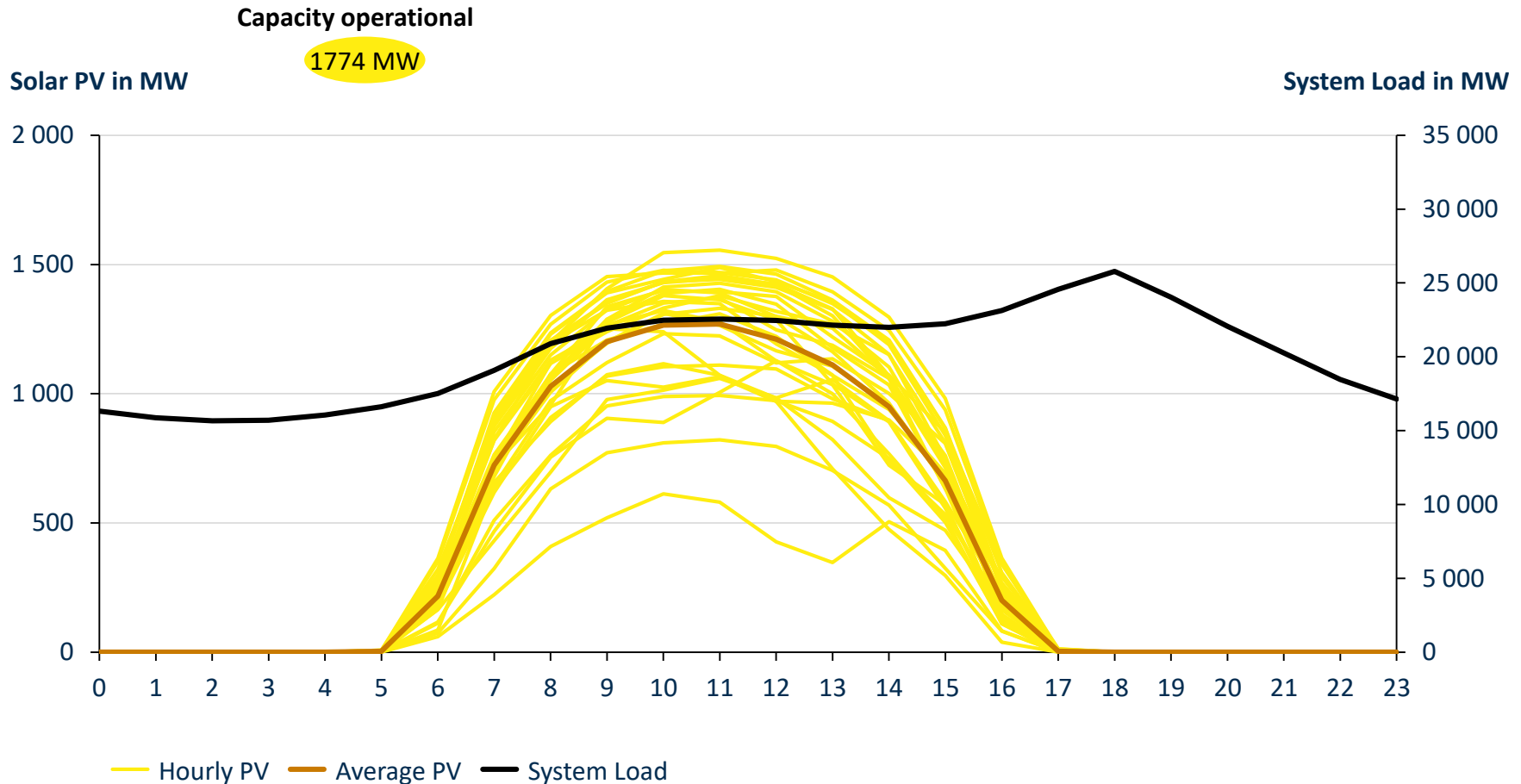
Hourly solar PV production for all 31 days of March 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Apr 2020 very stable

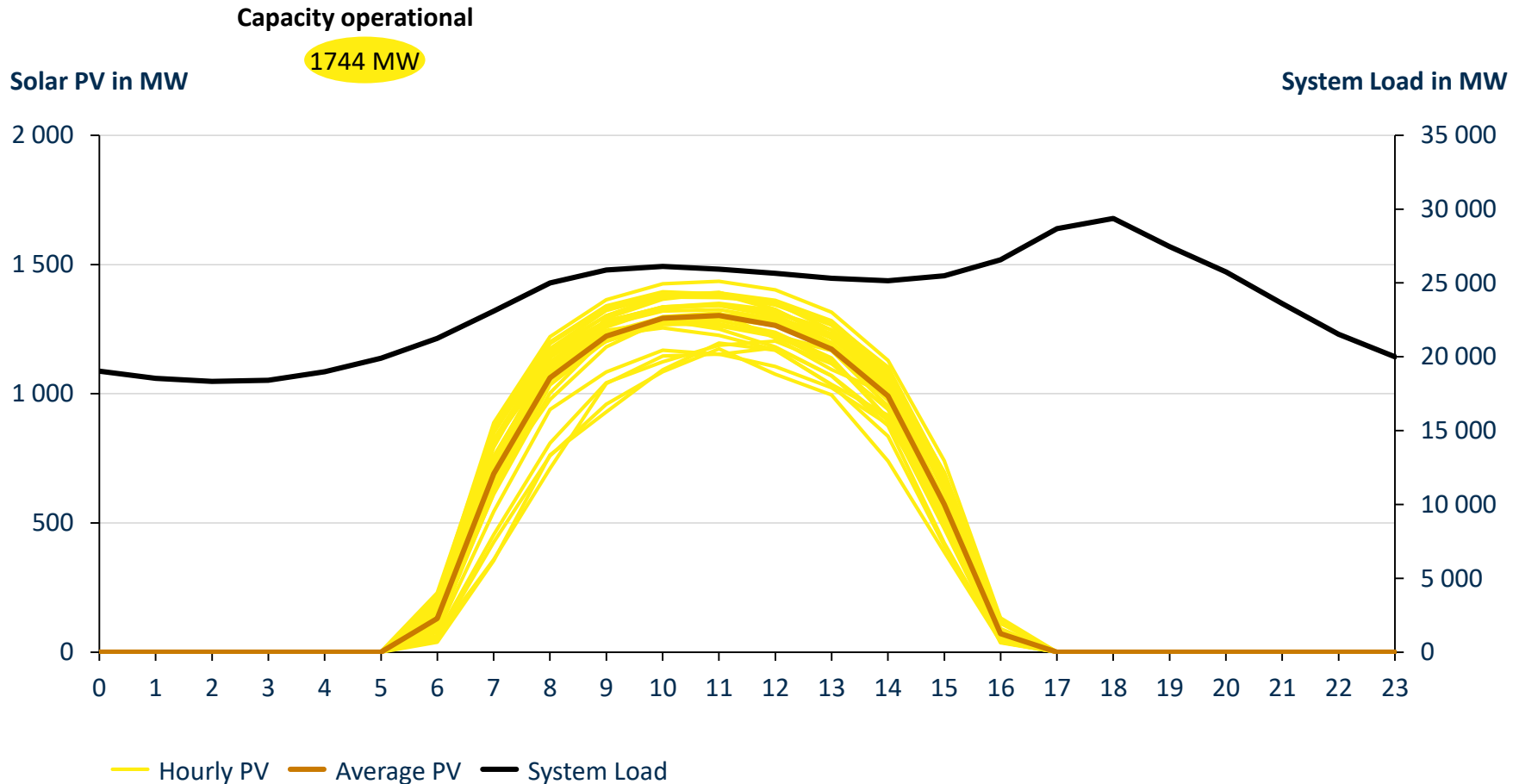
Hourly solar PV production for all 30 days of April 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in May 2020 very stable

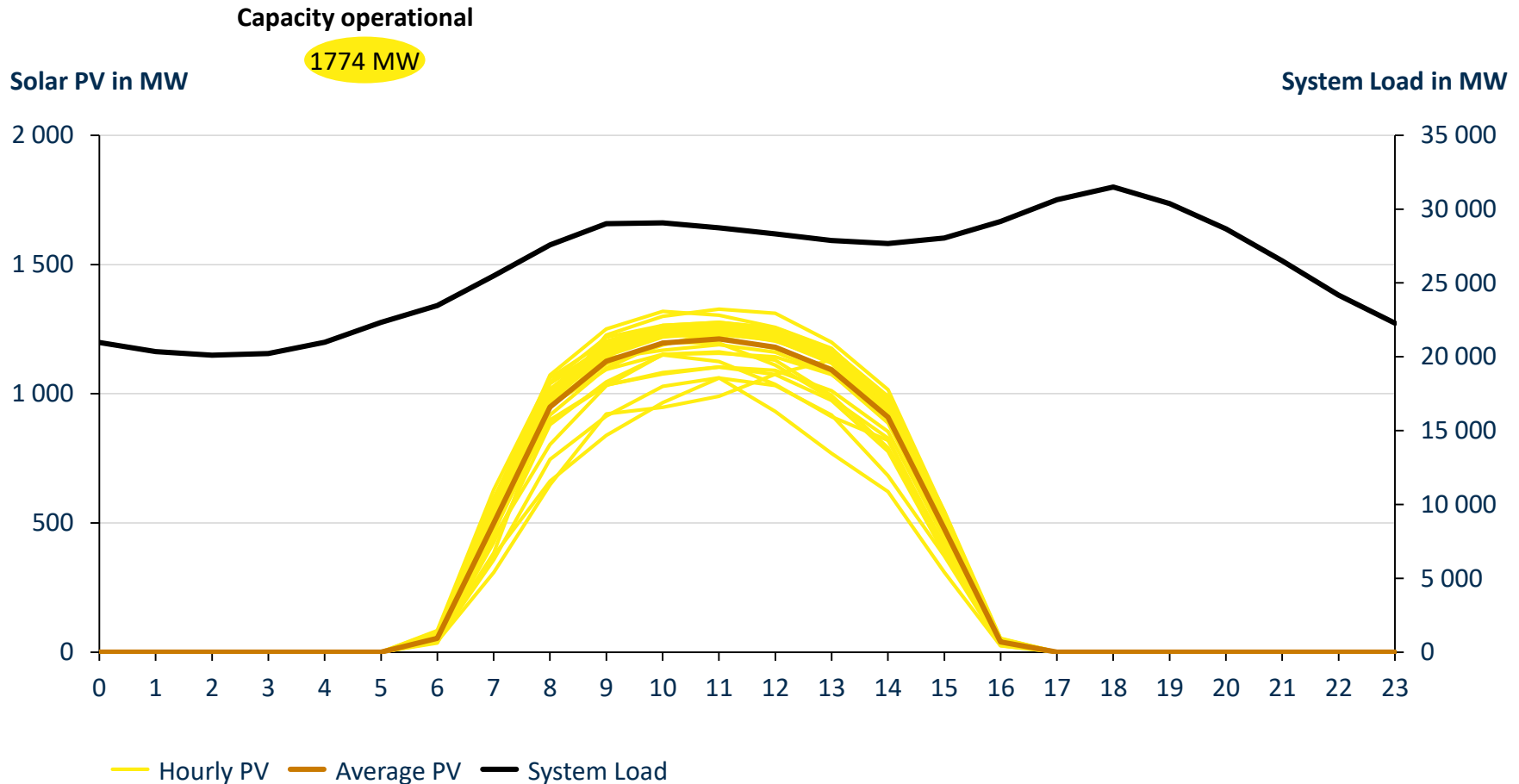
Hourly solar PV production for all 31 days of May 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Jun 2020 very stable

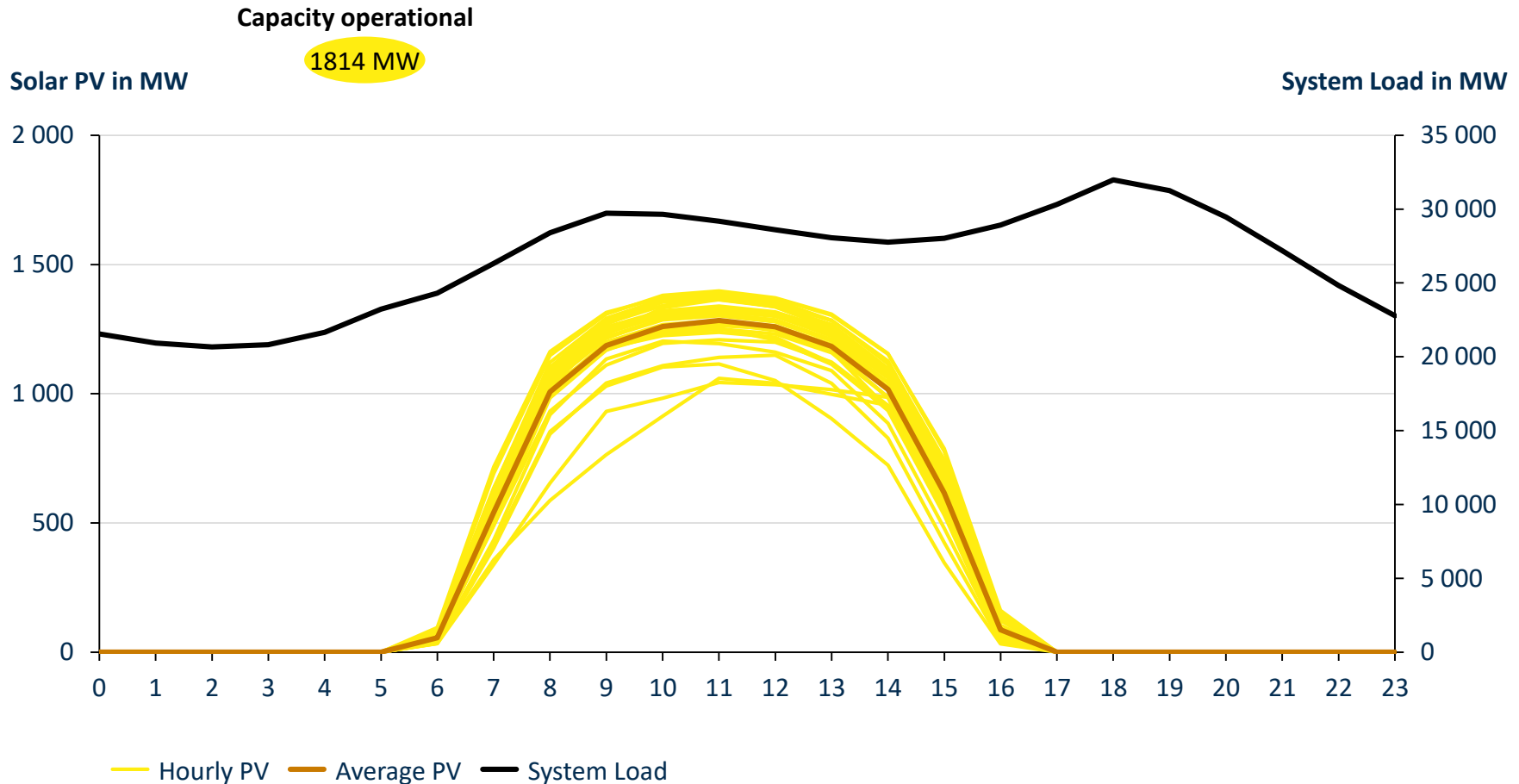
Hourly solar PV production for all 30 days of June 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Jul 2020 very stable

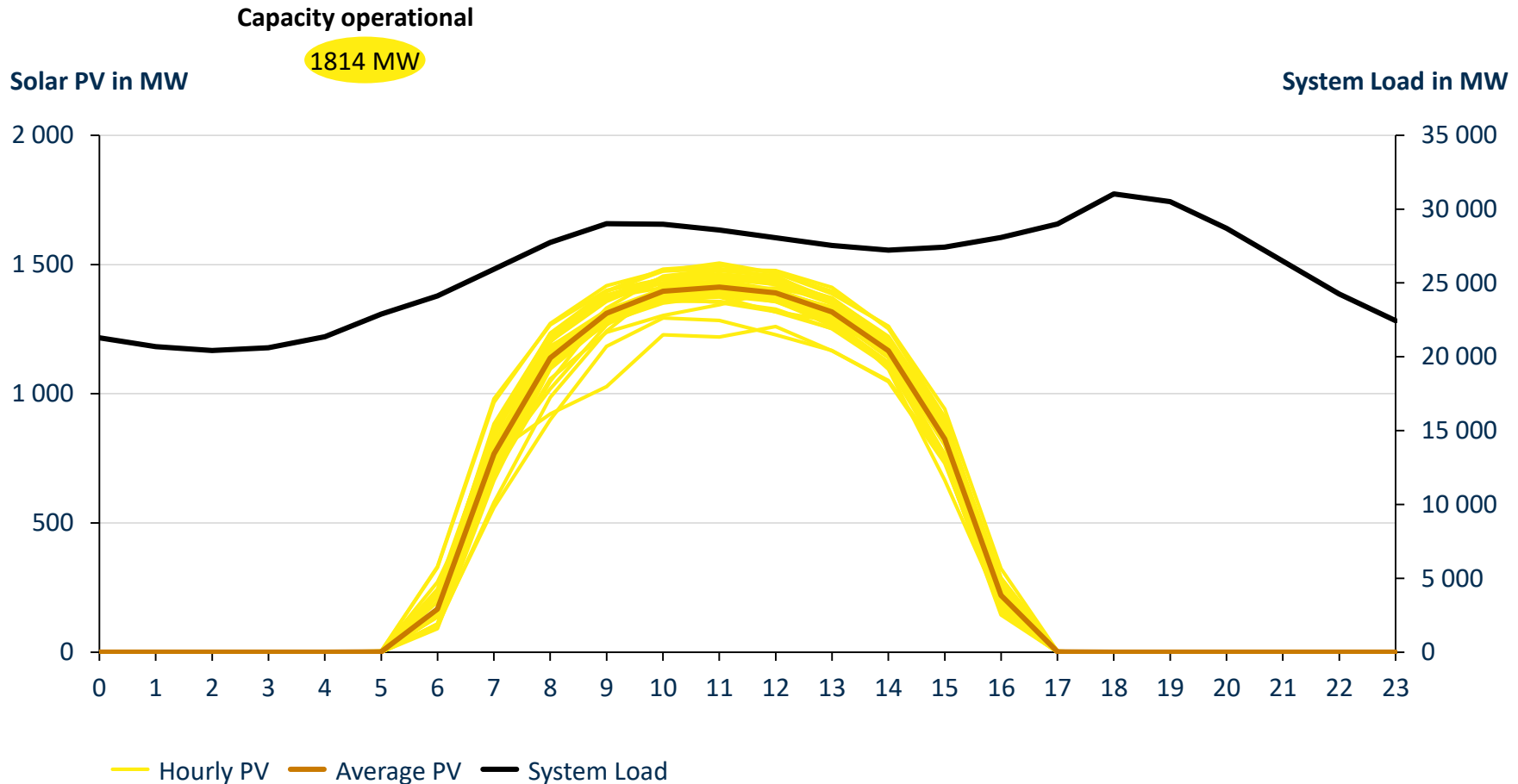
Hourly solar PV production for all 31 days of July 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

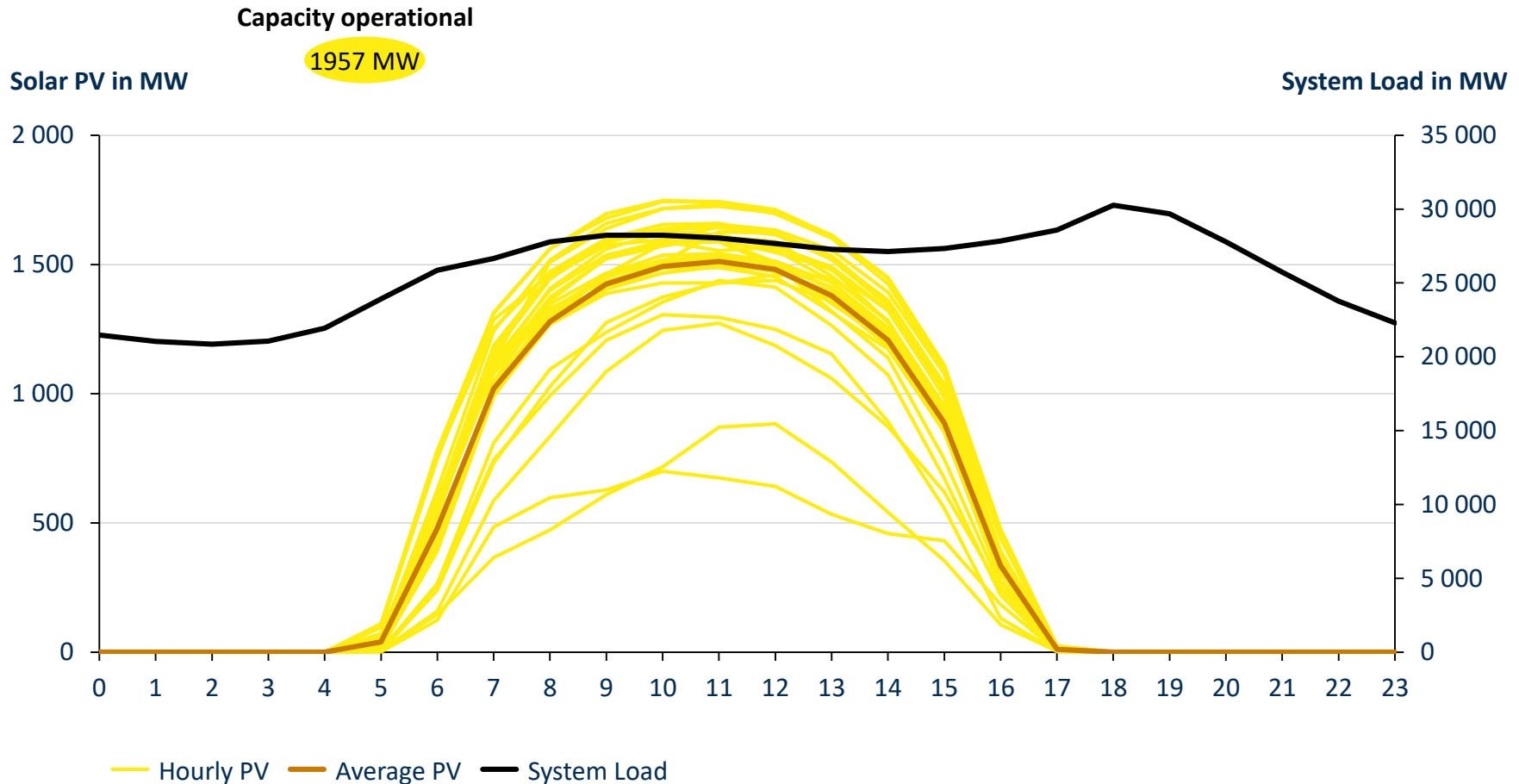
Solar PV supply in Aug 2020 very stable

Hourly solar PV production for all 31 days of August 2020 & average system load diurnal course



Solar PV supply in Sep 2020 very stable

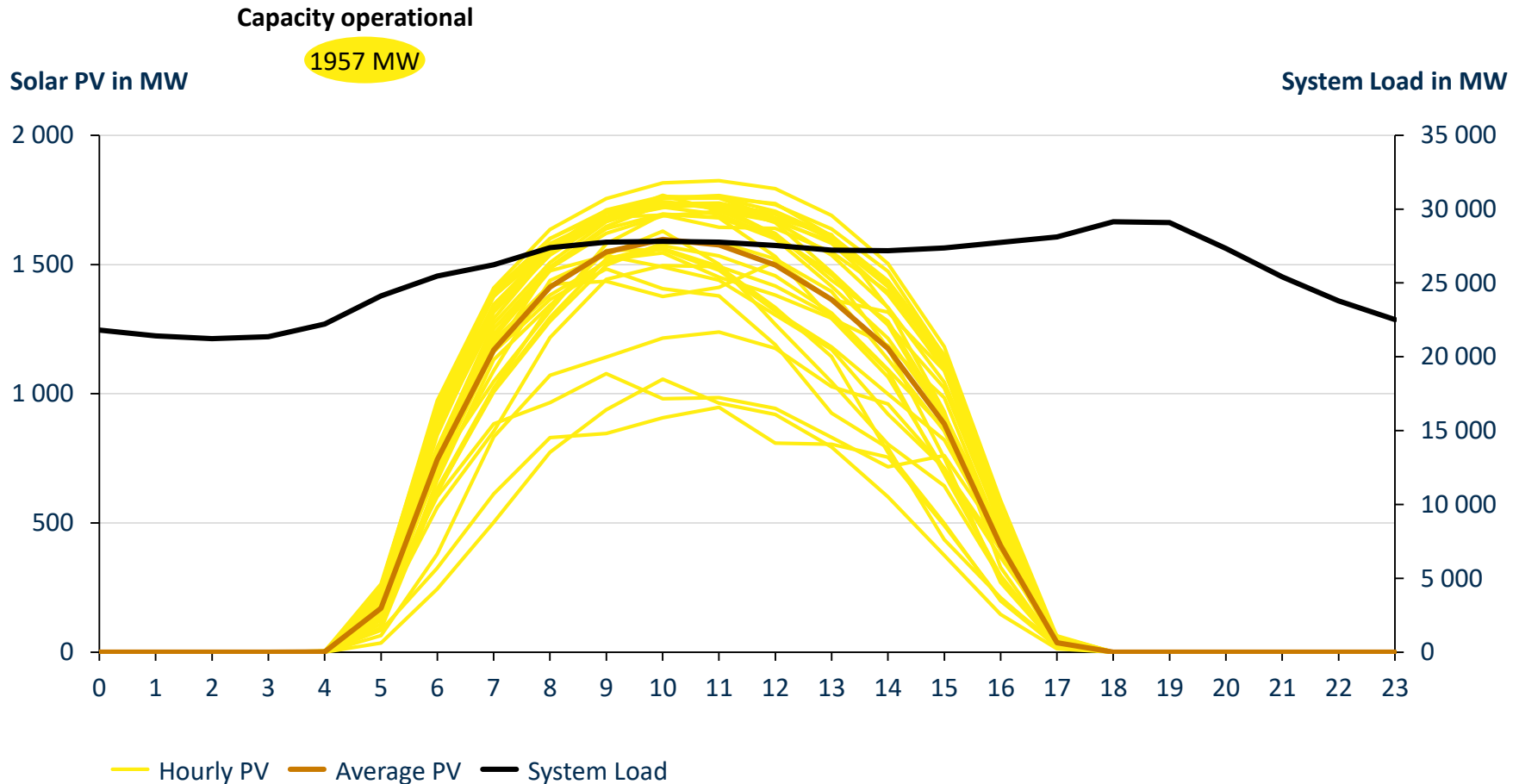
Hourly solar PV production for all 30 days of September 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Solar PV supply in Oct 2020 very stable

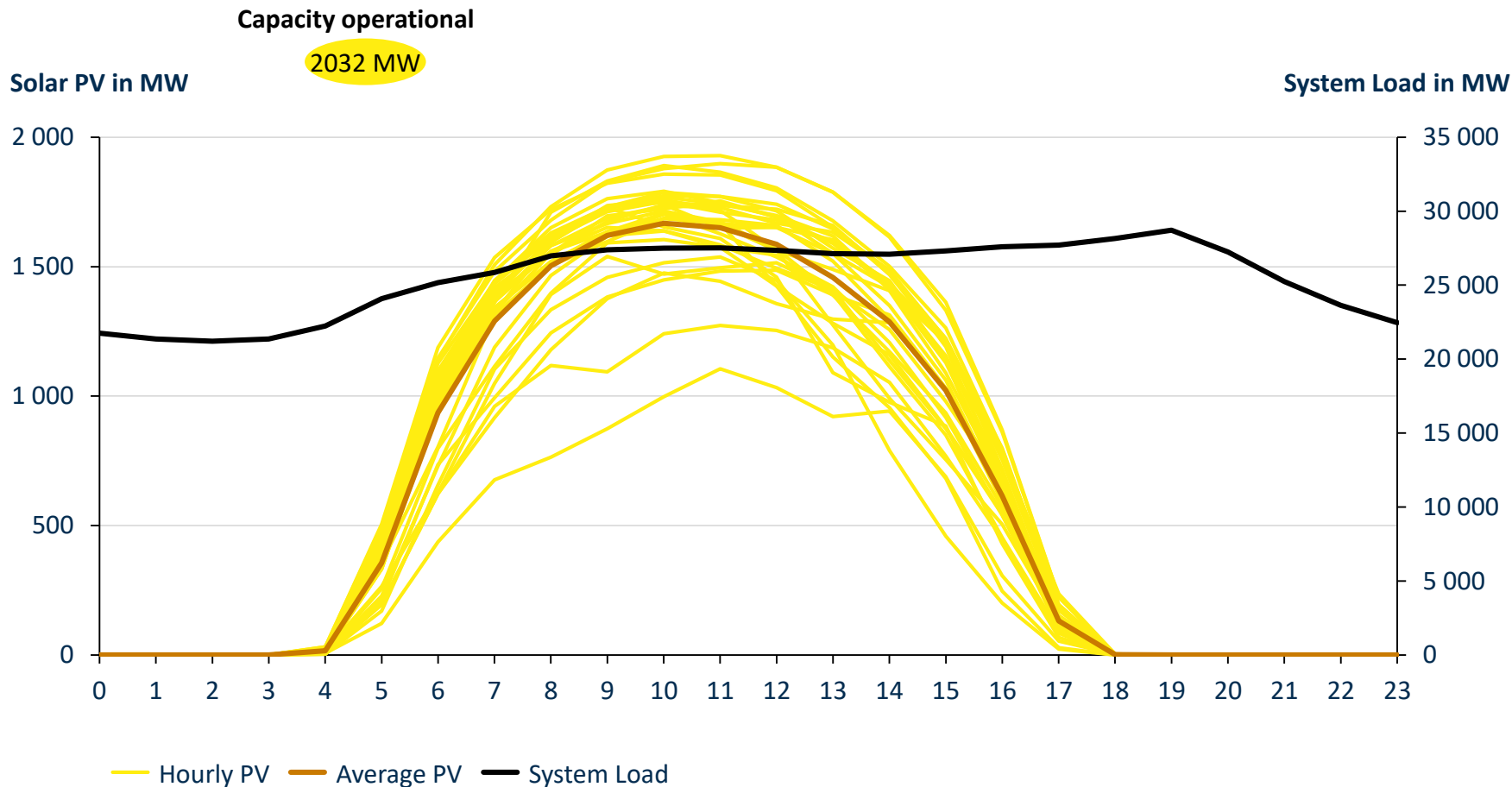
Hourly solar PV production for all 31 days of October 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

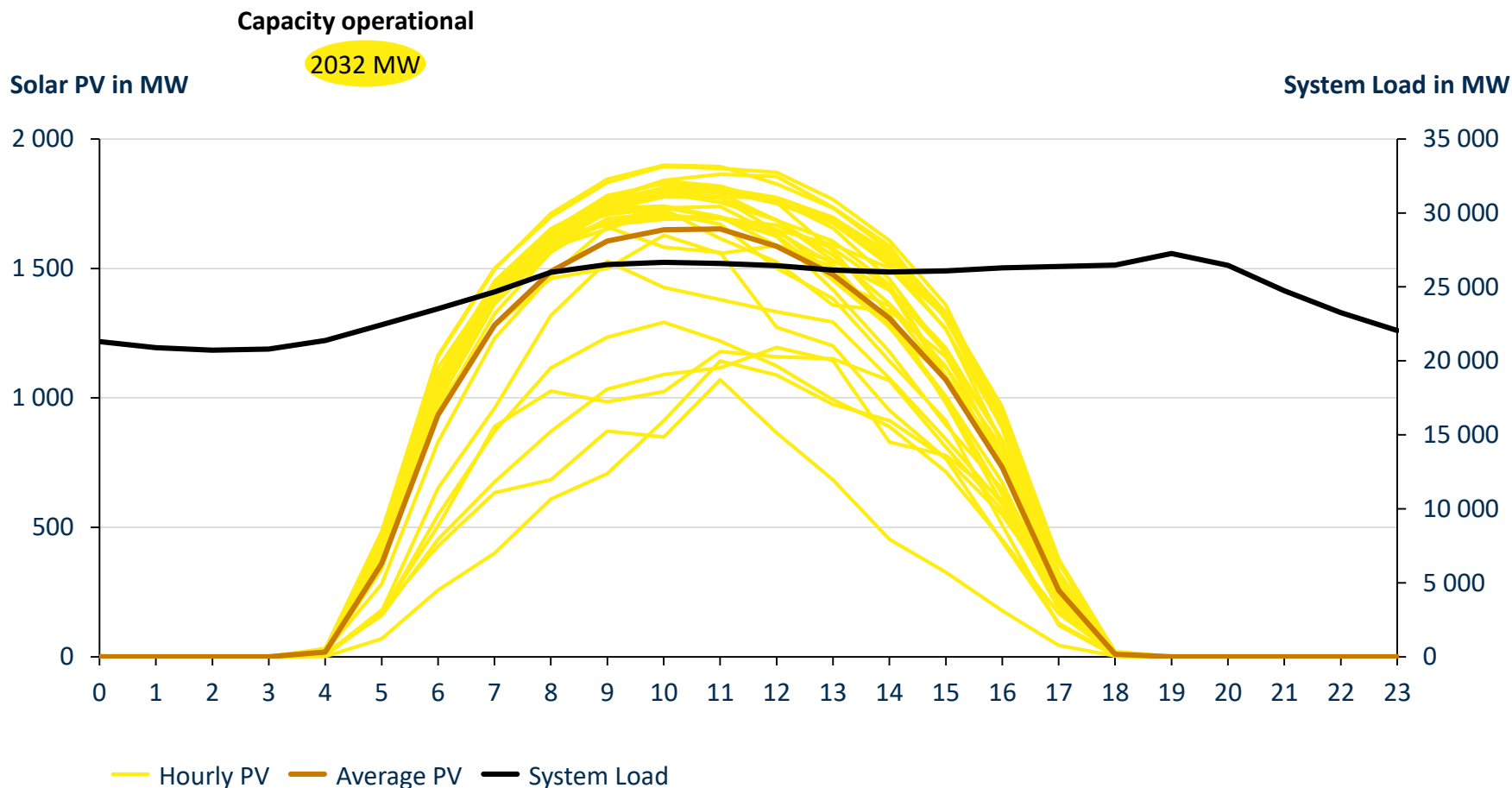
Solar PV supply in Nov 2020 very stable

Hourly solar PV production for all 30 days of November 2020 & average system load diurnal course



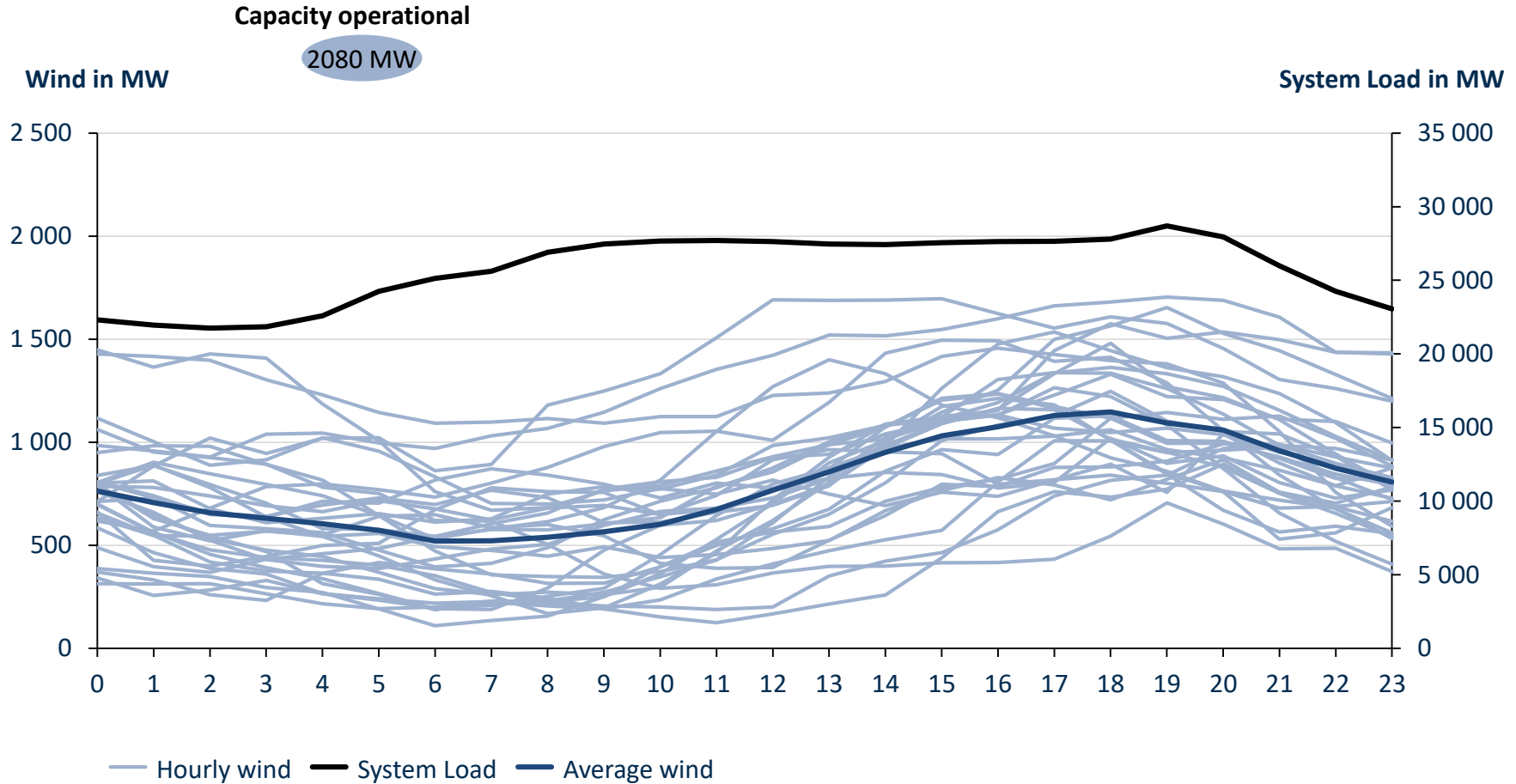
Solar PV supply in Dec 2020 very stable

Hourly solar PV production for all 31 days of December 2020 & average system load diurnal course



In Jan 2020, wind supply increased in the evenings

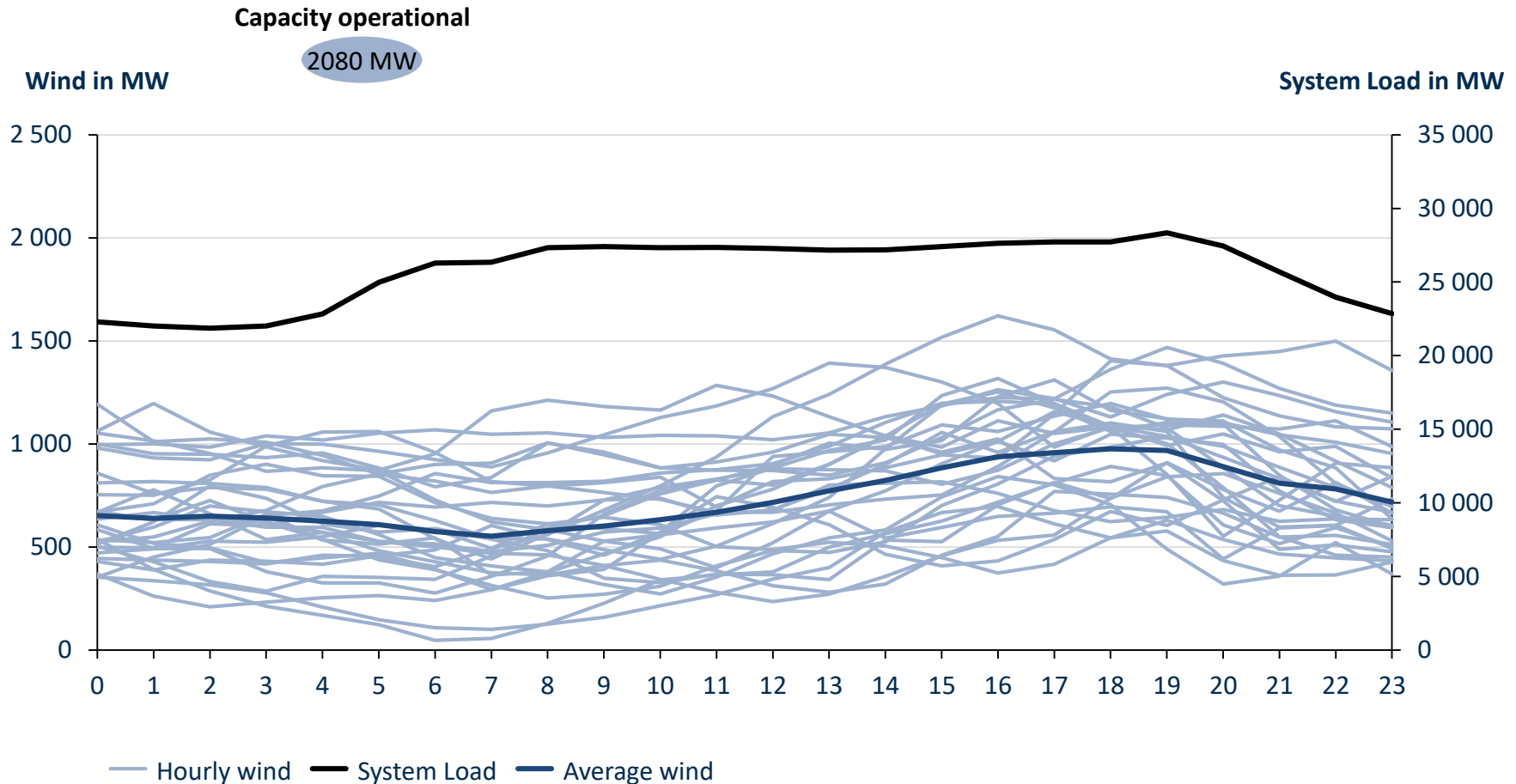
Hourly wind production for all 31 days of January 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Feb 2020, wind supply increased during the evening peak

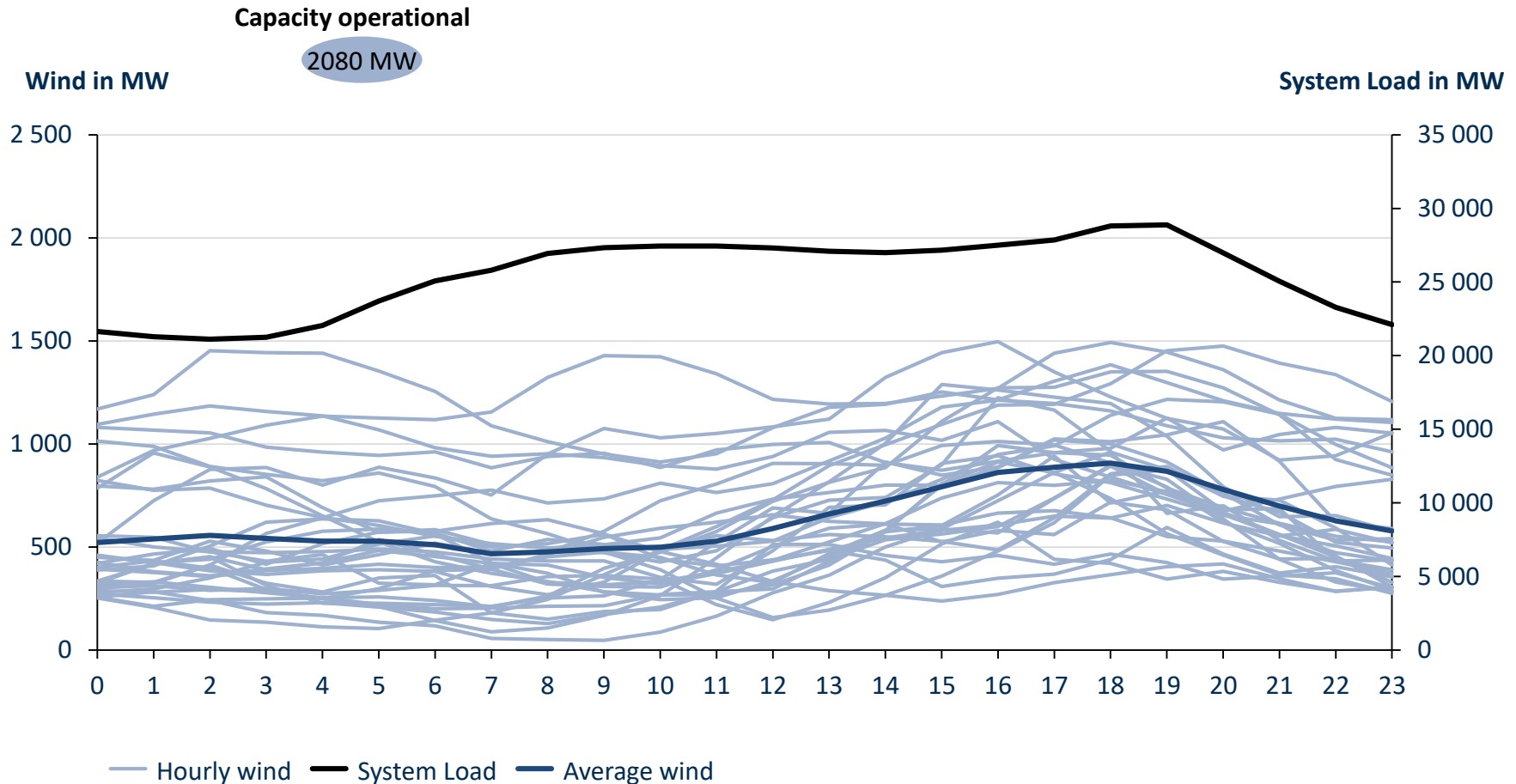
Hourly wind production for all 29 days of February 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Mar 2020, wind supply increased during the evening peak

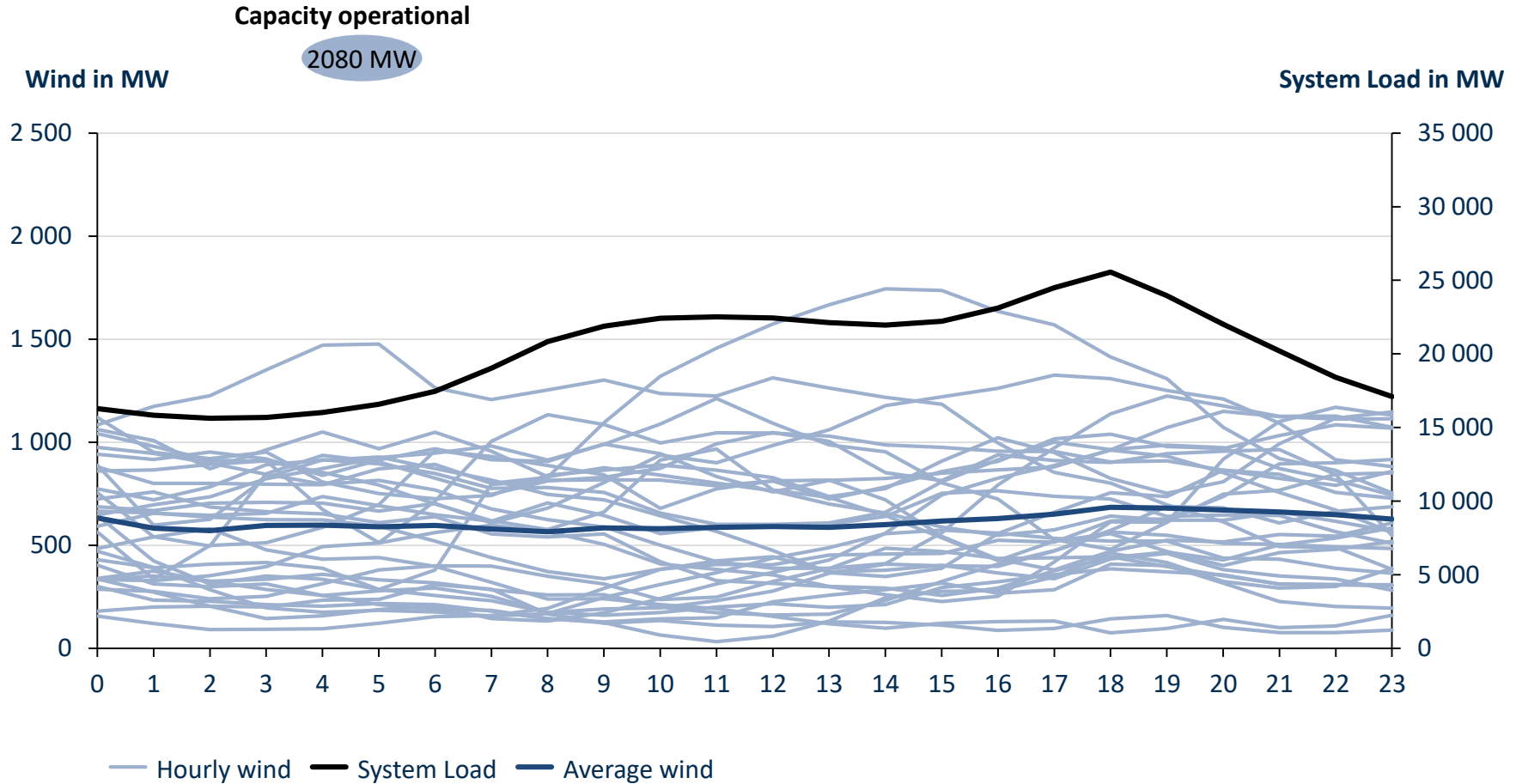
Hourly wind production for all 31 days of March 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

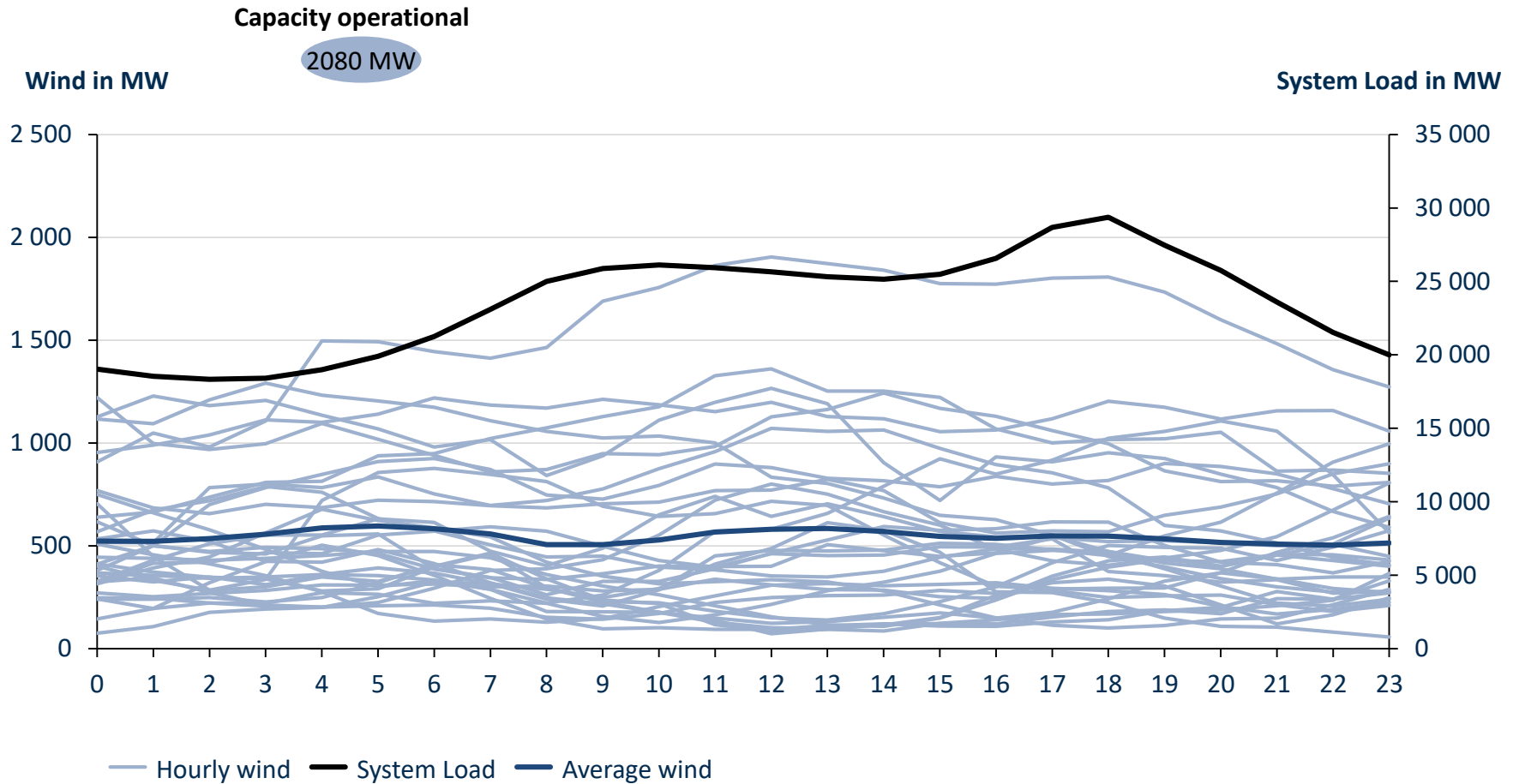
In Apr 2020, wind fluctuated day-to-day

Hourly wind production for all 30 days of April 2020 & average system load diurnal course



In May 2020, wind fluctuated day-to-day

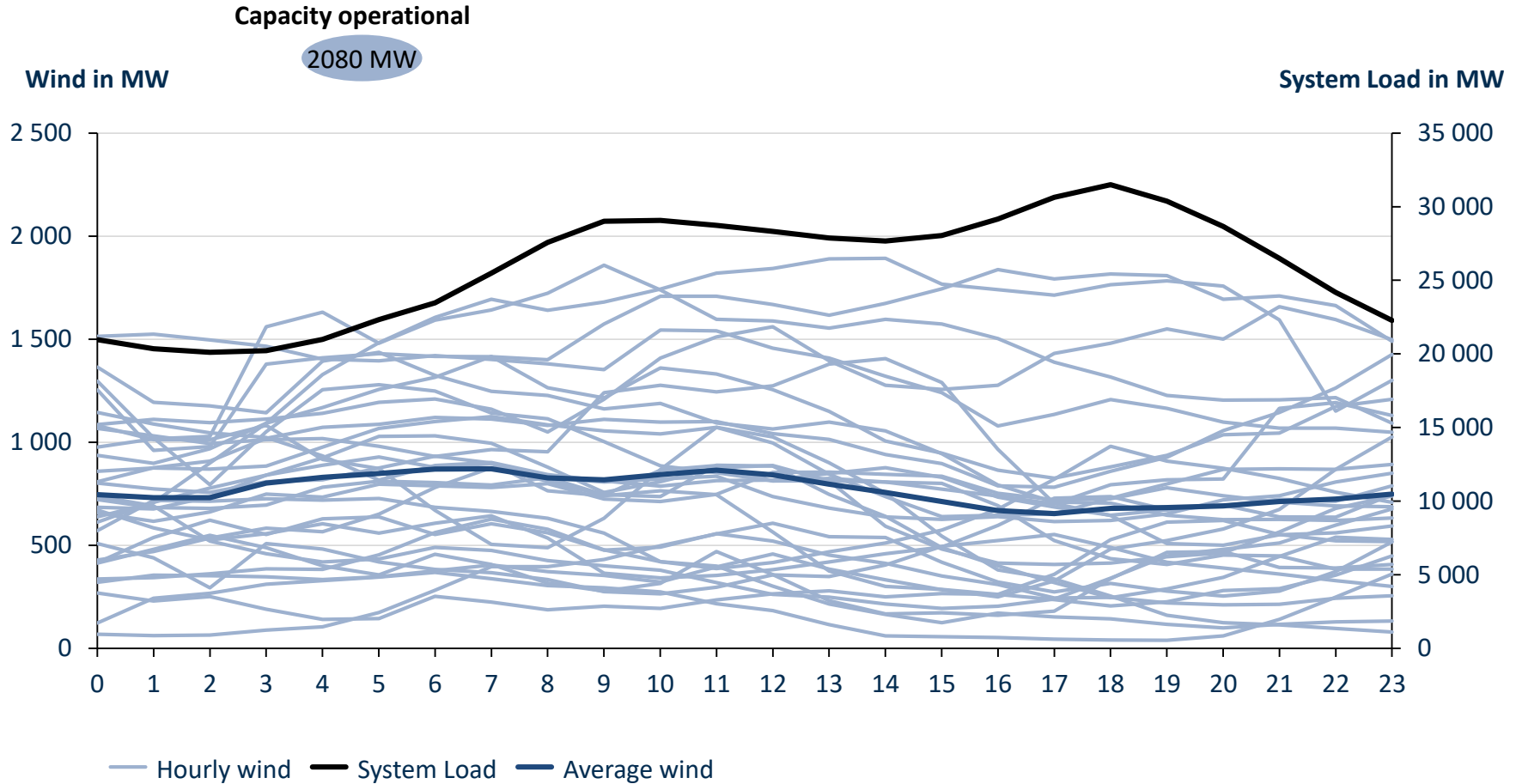
Hourly wind production for all 31 days of May 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Jun 2020, wind fluctuated day-to-day

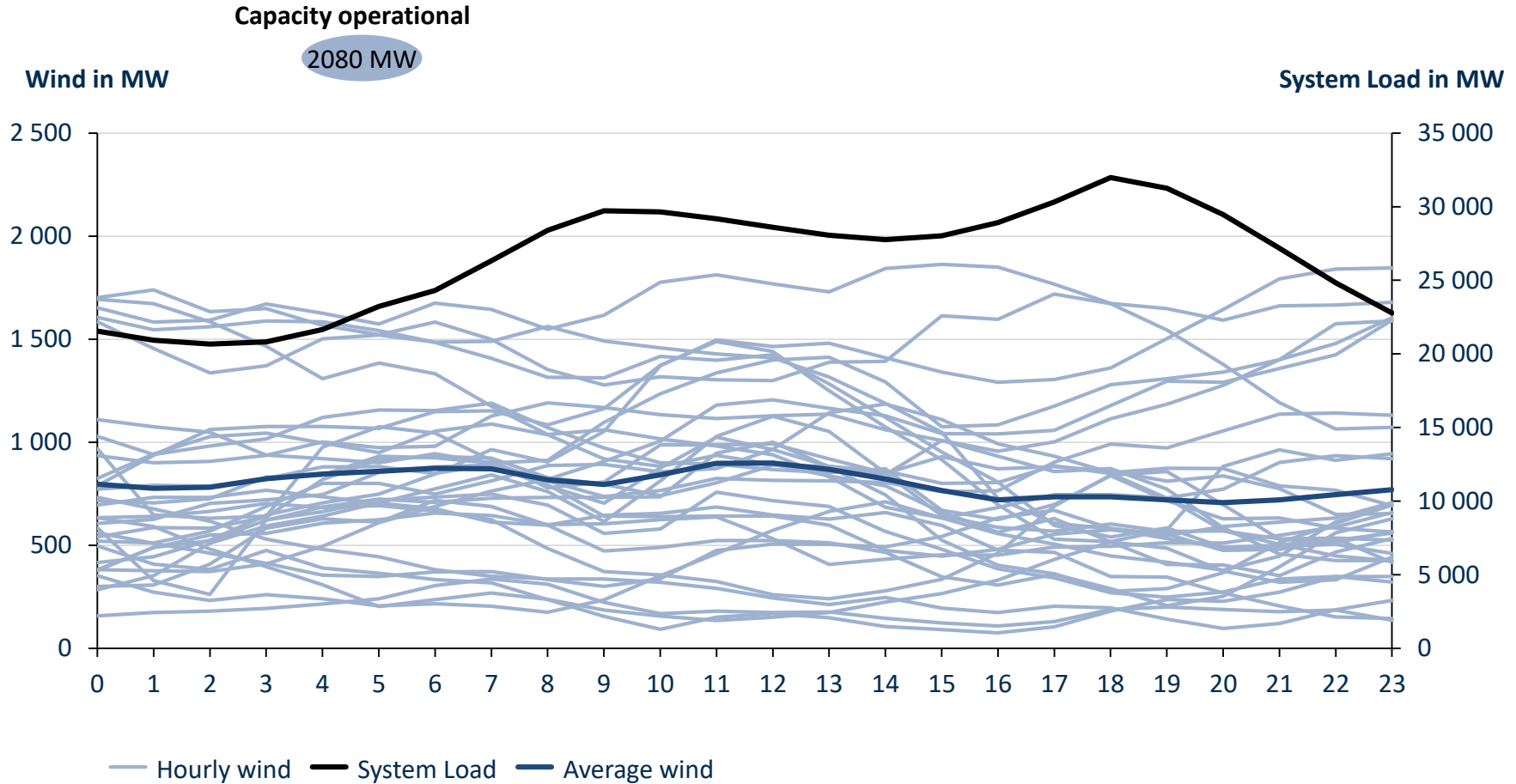
Hourly wind production for all 30 days of June 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Jul 2020, wind fluctuated day-to-day

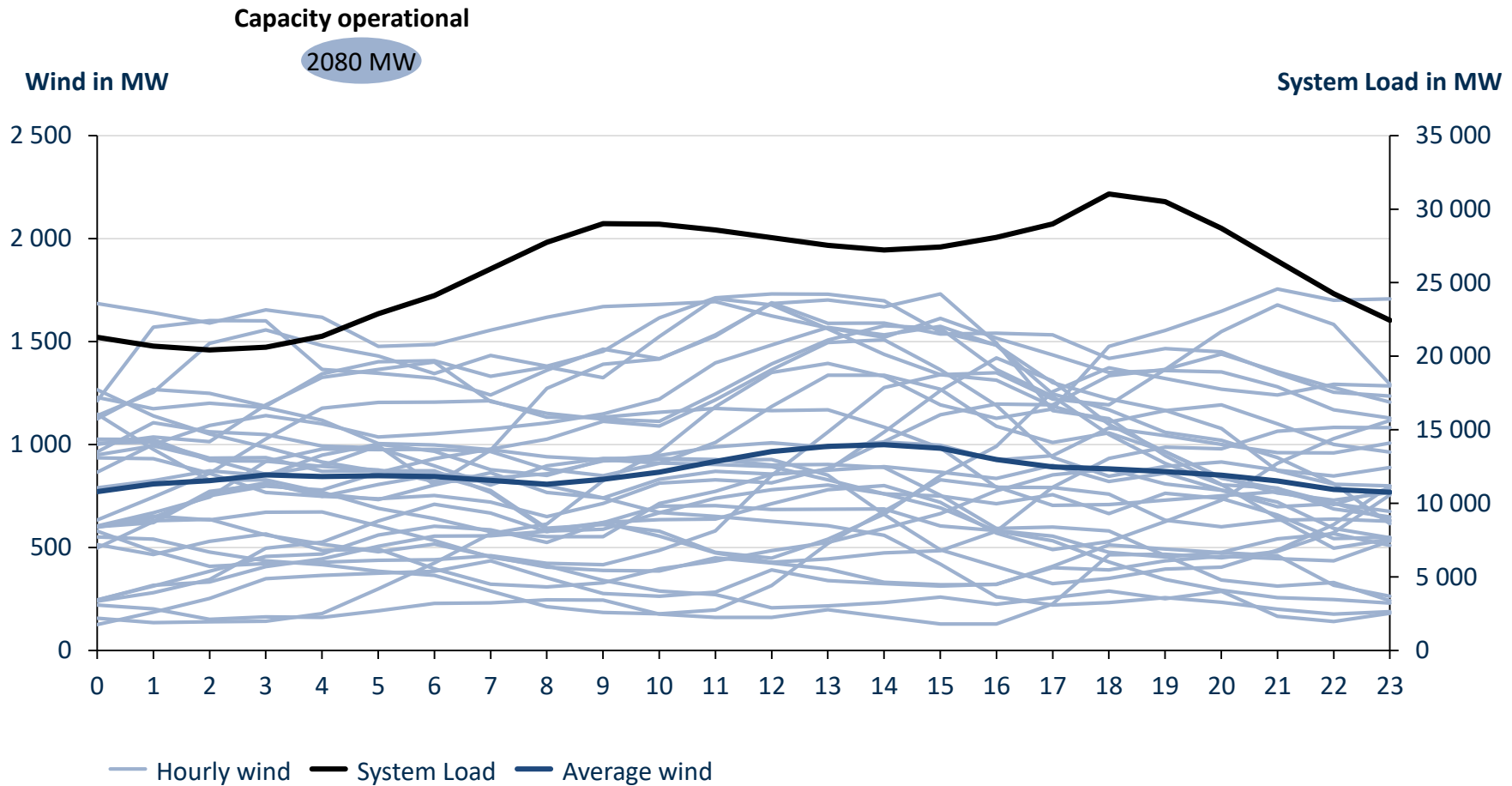
Hourly wind production for all 31 days of July 2020 and average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Aug 2020, wind fluctuated day-to-day

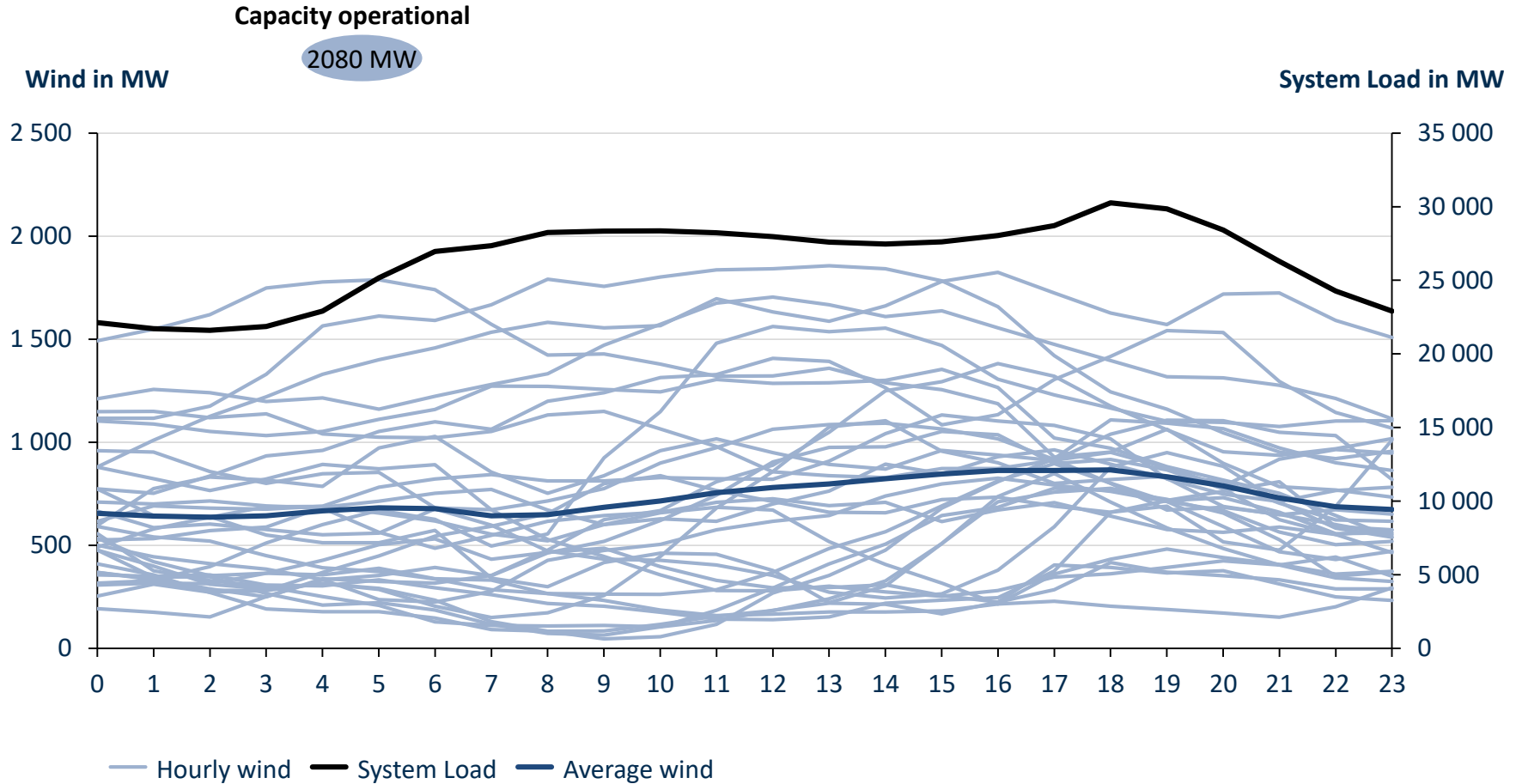
Hourly wind production for all 31 days of August 2020 and average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Sep 2020, wind fluctuated day-to-day

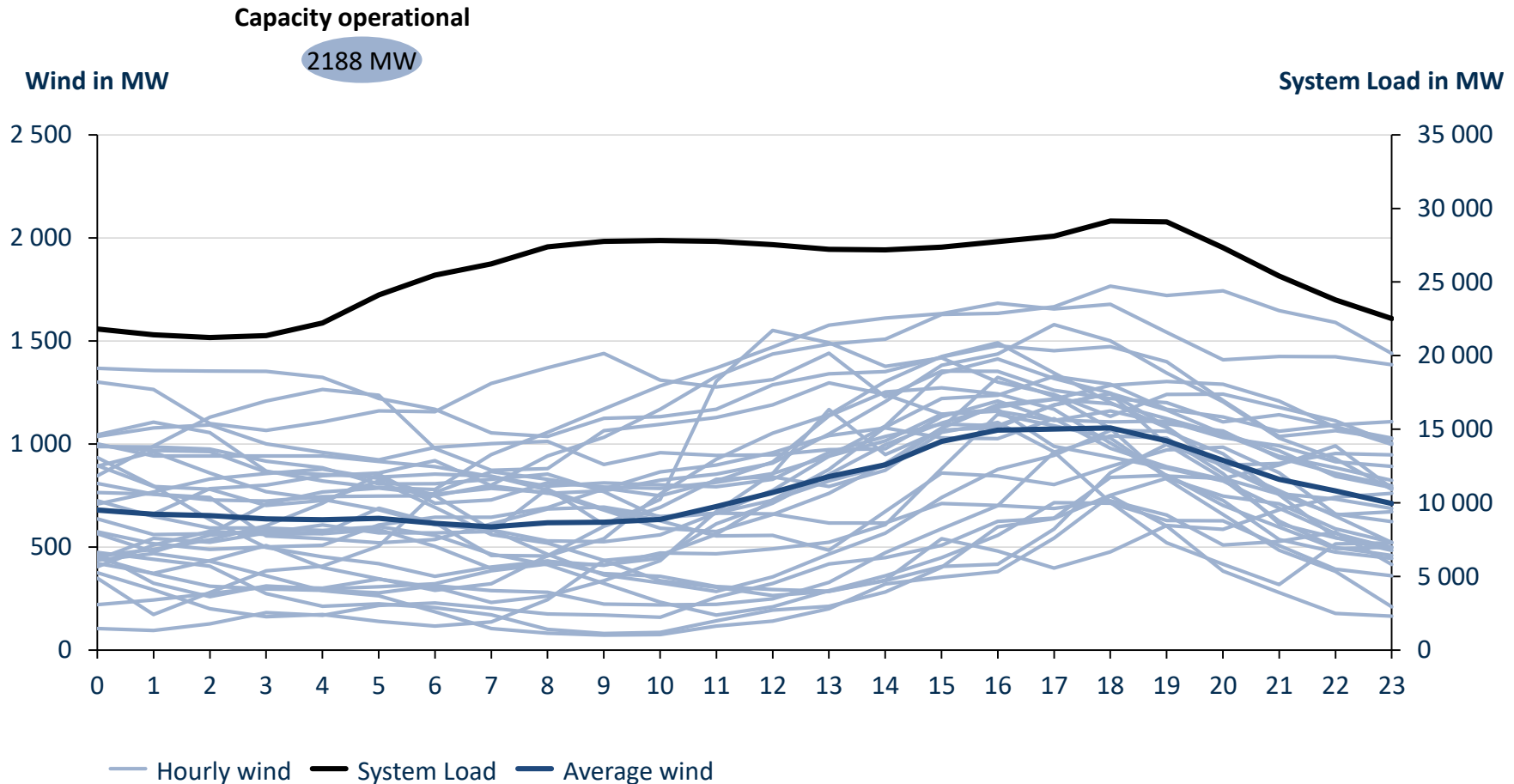
Hourly wind production for all 30 days of September 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Oct 2020, wind supply increased towards the evening peak

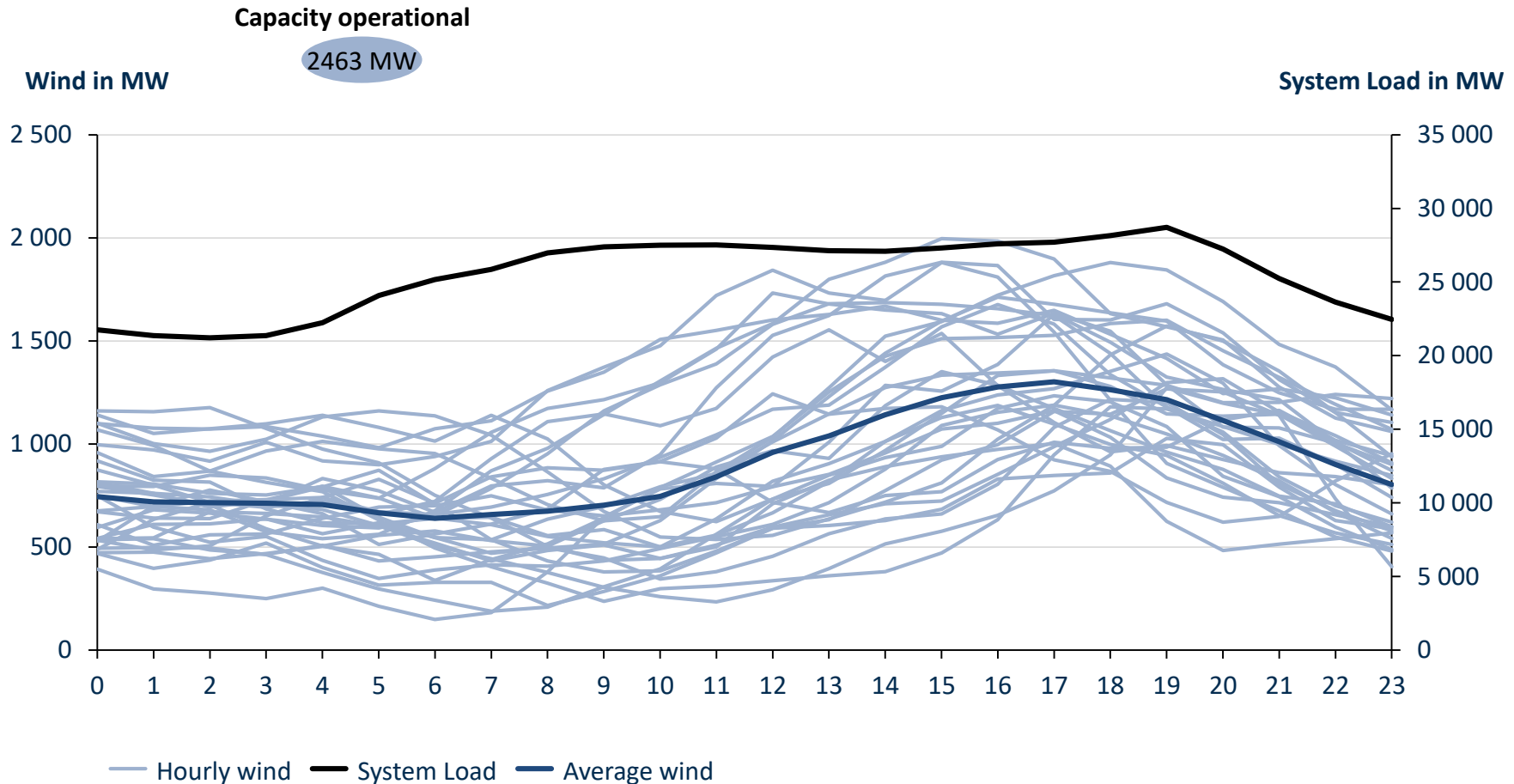
Hourly wind production for all 31 days of October 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Nov 2020, wind supply increased during the evening peak

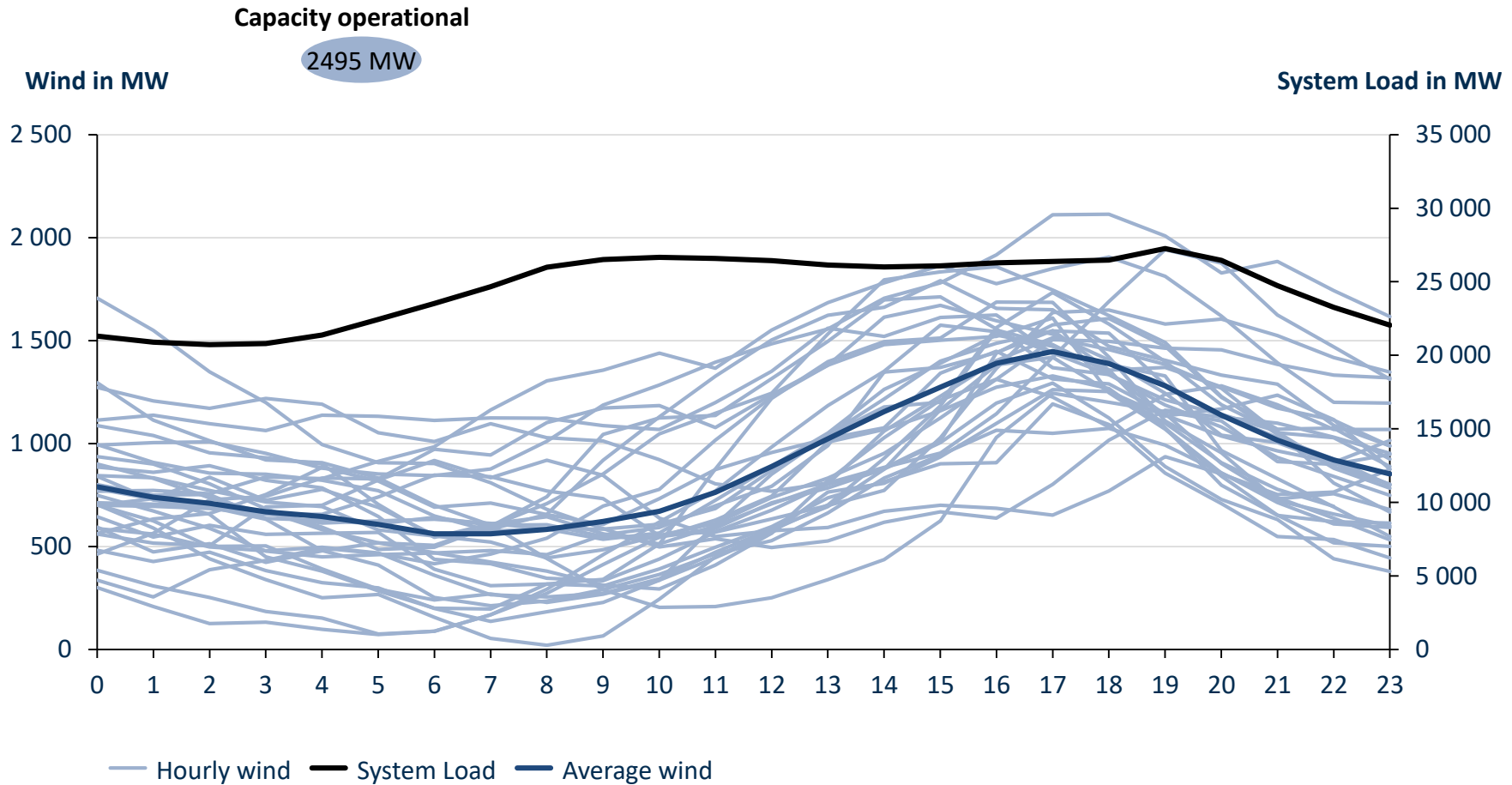
Hourly wind production for all 30 days of November 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

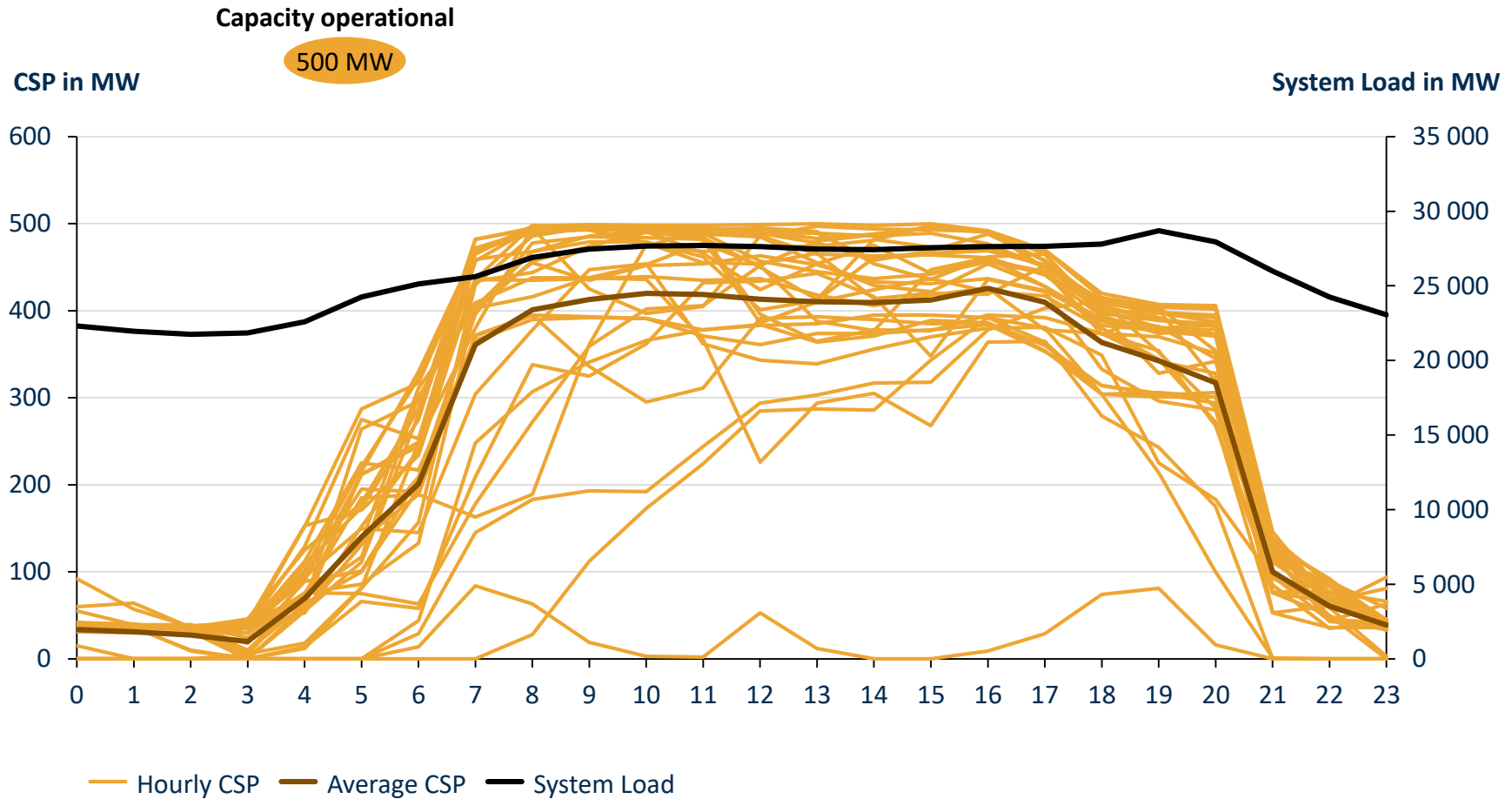
In Dec 2020, wind supply increased during the evening peak

Hourly wind production for all 31 days of December 2020 & average system load diurnal course



In Jan 2020, CSP storage used in evenings

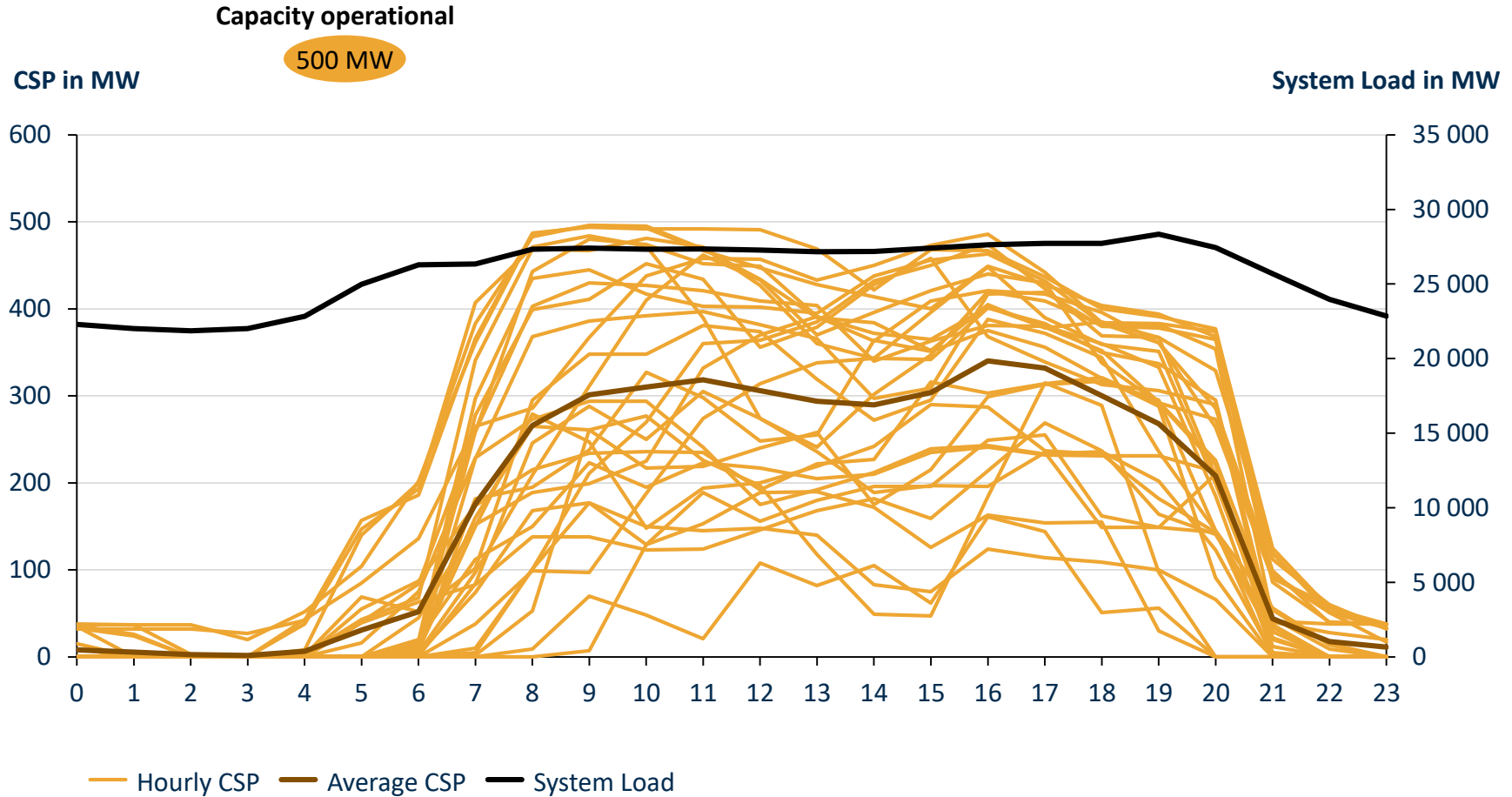
Hourly CSP production for all 31 days of January 2020 & average system load diurnal course



128 Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Feb 2020, CSP storage used in evenings

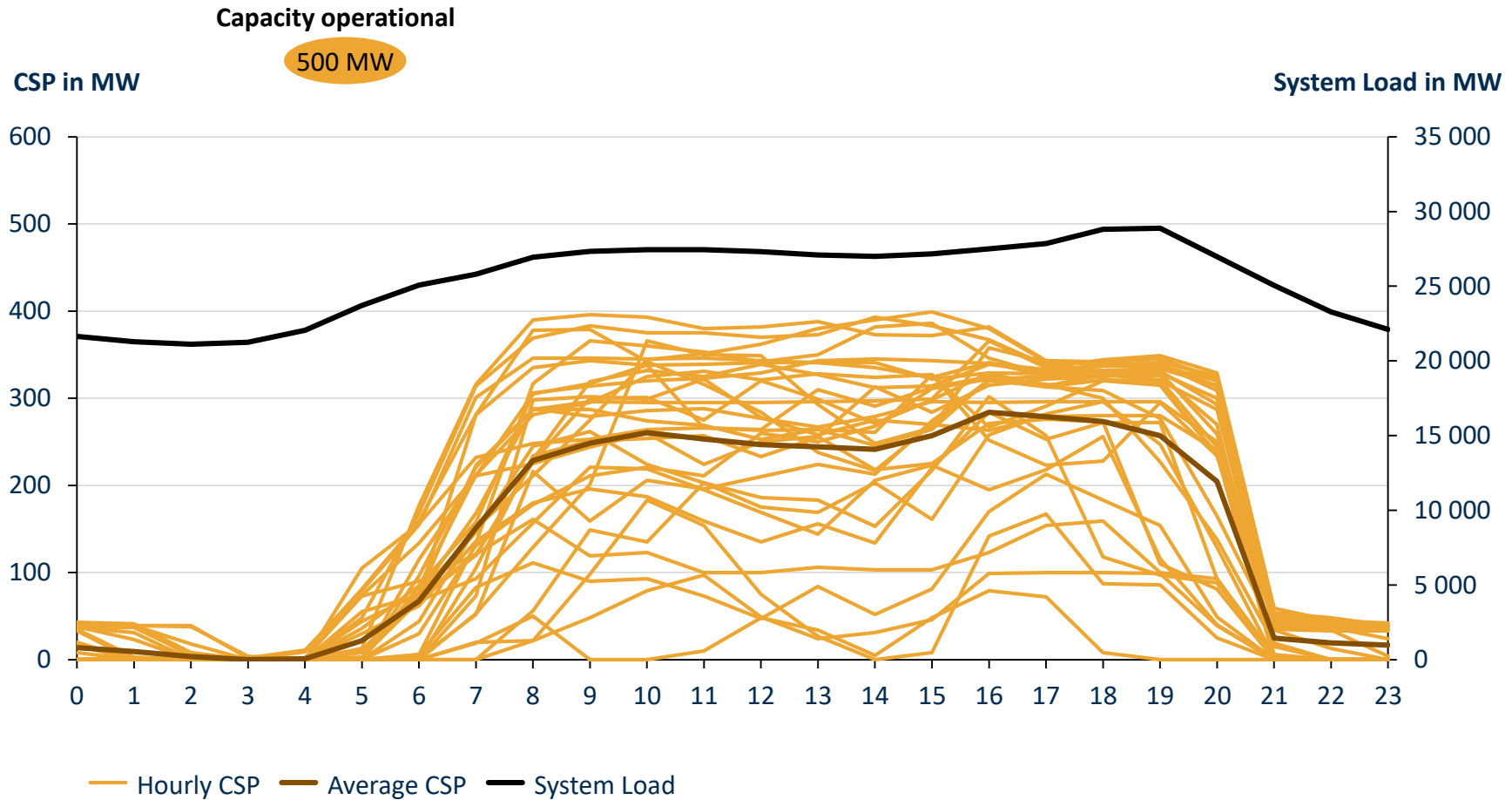
Hourly CSP production for all 28 days of February 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Mar 2020, CSP storage used in evenings

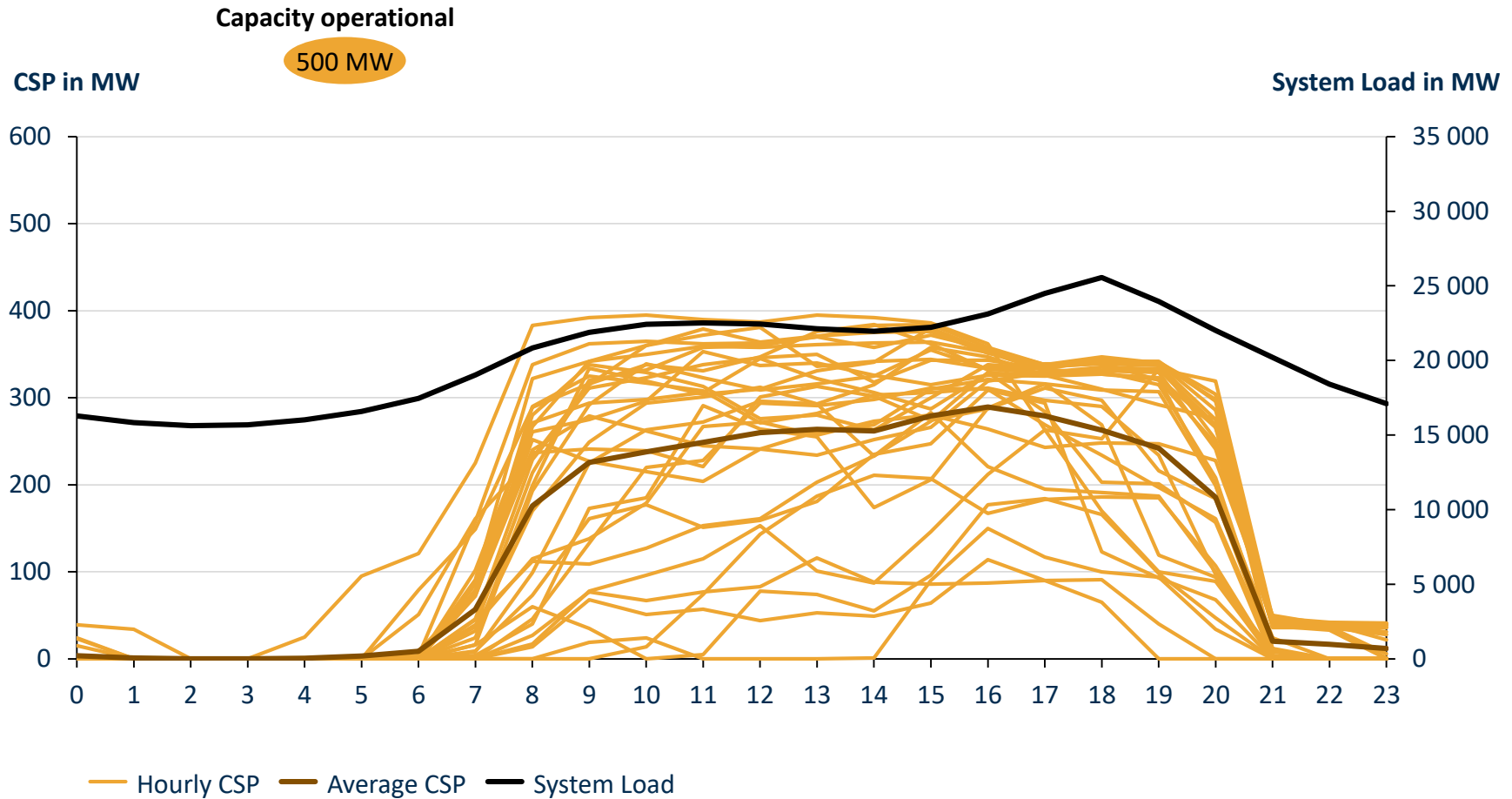
Hourly CSP production for all 31 days of March 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In Apr 2020, CSP storage used in evenings

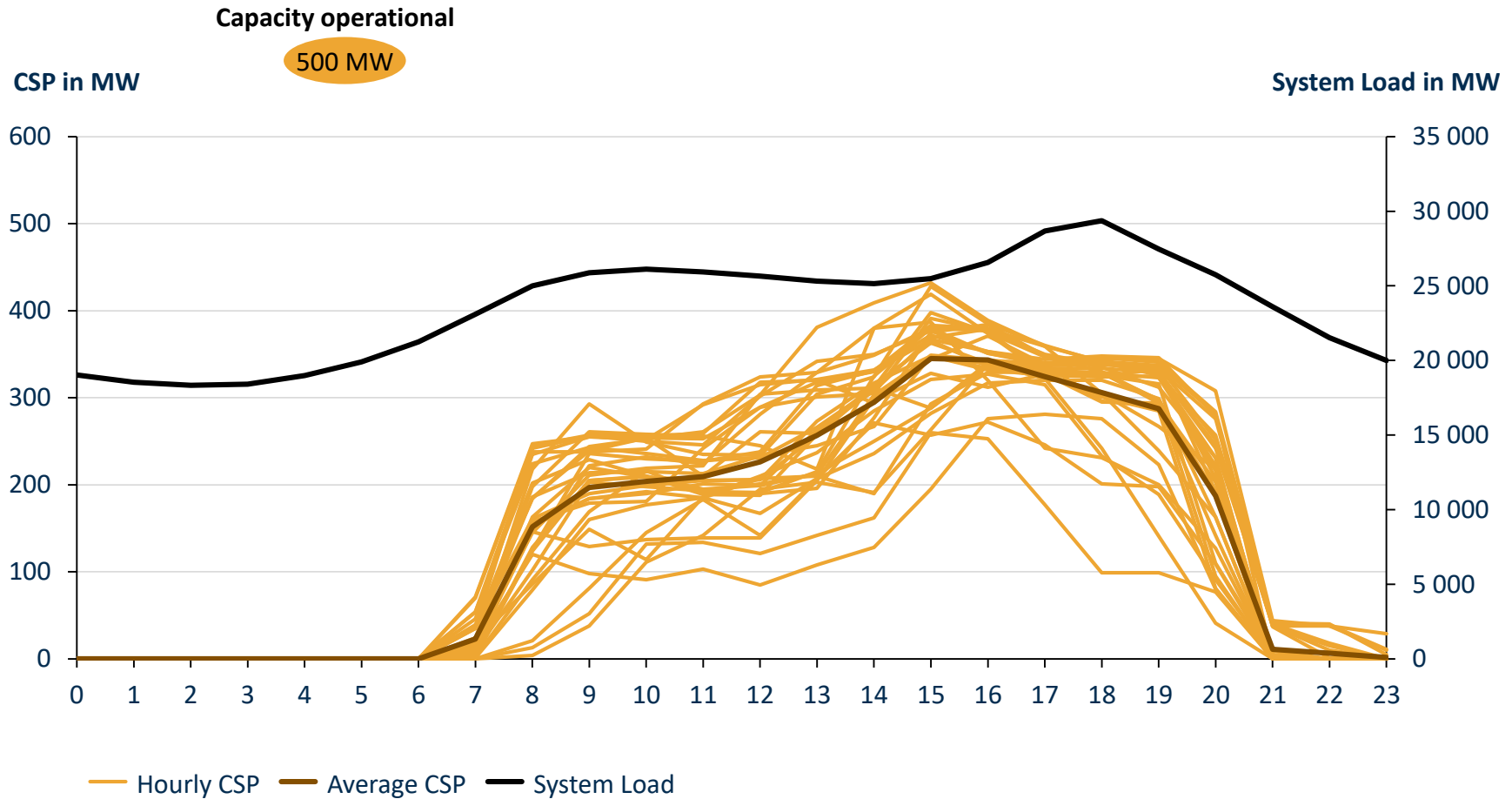
Hourly CSP production for all 30 days of April 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

In May 2020, CSP storage used in evenings

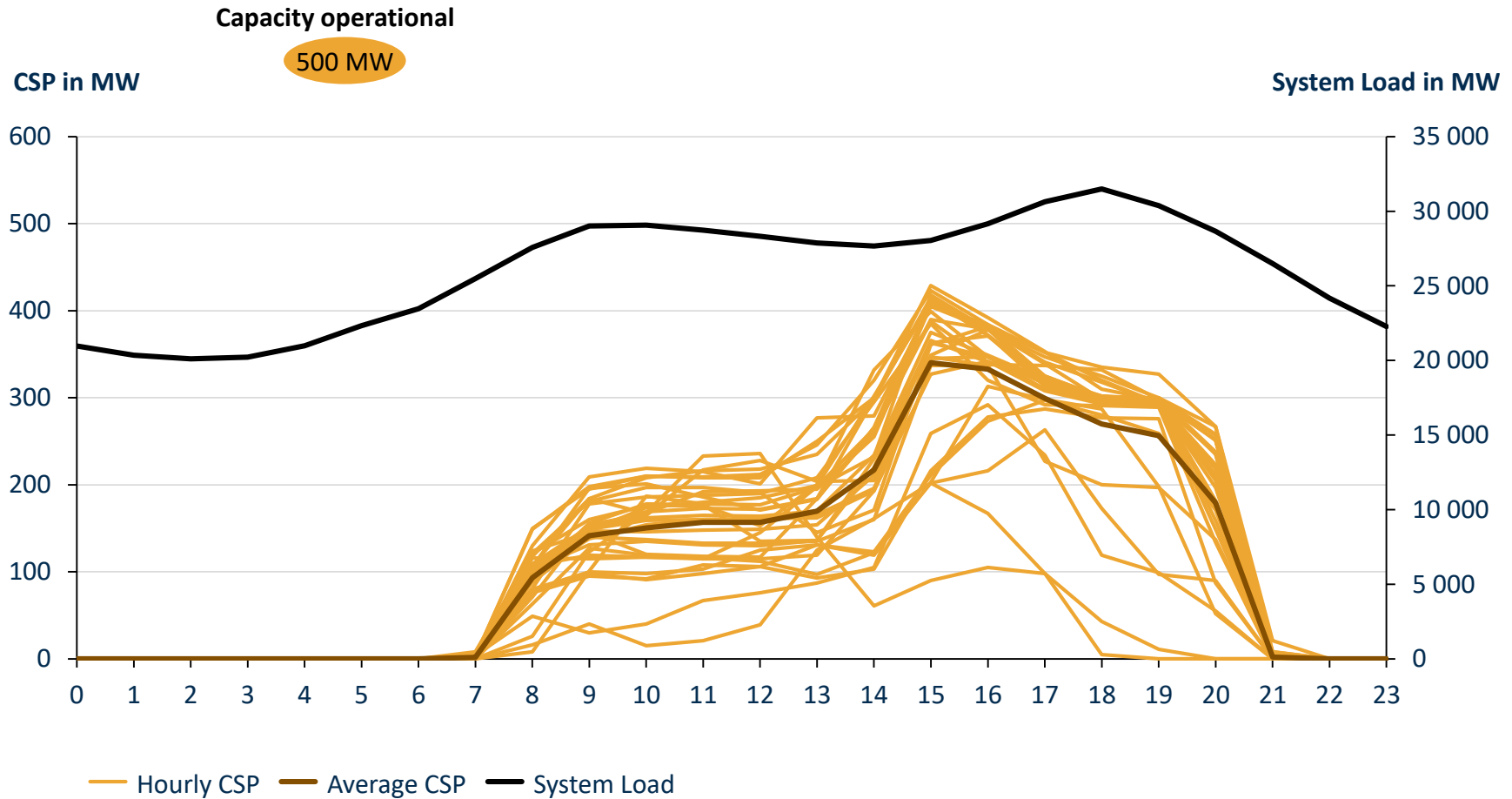
Hourly CSP production for all 31 days of May 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

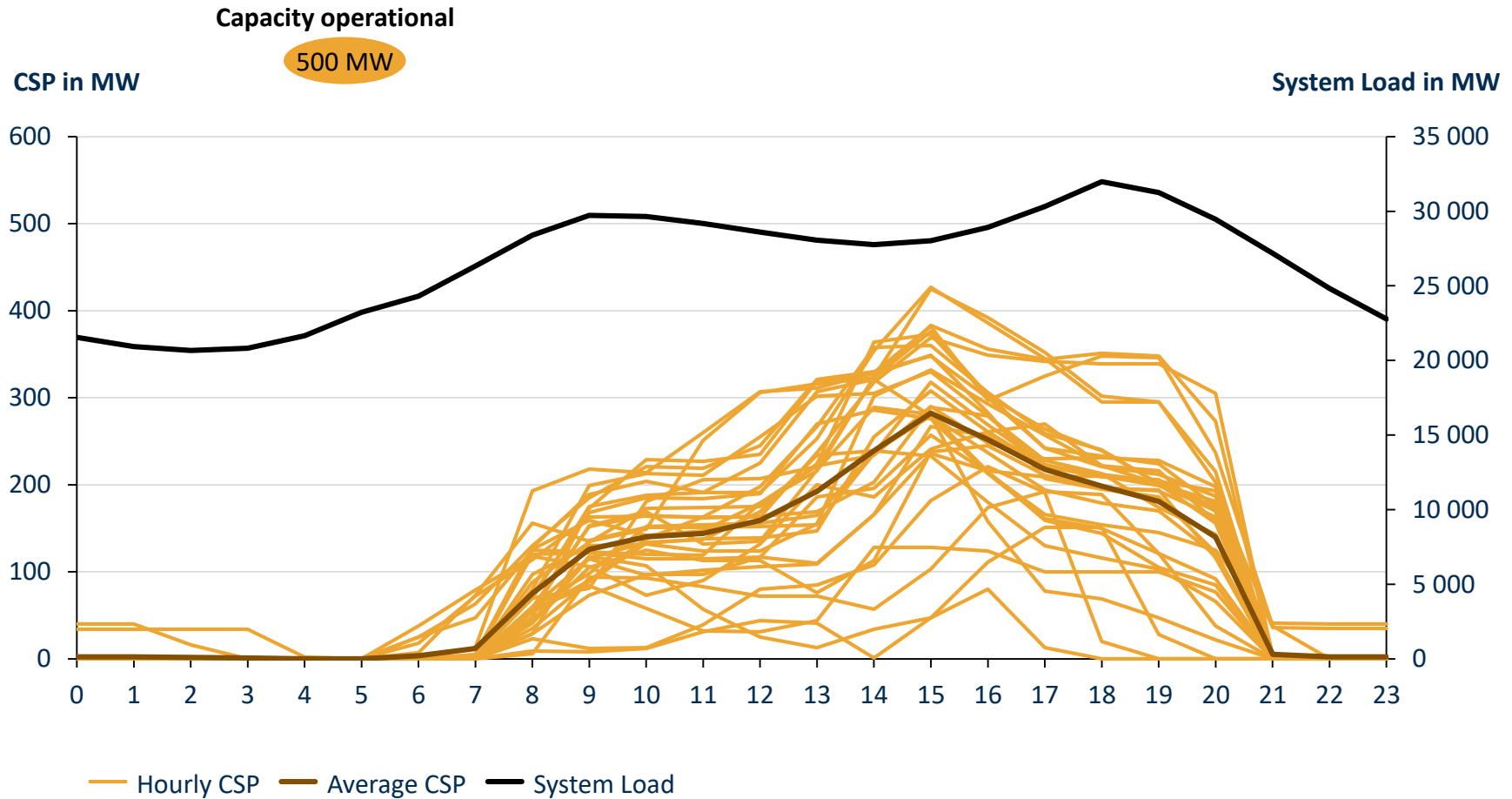
In Jun 2020, CSP storage used in evenings

Hourly CSP production for all 30 days of June 2020 & average system load diurnal course



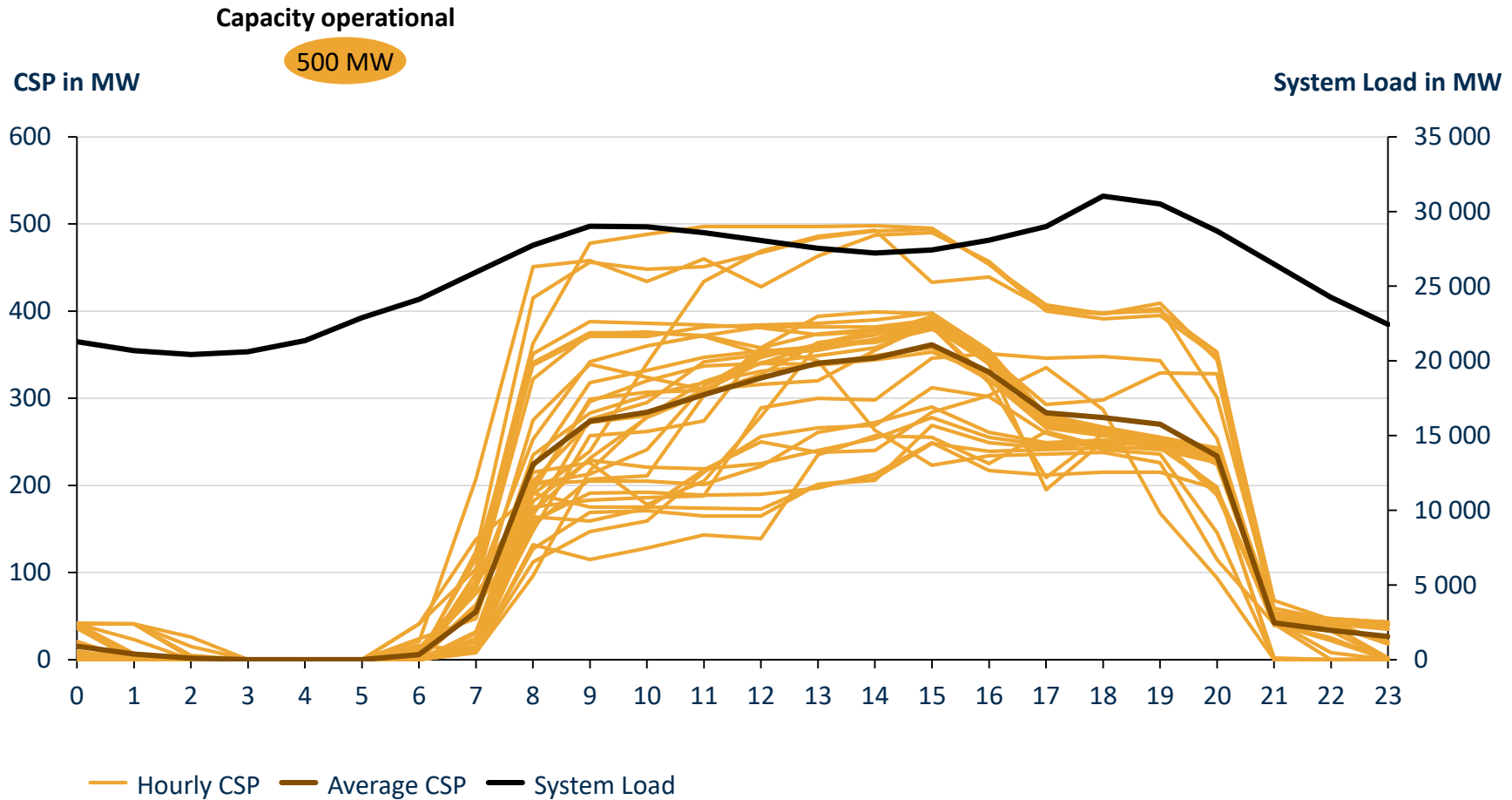
In Jul 2020, CSP storage used in evenings

Hourly CSP production for all 31 days of July 2020 & average system load diurnal course



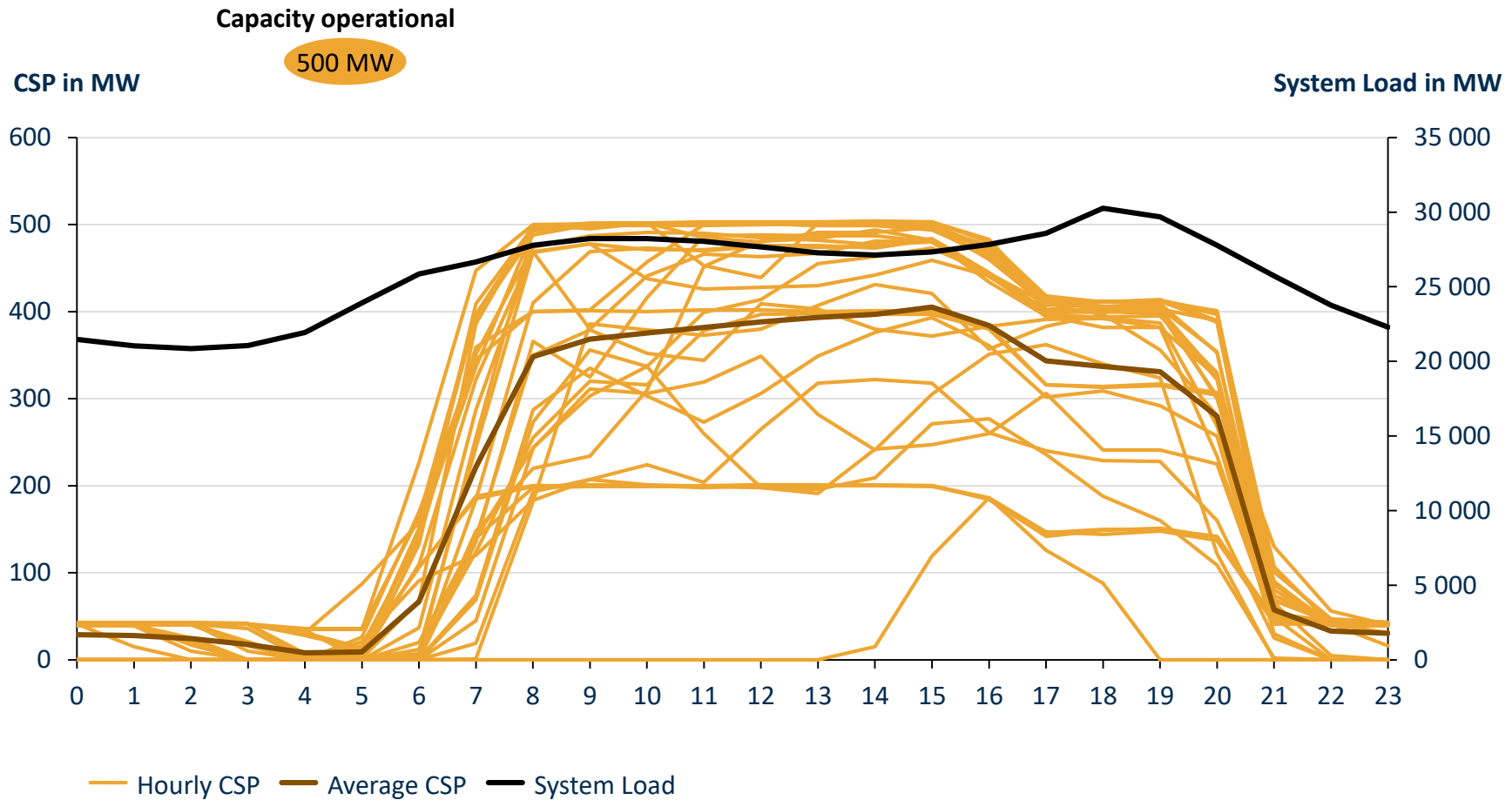
In Aug 2020, CSP storage used in evenings

Hourly CSP production for all 31 days of August 2020 & average system load diurnal course



In Sep 2020, CSP storage used in evenings

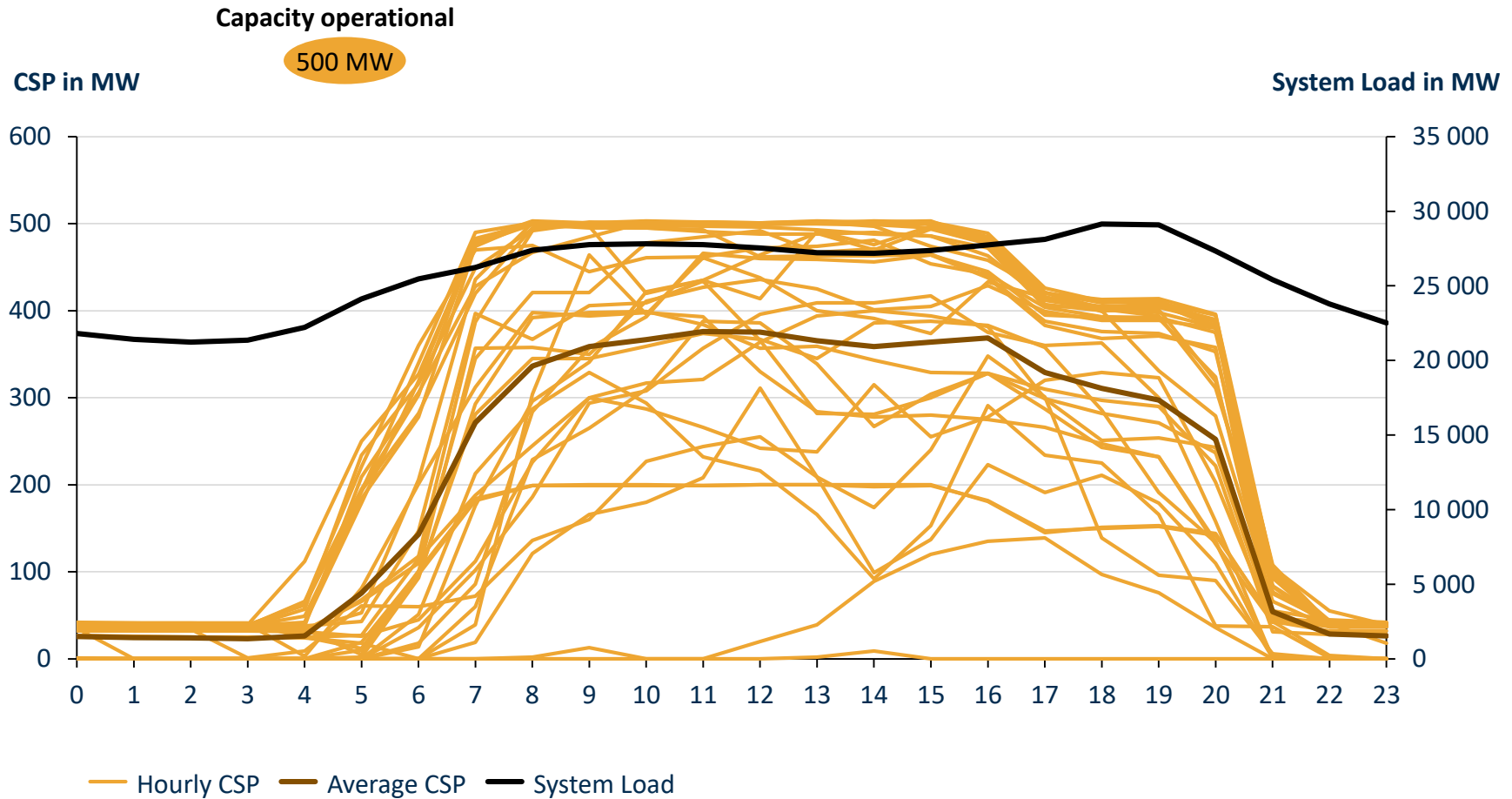
Hourly CSP production for all 30 days of September 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

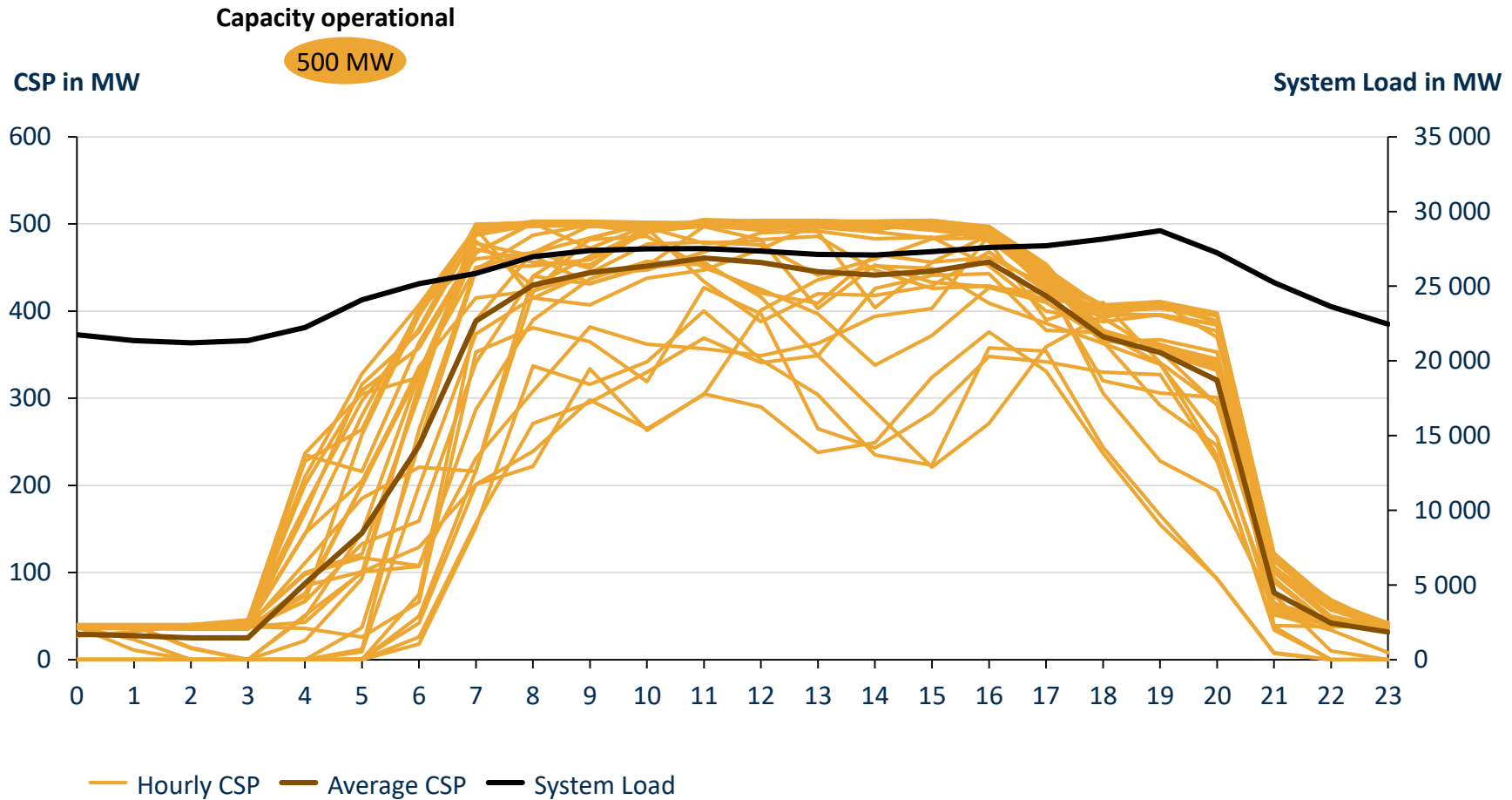
In Oct 2020, CSP storage used in evenings

Hourly CSP production for all 31 days of October 2020 & average system load diurnal course



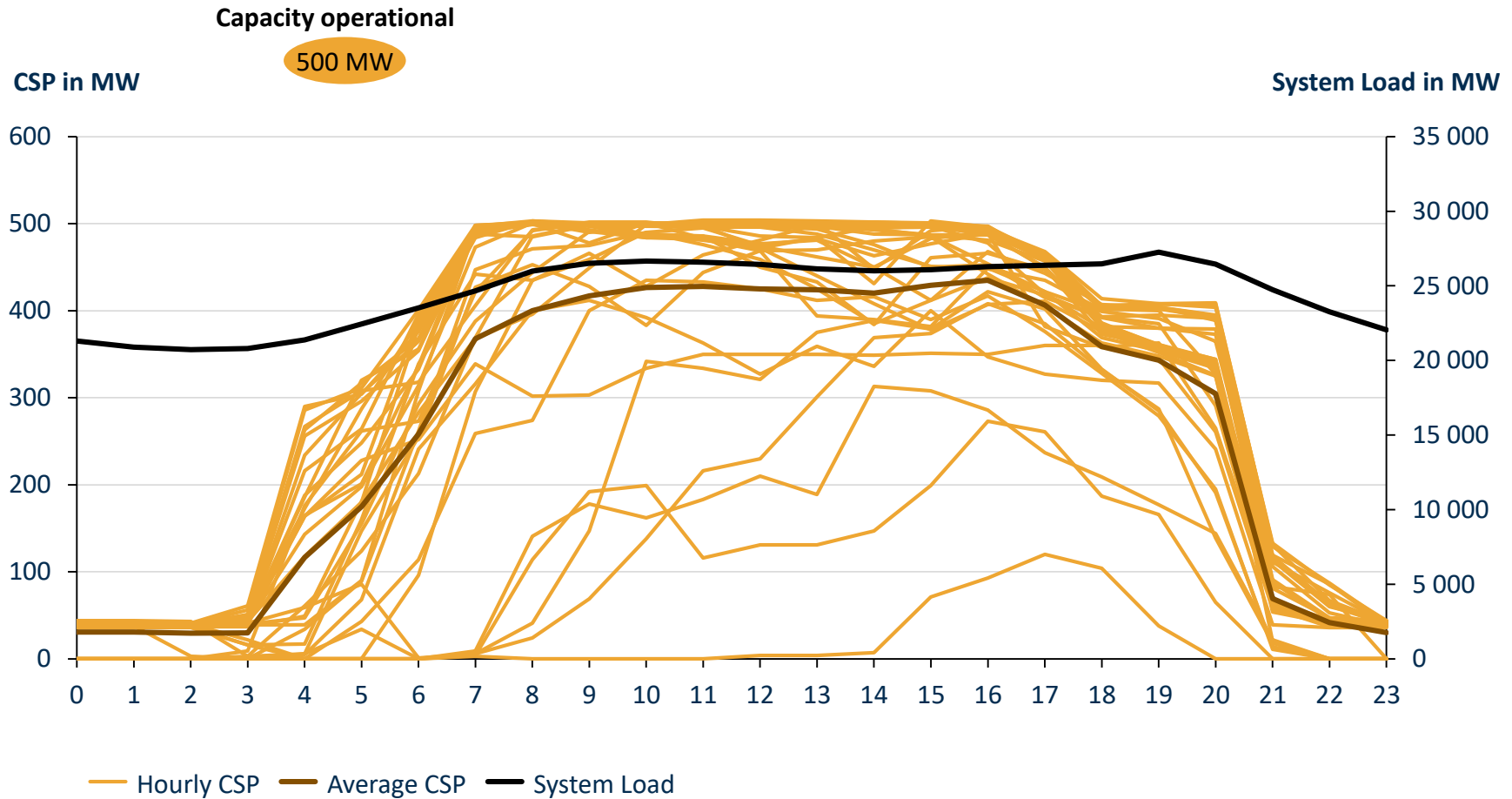
In Nov 2020, CSP storage used in evenings

Hourly CSP production for all 30 days of November 2020 & average system load diurnal course



In Dec 2020, CSP storage used in evenings

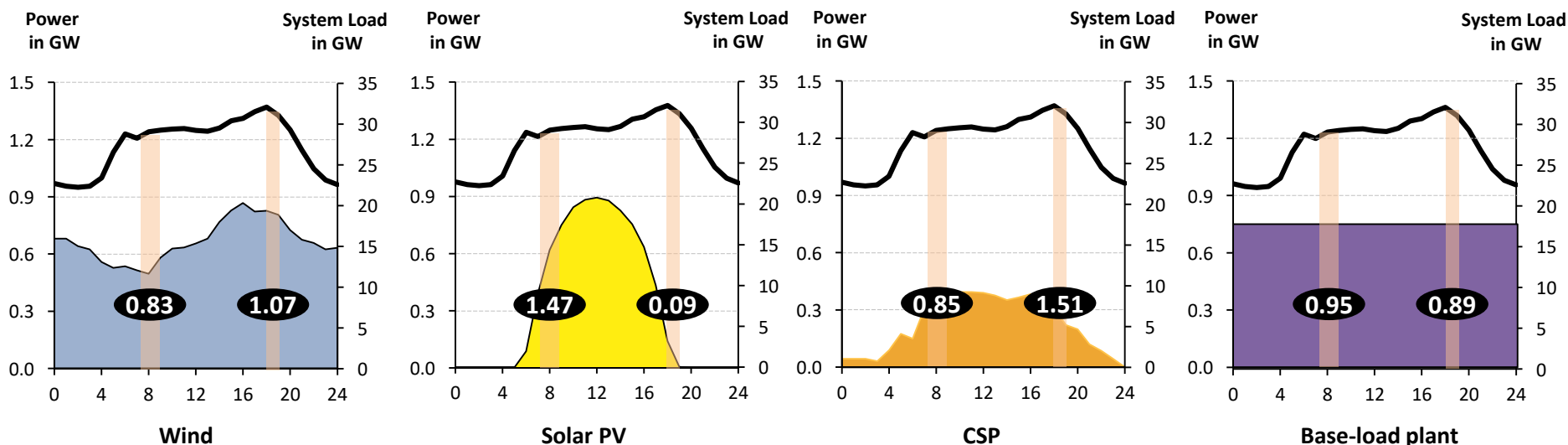
Hourly CSP production for all 30 days of December 2020 & average system load diurnal course



Note: System load excludes hydro pumping load
Sources: Eskom; CSIR Energy Centre analysis

Peak-hour contribution ratio of solar PV was higher than a base-load plant in the morning, wind & CSP higher than base-load in evening peak

Illustrative days showing the overlap of wind, solar PV, CSP and a base-load plant with the morning and evening peak hours

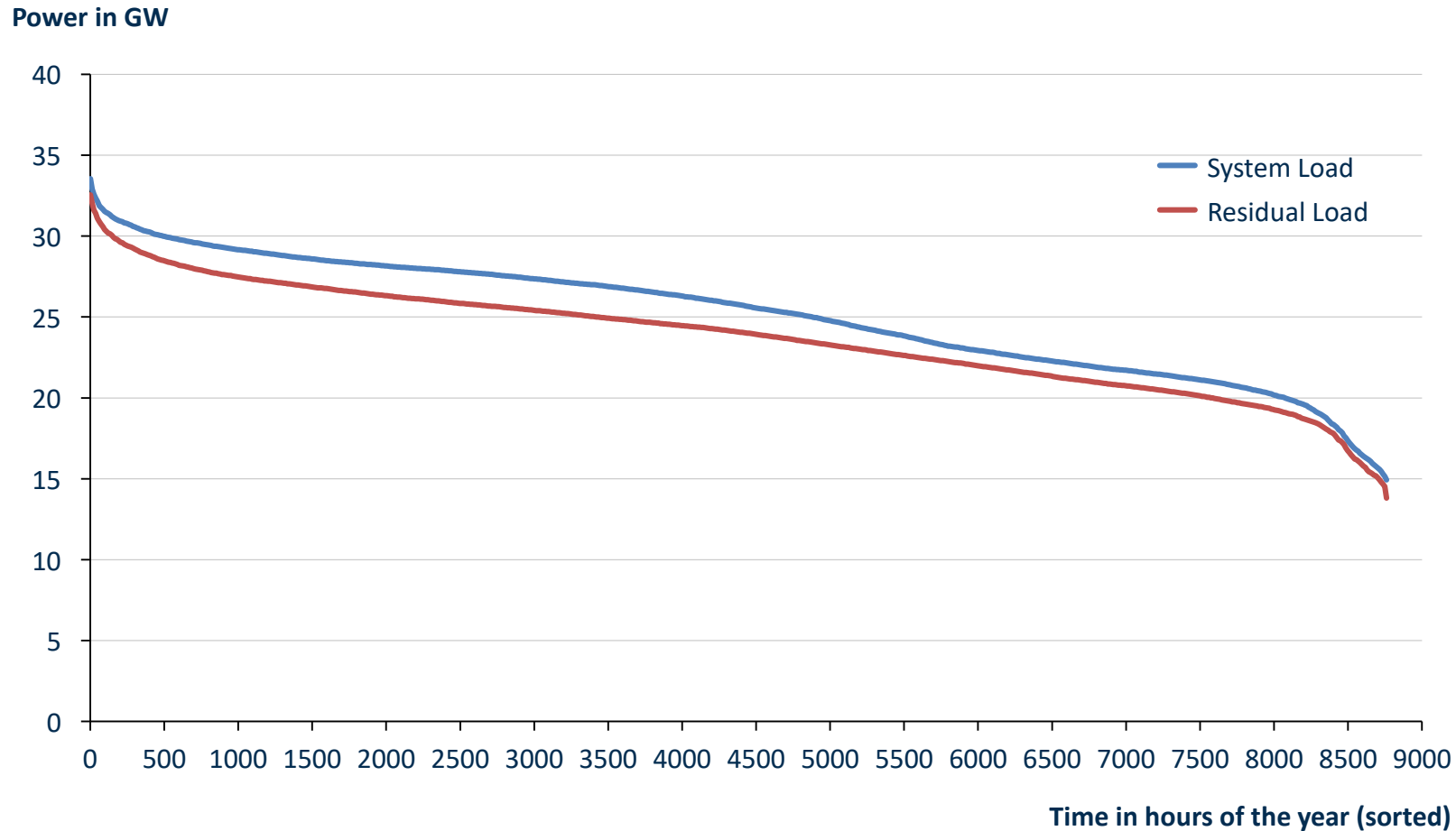


Peak-hour contribution ratio = relative energy contribution during peak / relative total energy contribution

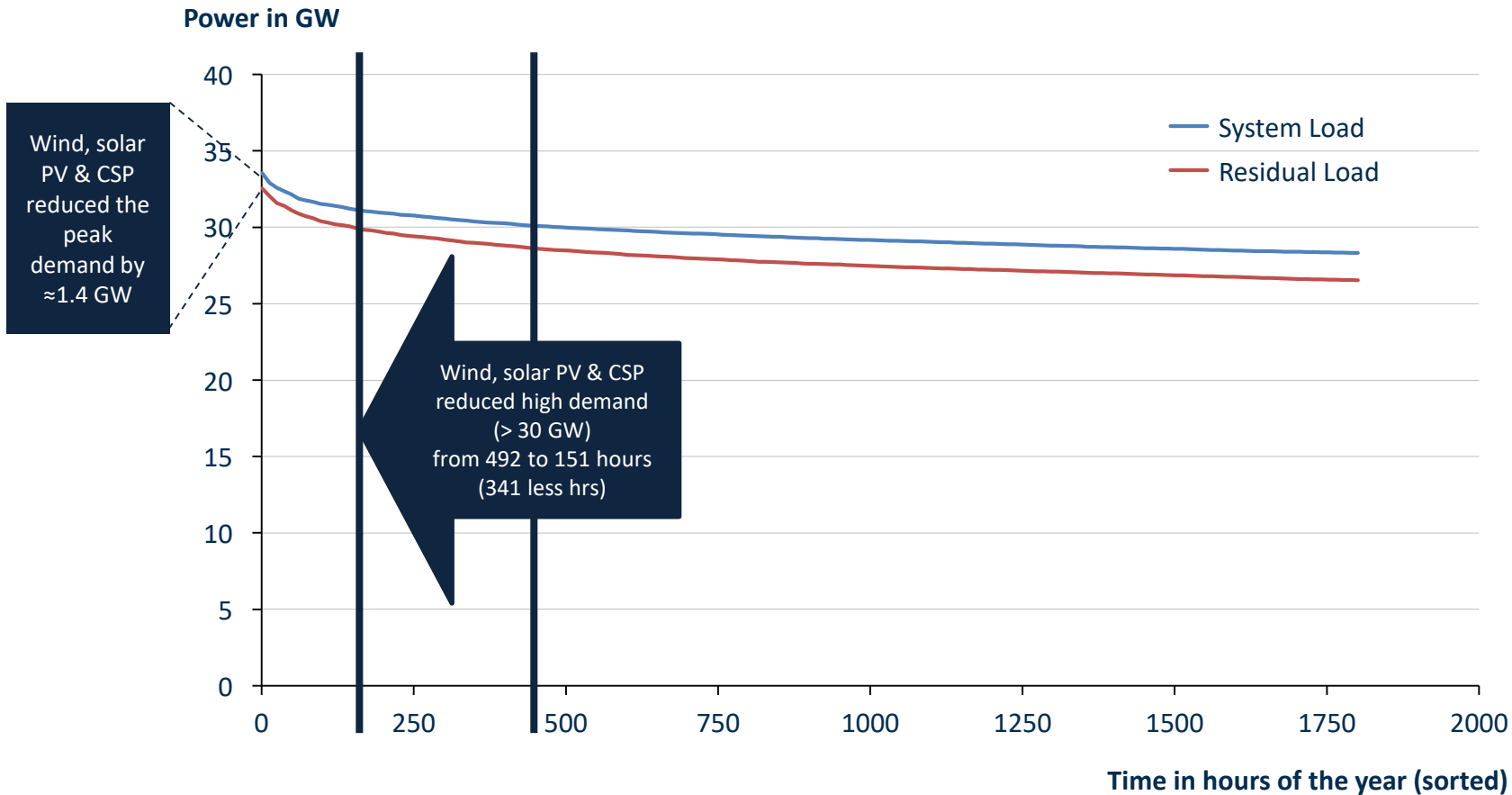
Wind, solar PV and CSP morning and evening peak-hour contribution ratios (for all hours from Jan-Dec 2020) show that:

- Wind contributes 7% more energy during the evening peaks than it does during the other hours of the day
- Solar PV contributes 47% more energy in the morning peaks than it does during the other hours of the day
- CSP contributes 51% more energy during the evening peaks than it does during the other hours of the day

Jan - Dec 2020 system load and residual load duration curves

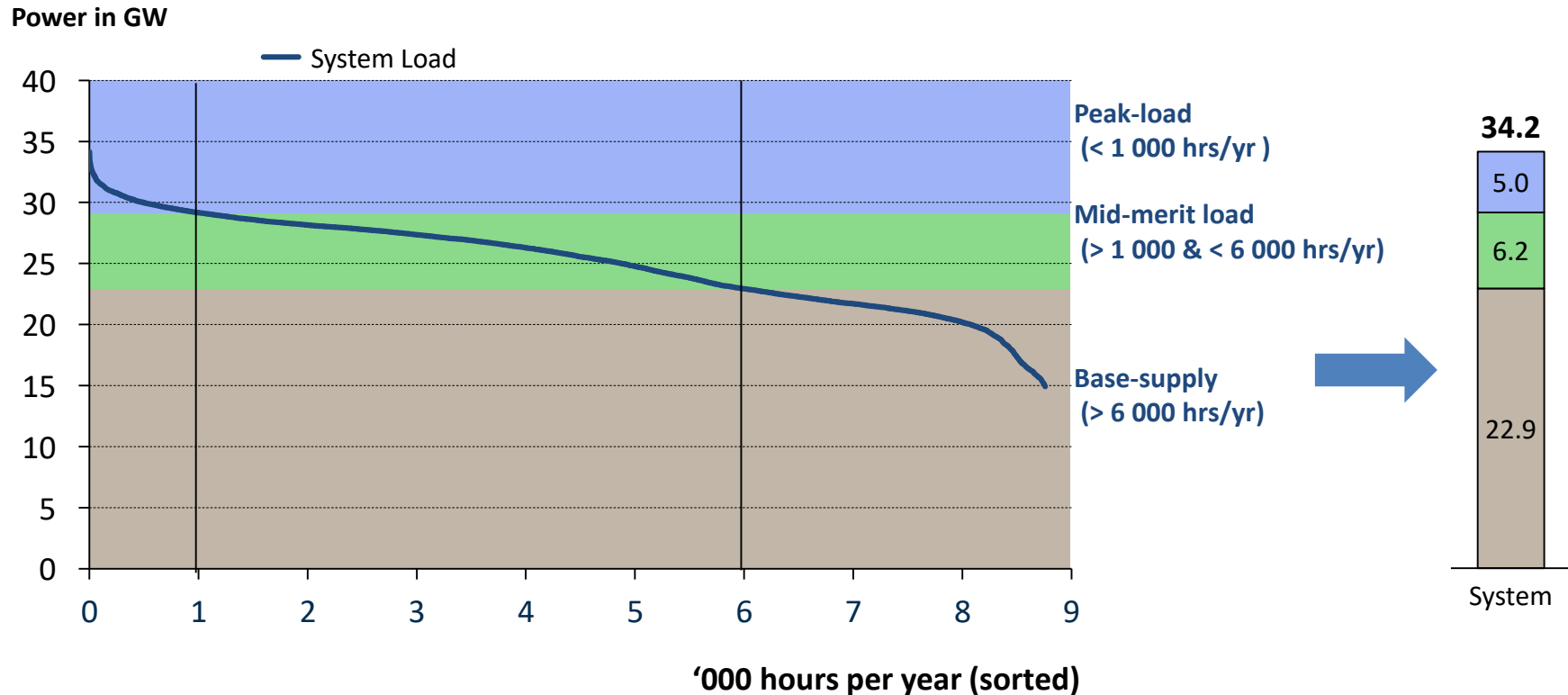


From Jan-Dec 2020 - wind, solar PV & CSP reduced the number of hours with > 30 GW total load from 492 to 151 (~341 hours less)



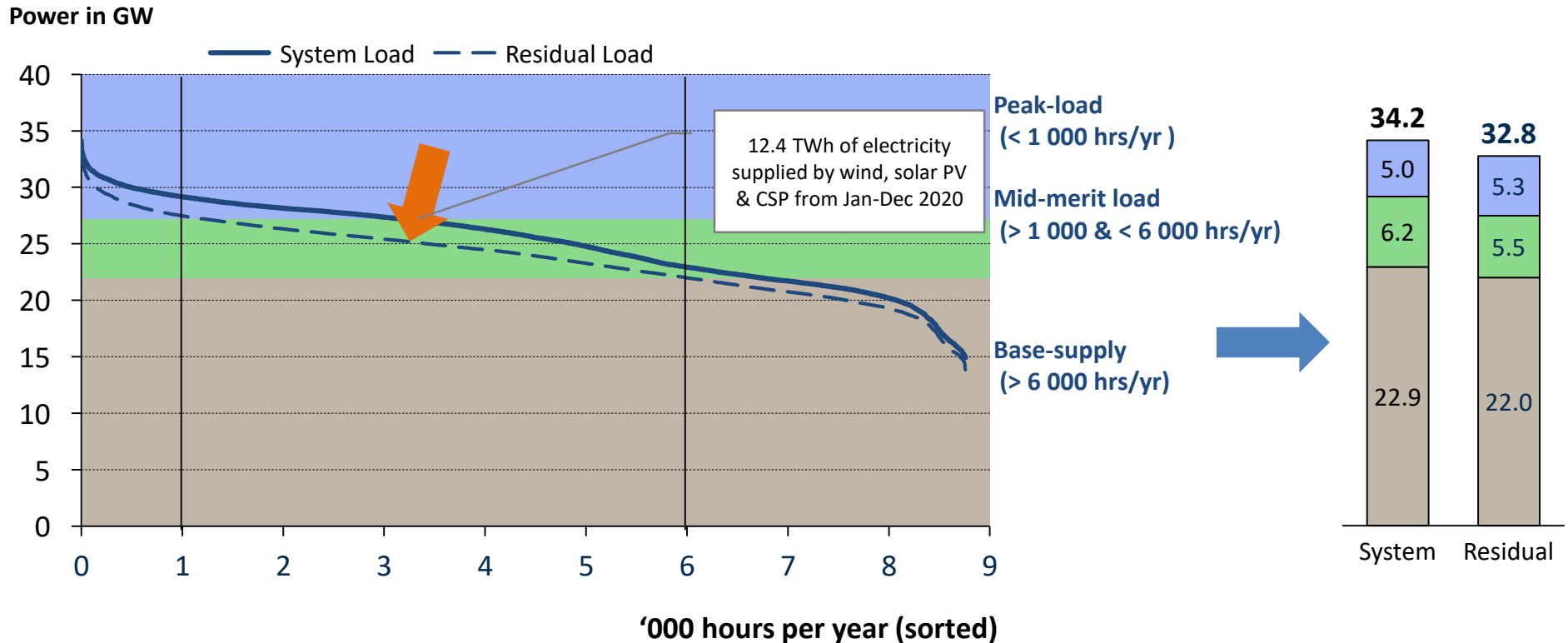
System load for 2020 meant peaking type capacity of 5.0 GW, mid-merit capacity of 6.2 GW, and base-load capacity of 22.9 GW

Load Duration Curve for Jan to Dec 2020 as per actual data



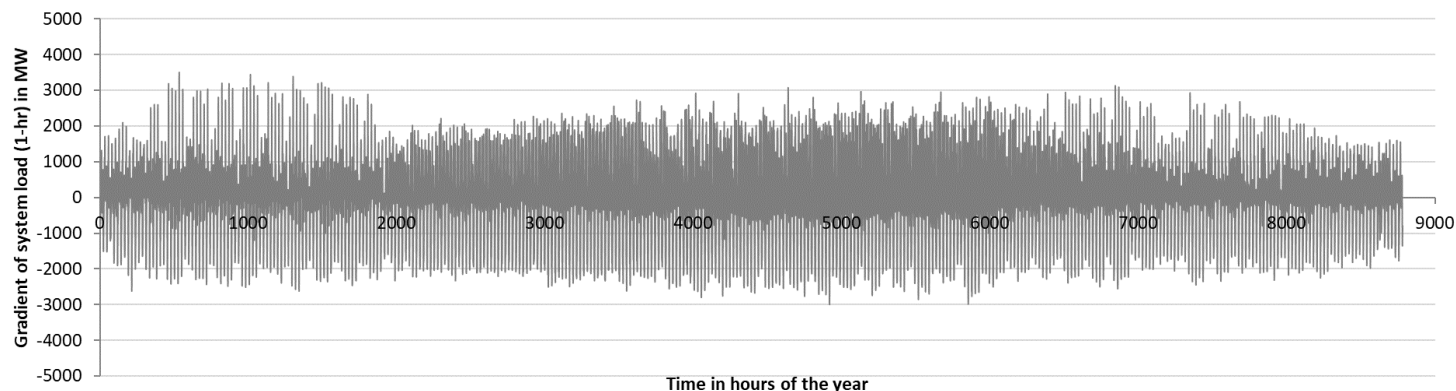
Wind/PV/CSP changes residual load shape - more peaking (+6%), notably less mid-merit (-12%) and slightly less base-supply type capacity (-4%)

Load Duration Curve for Jan to Dec 2020 as per actual data



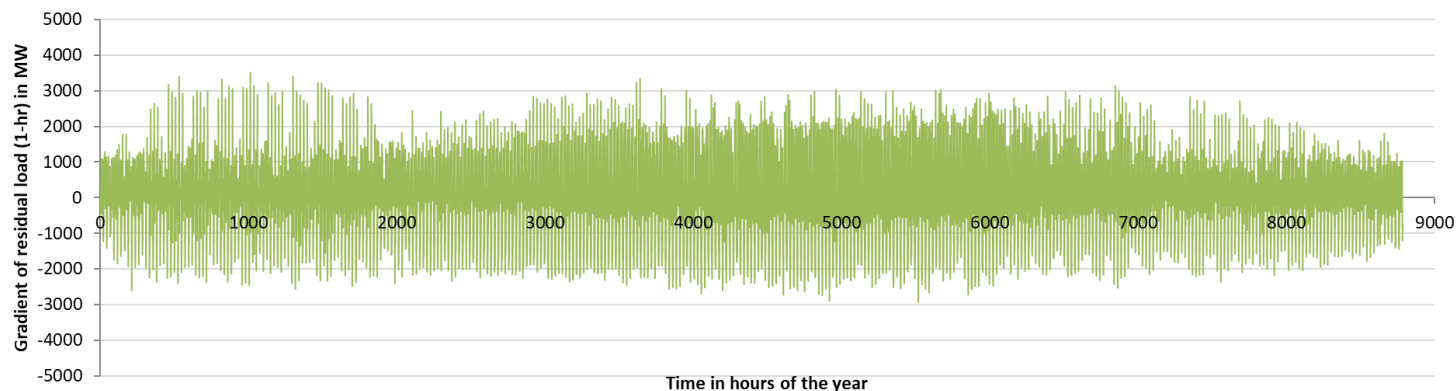
1-hour gradients minimally affected by 5 GW of wind, solar PV & CSP

System Load 1-hour-gradients Jan - Dec 2020



- Max gradient of 3 498 MW on 23 Jan 2020
- Min gradient of -3 000 MW on 23 Jul 2020

Residual Load 1-hour-gradients Jan - Dec 2020



- Max gradient of 3 514 MW on 12 Feb 2020
- Min gradient of -2 930 MW on 17 Aug 2020

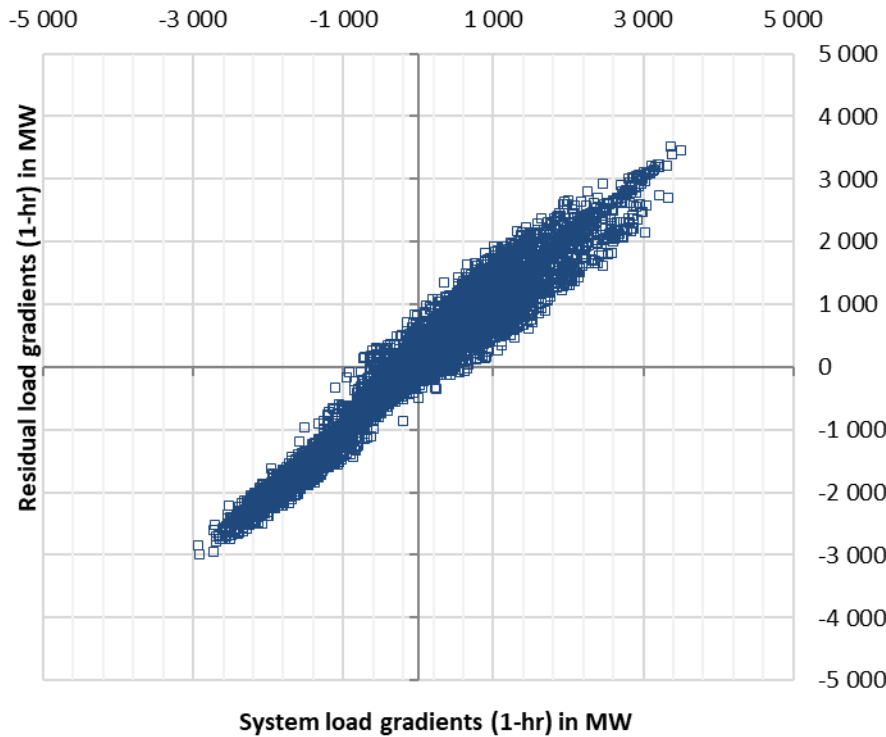
Residual load = System load - Solar PV - Wind - CSP



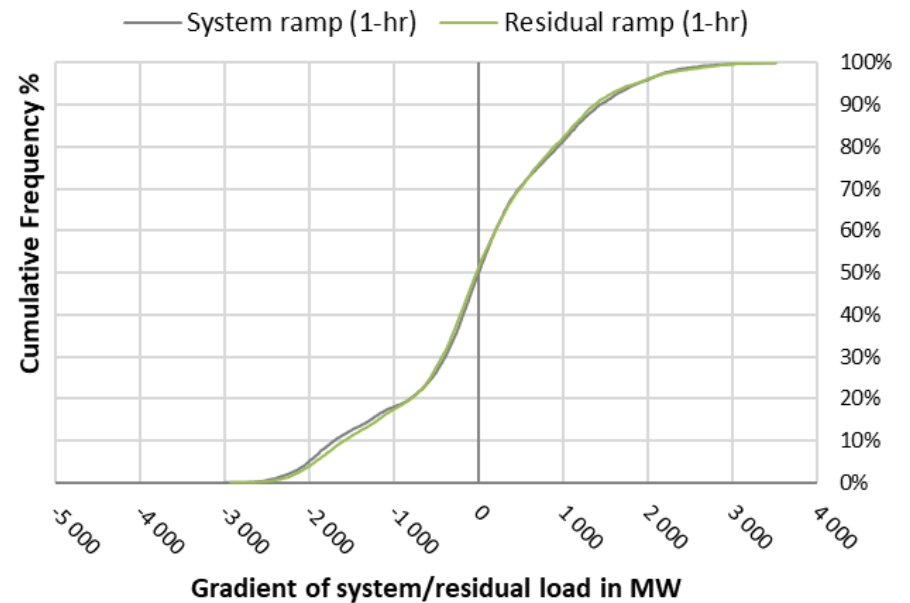
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1-hour gradients did not significantly increase due to 5 GW of wind, solar PV & CSP

System load 1-hour gradients vs. residual load 1-hour gradients for all hours from Jan – Dec 2020

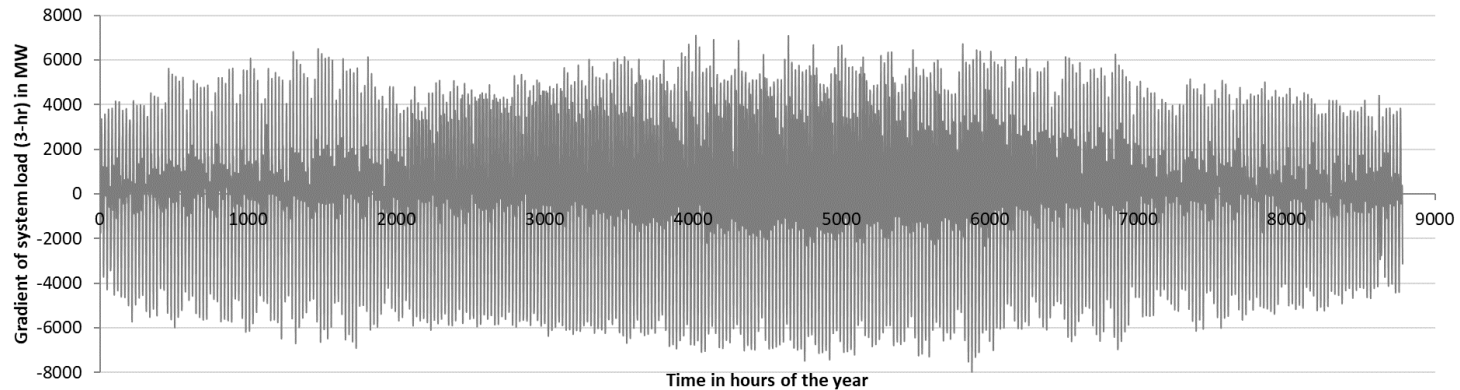


Cumulative frequency distribution of 1-hour gradients for all hours from Jan – Dec 2020



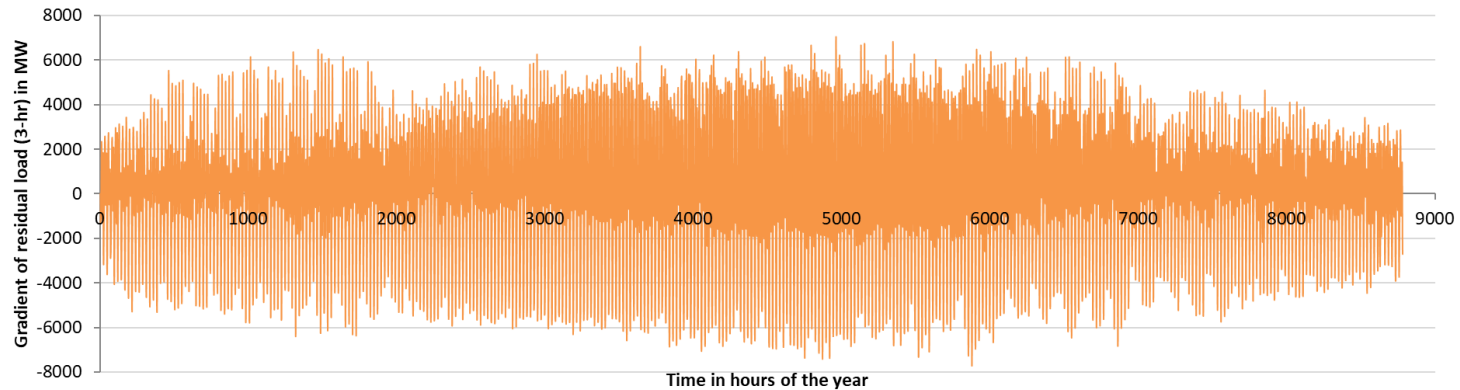
3-hour gradients minimally affected by 5 GW of wind, solar PV & CSP

System Load 3-hour-gradients Jan - Dec 2020



- Max gradient of 7 094 MW on 16 Jun 2020
- Min gradient of -7 925 MW on 1 Sep 2020

Residual Load 3-hour-gradients Jan - Dec 2020



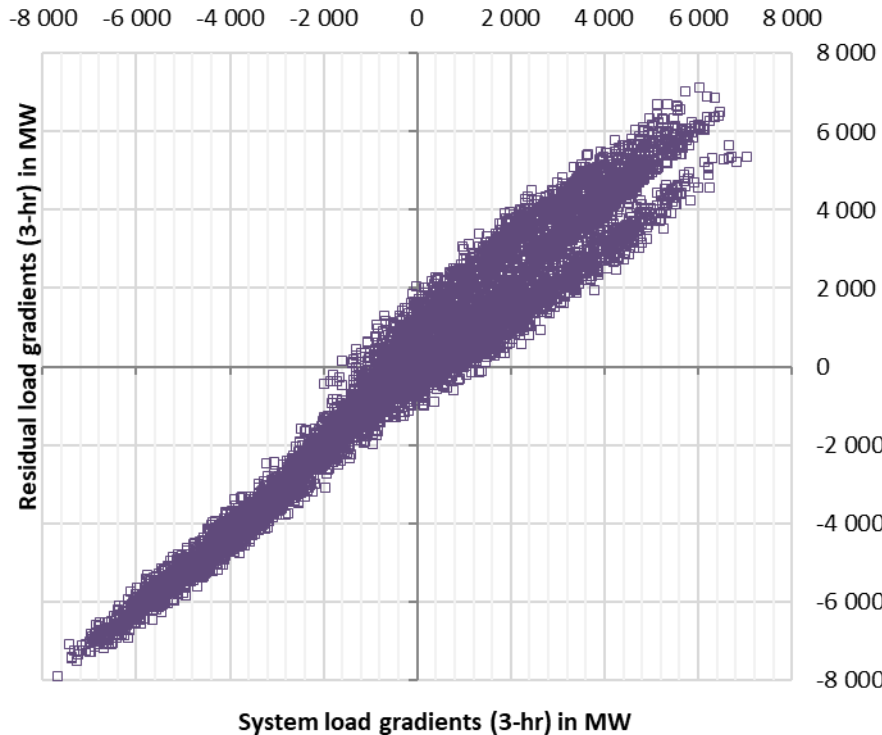
- Max gradient of 7 053 MW on 25 Jul 2020
- Min gradient of -7 672 MW on 1 Sep 2020

Residual load = System load - Solar PV - Wind - CSP

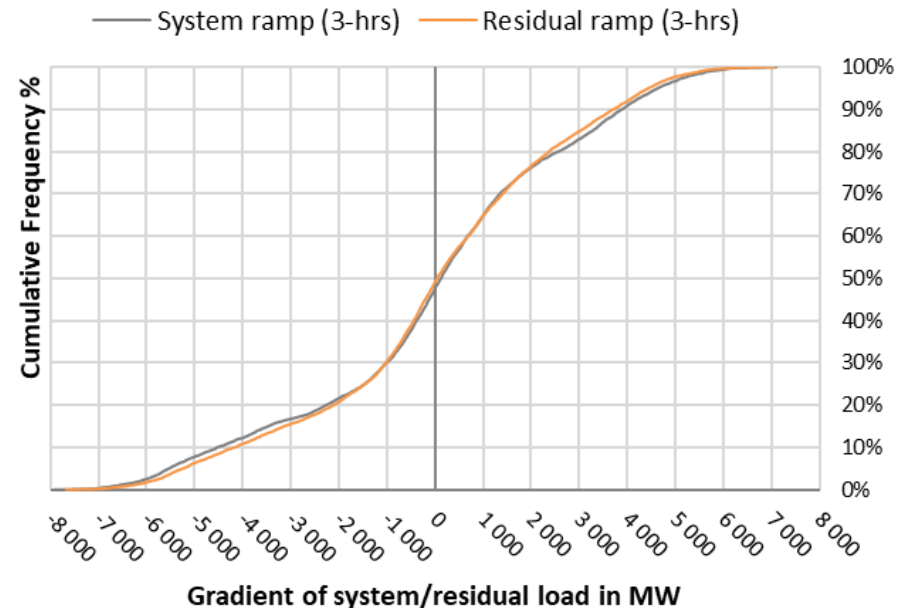


Similarly - 3-hour gradients did not significantly increase due to 5 GW of wind, solar PV & CSP

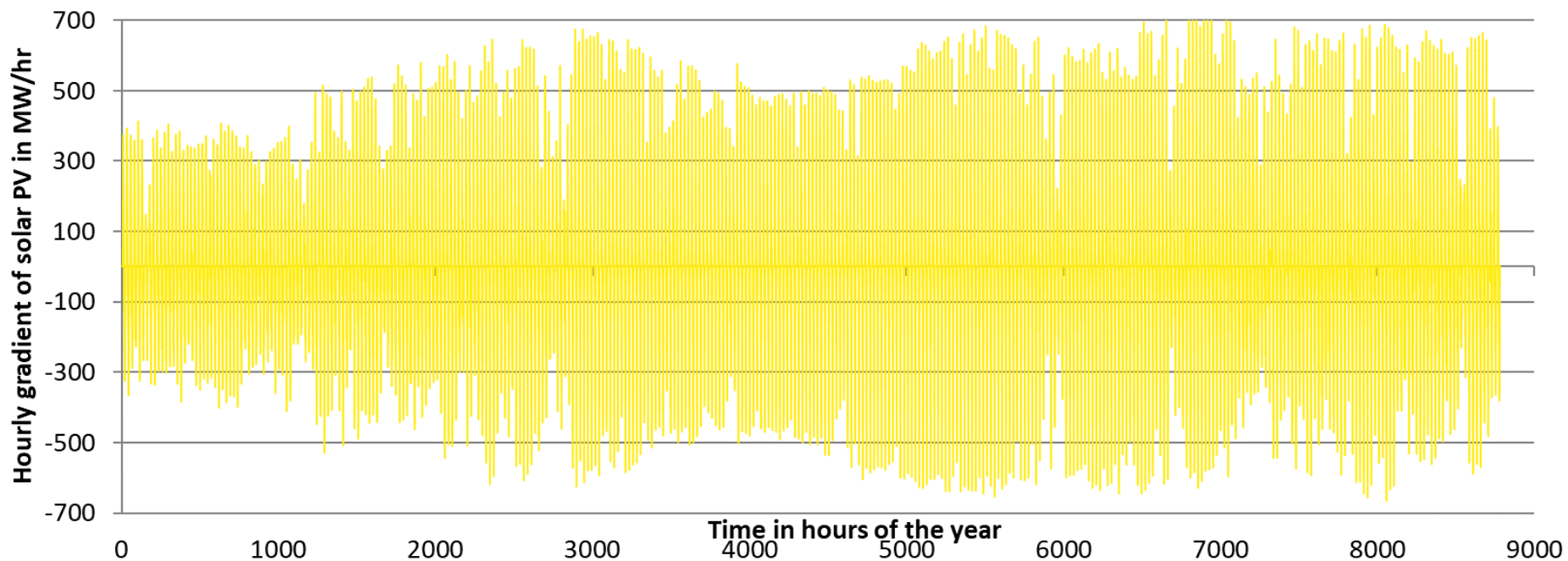
System load 3-hour gradients vs. residual load 3-hour gradients for all hours from Jan – Dec 2020



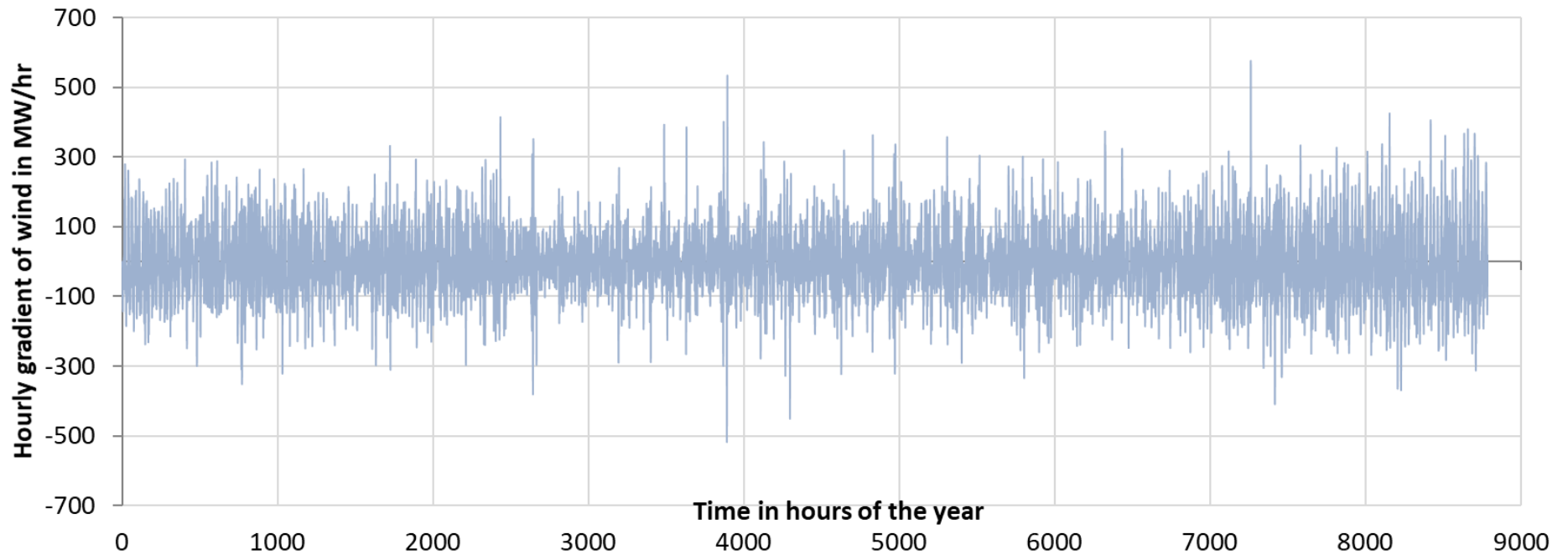
Cumulative frequency distribution of 3-hour gradients for all hours from Jan – Dec 2020



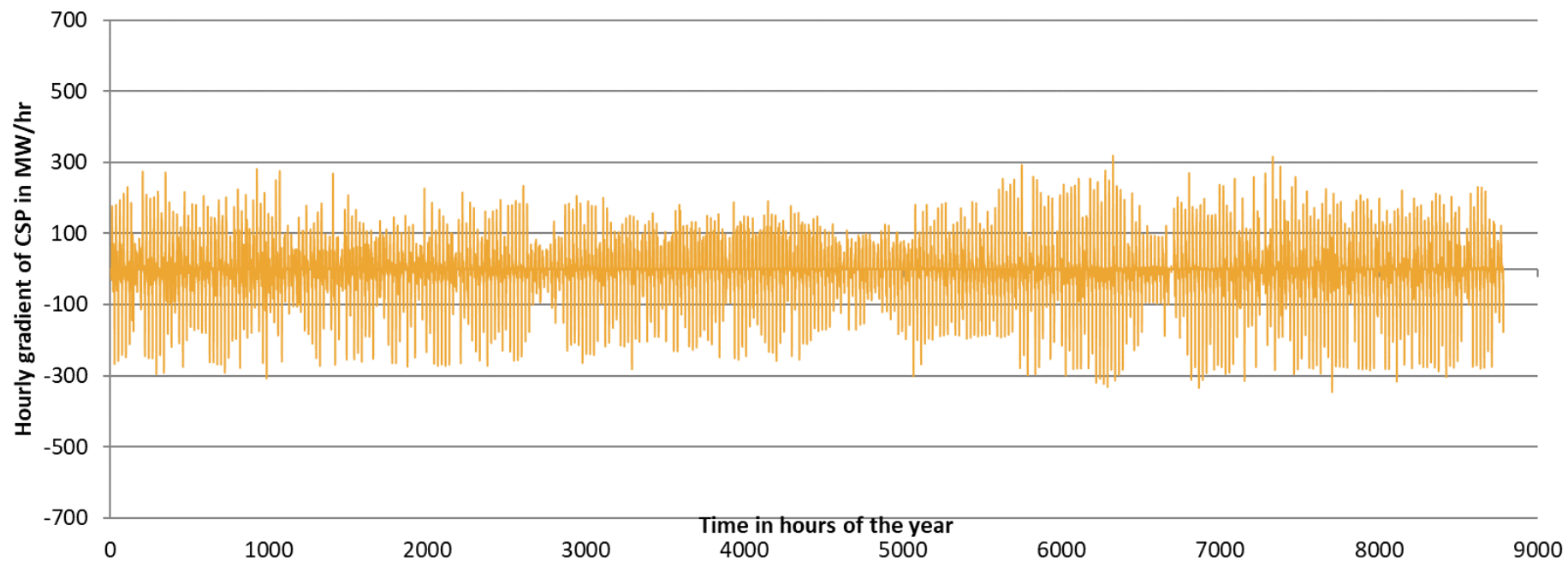
Jan - Dec 2020 1-hour gradients of solar PV supply



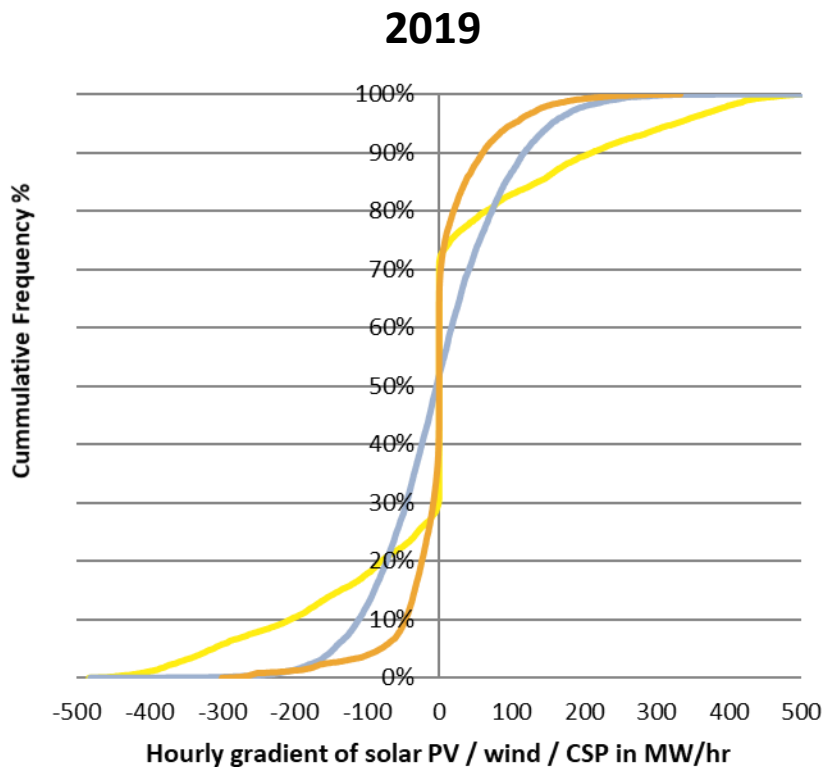
Jan - Dec 2020: 1-hour gradients of wind supply



Jan - Dec 2020 1-hour gradients of CSP supply

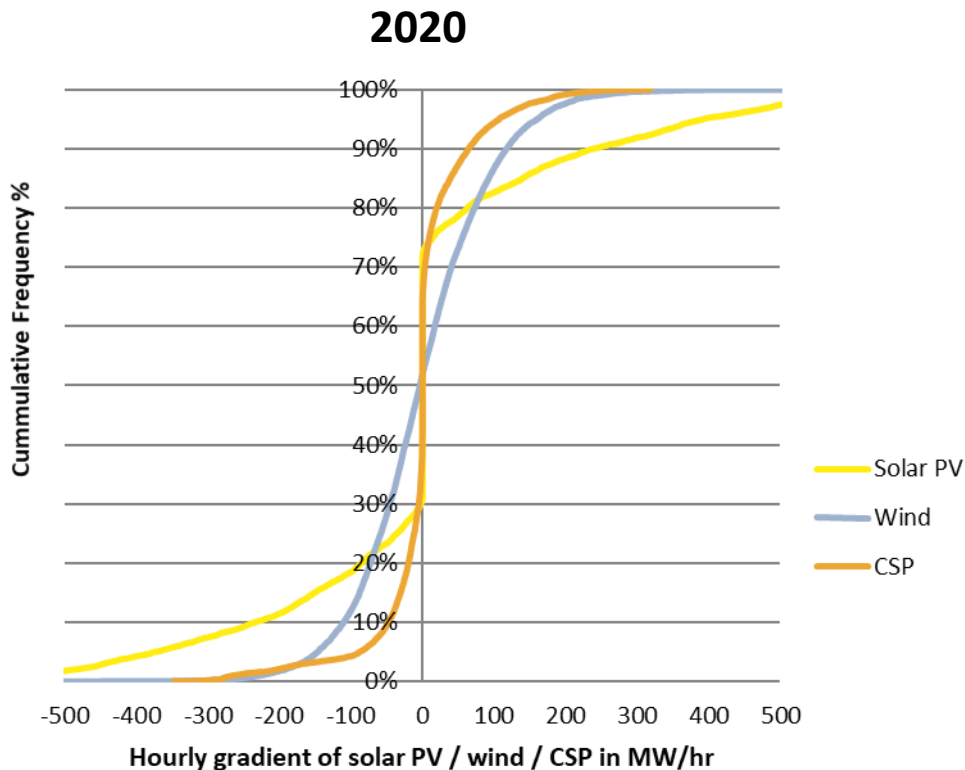


Wind, solar PV & CSP frequency distribution of 1-hour gradients in 2019 and 2020



Capacity operational (end of year)

- 1474 MW
- 2080 MW
- 500 MW



Capacity operational (end of year)

- 2032 MW
- 2495 MW
- 500 MW

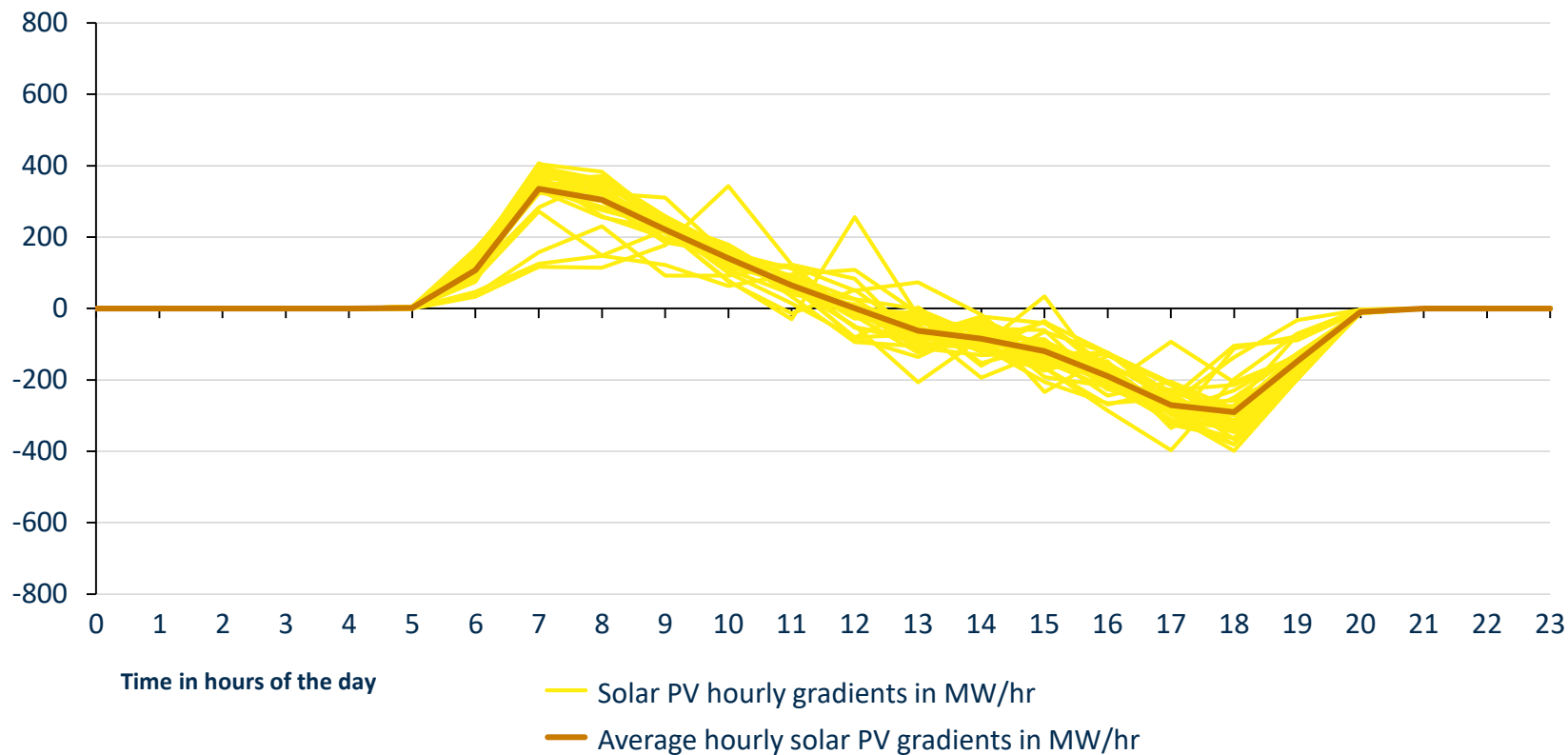


Solar PV 1-hour gradients in January 2020

Capacity operational

1474 MW

Solar PV hourly gradients in MW/h

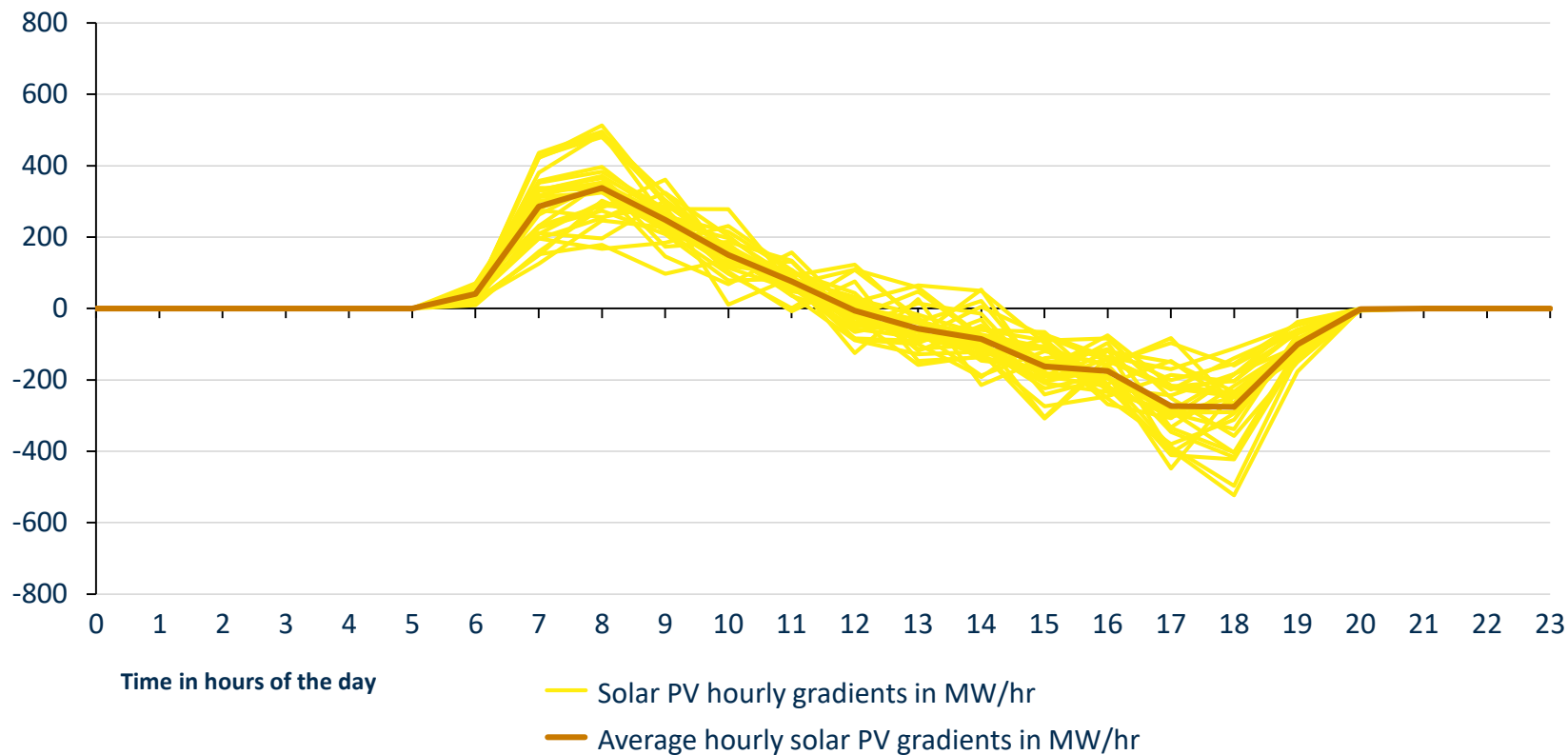


Solar PV 1-hour gradients in February 2020

Capacity operational

1549 MW

Solar PV hourly gradients in MW/h

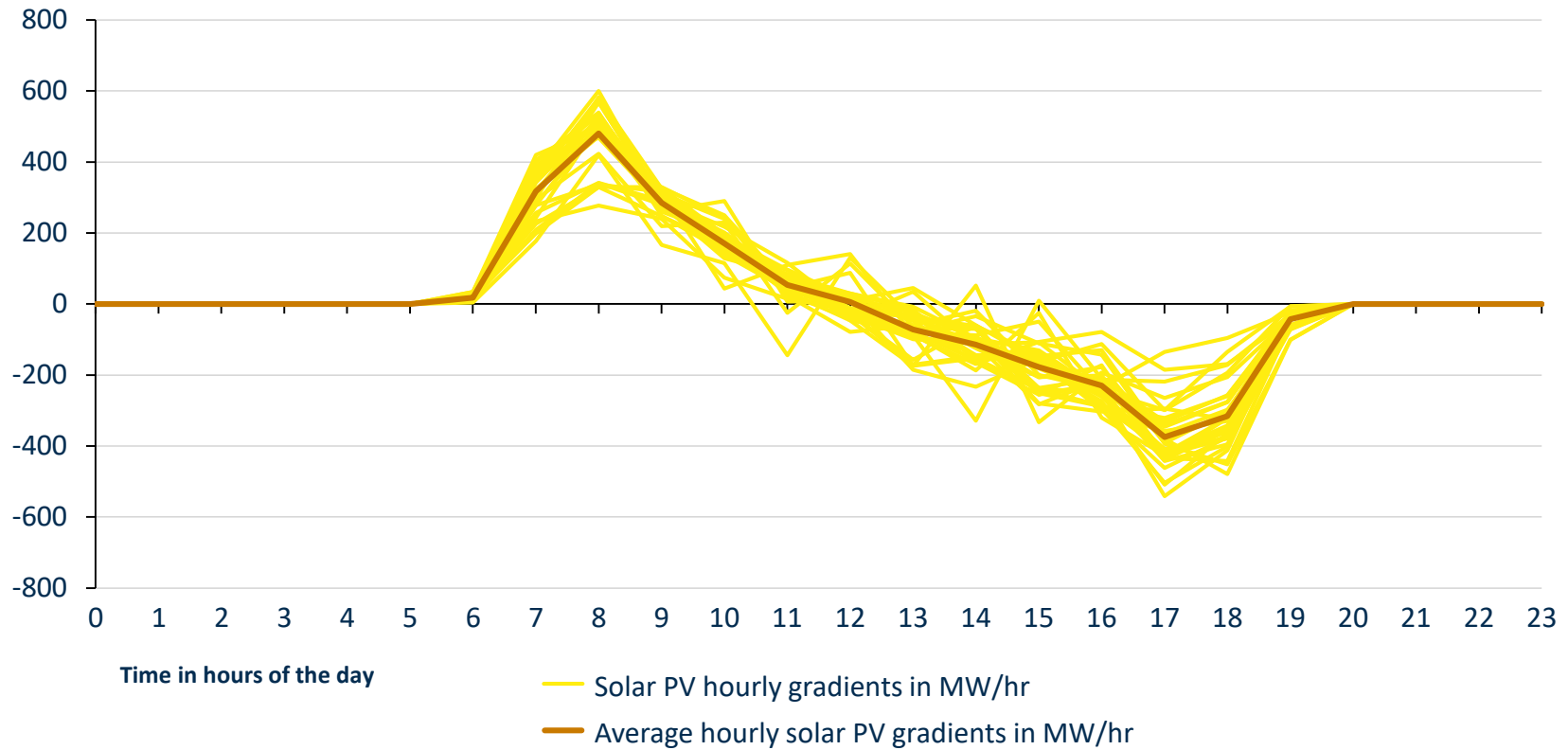


Solar PV 1-hour gradients in March 2020

Capacity operational

1699 MW

Solar PV hourly gradients in MW/h

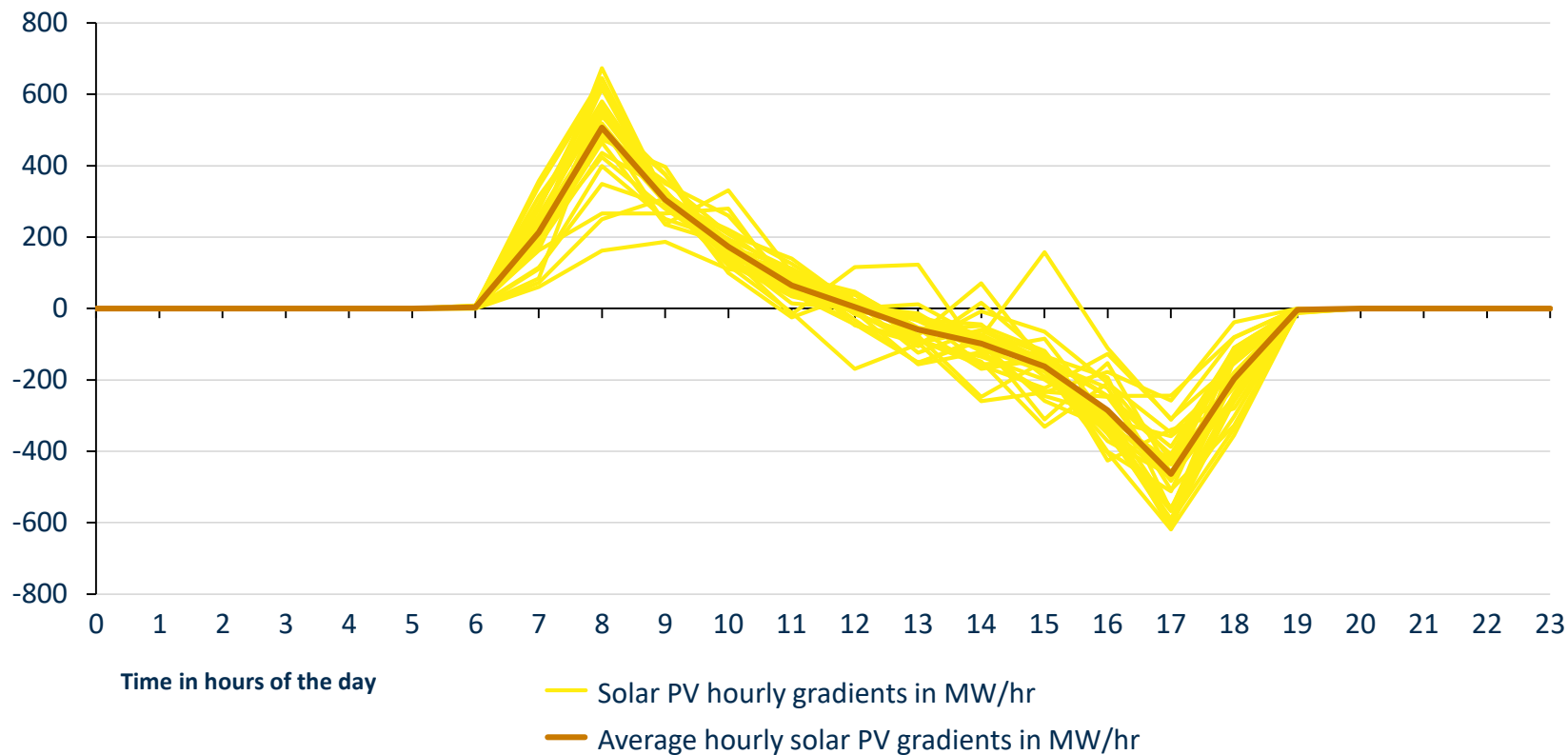


Solar PV 1-hour gradients in April 2020

Capacity operational

1774 MW

Solar PV hourly gradients in MW/h

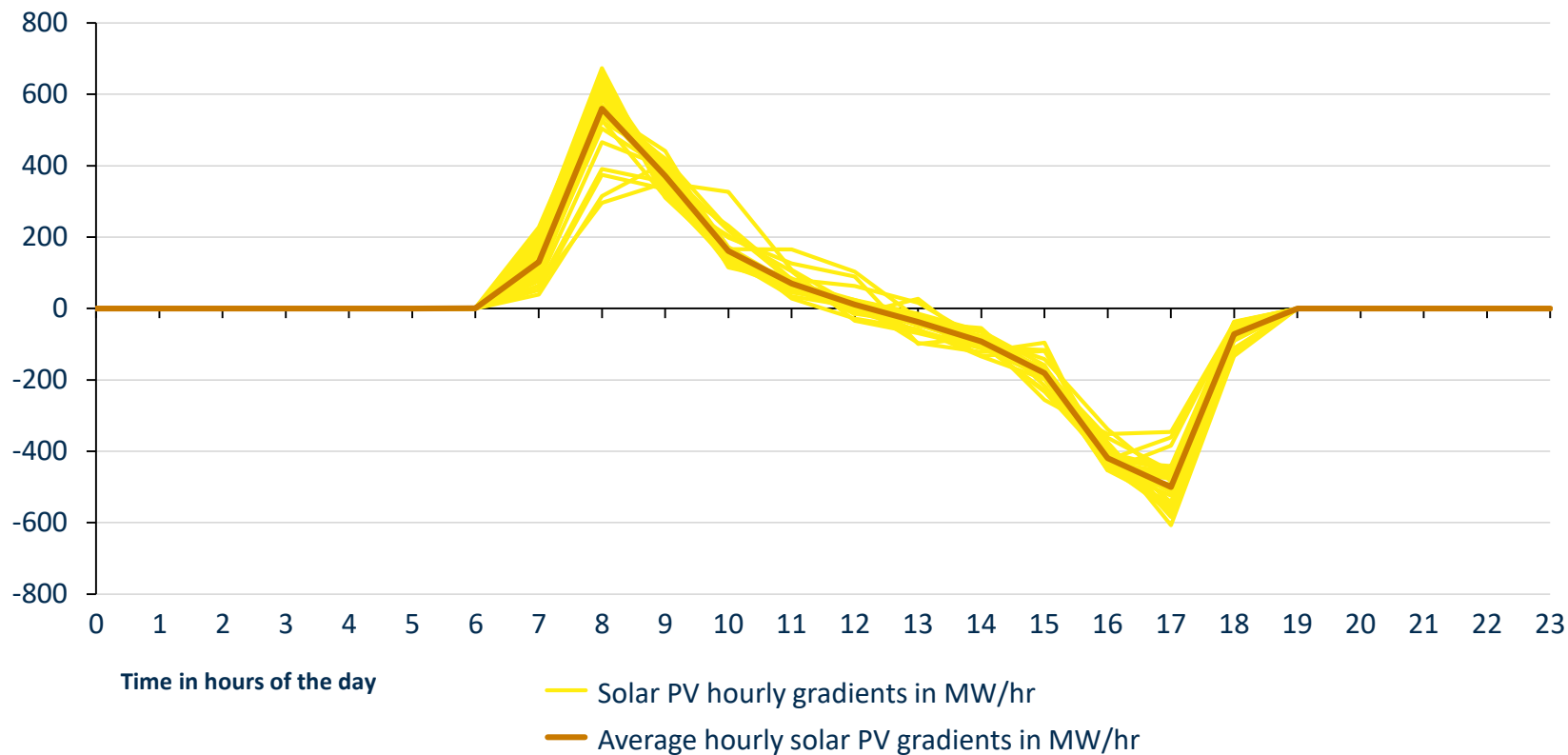


Solar PV 1-hour gradients in May 2020

Capacity operational

1774 MW

Solar PV hourly gradients in MW/h

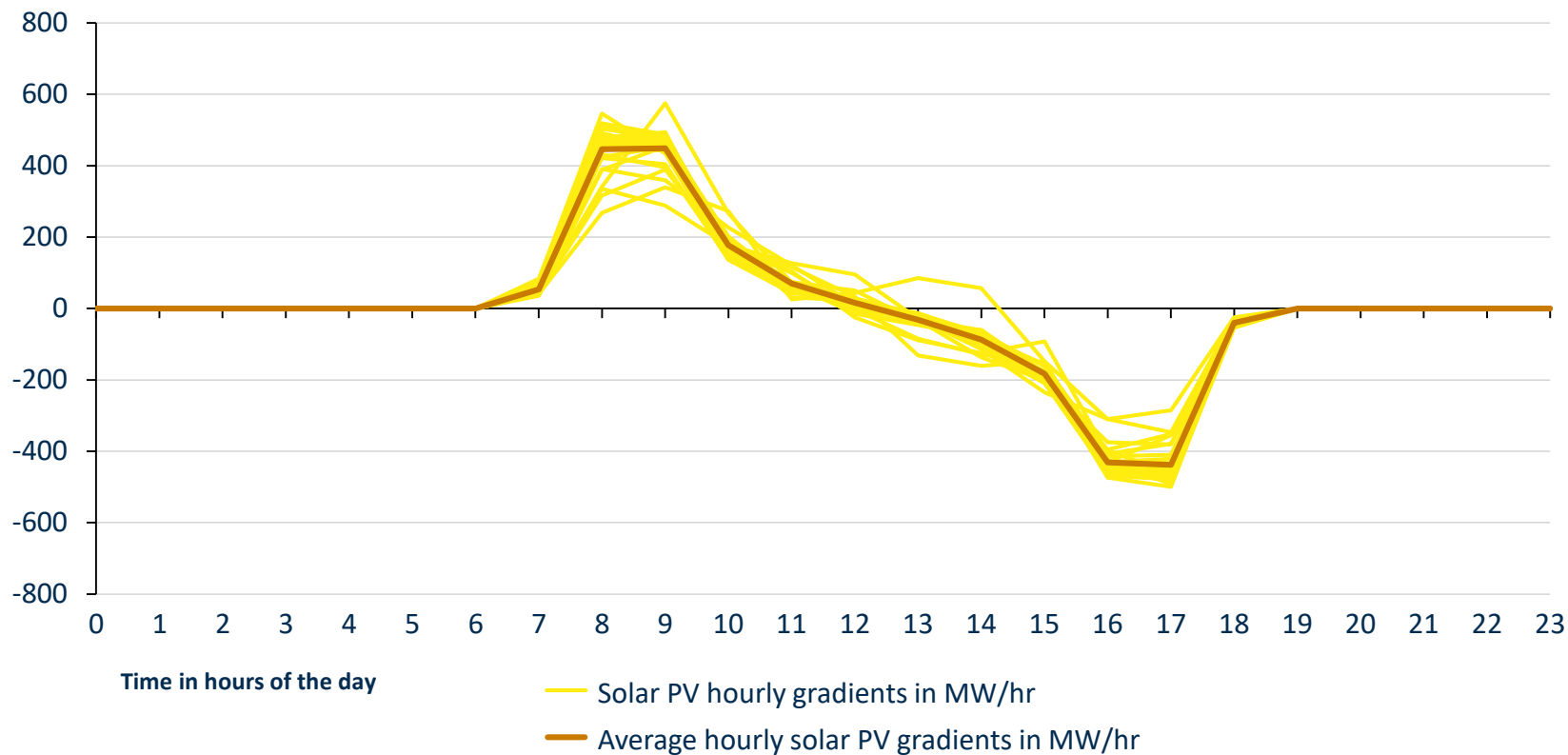


Solar PV 1-hour gradients in June 2020

Capacity operational

1774 MW

Solar PV hourly gradients in MW/h

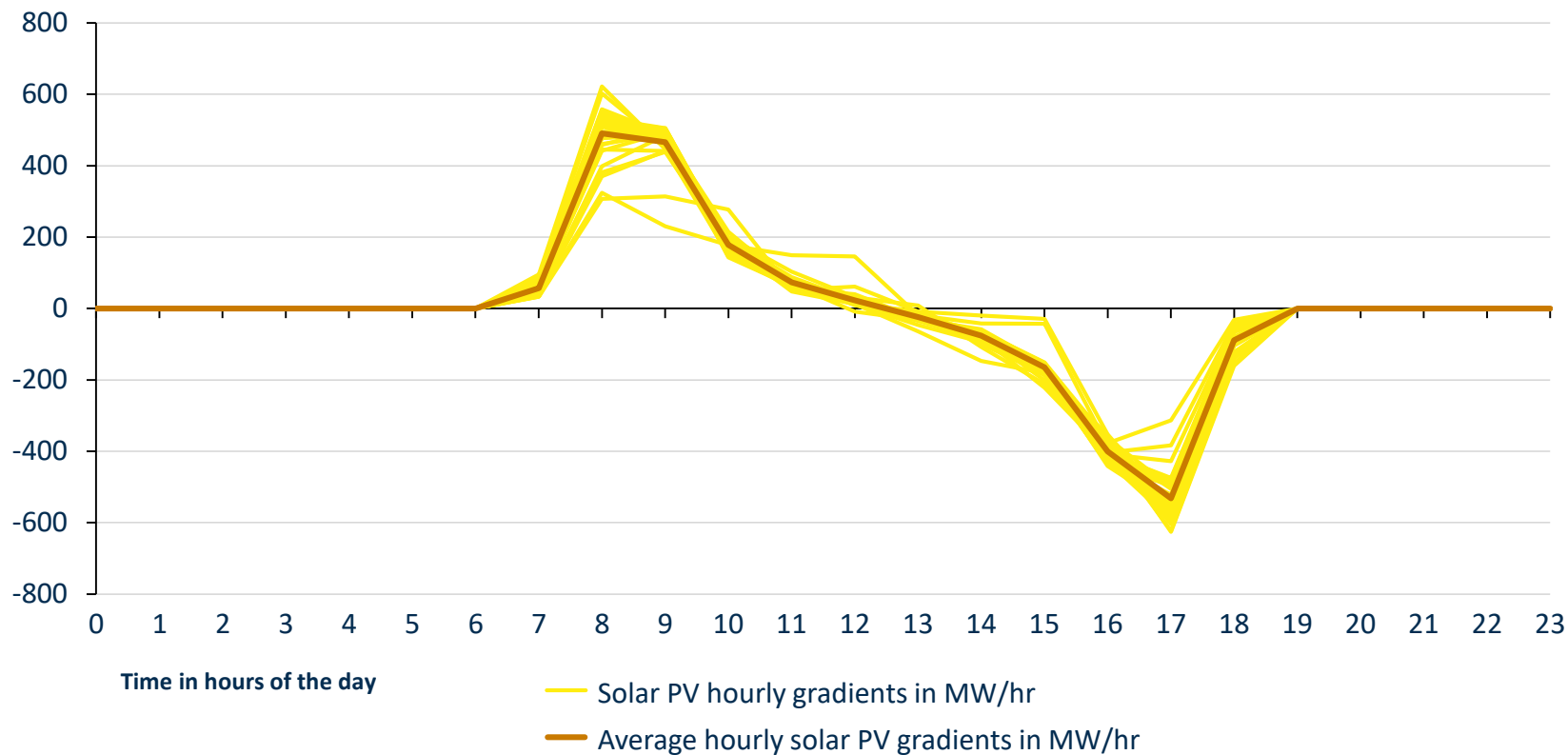


Solar PV 1-hour gradients in July 2020

Capacity operational

1814 MW

Solar PV hourly gradients in MW/h

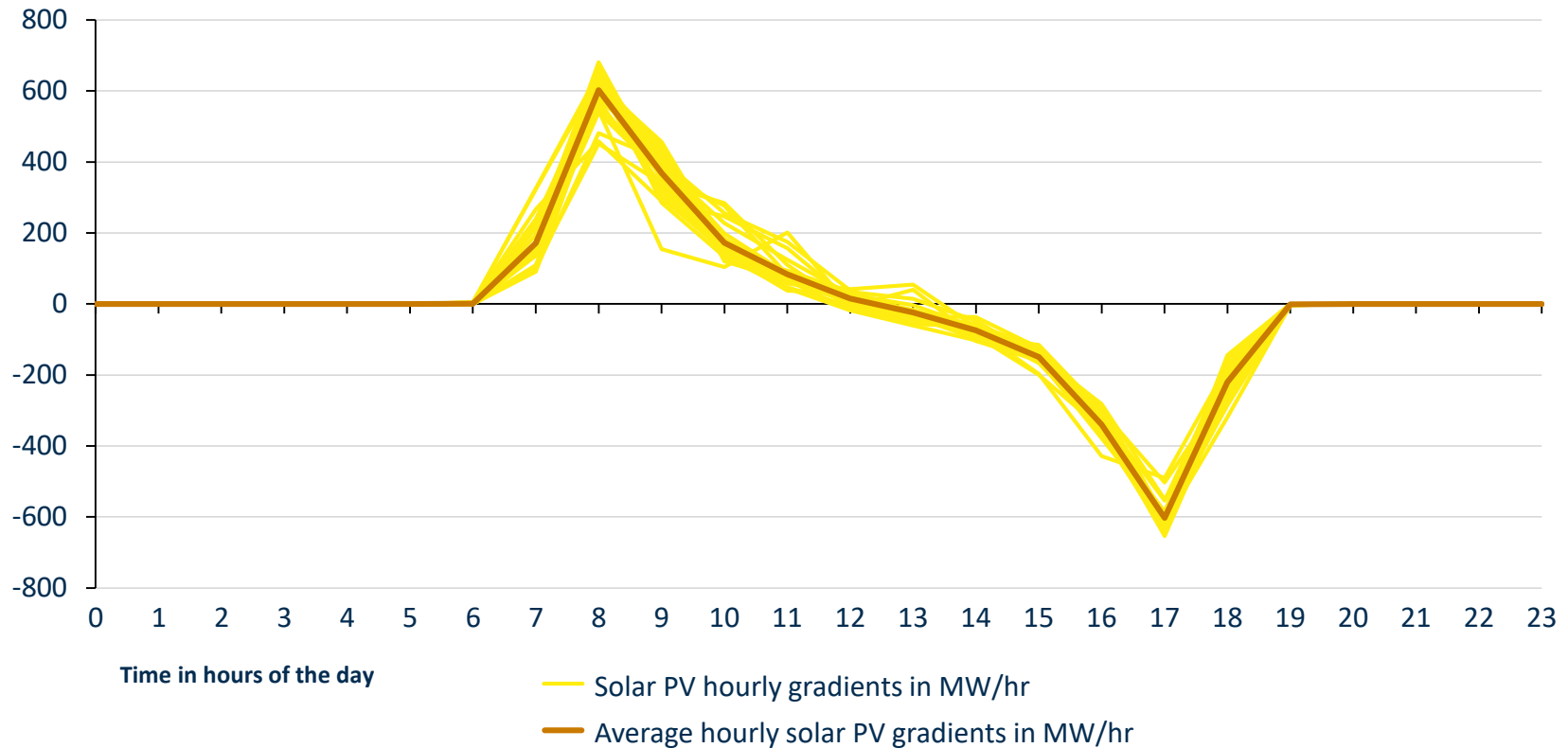


Solar PV 1-hour gradients in August 2020

Capacity operational

1814 MW

Solar PV hourly gradients in MW/h

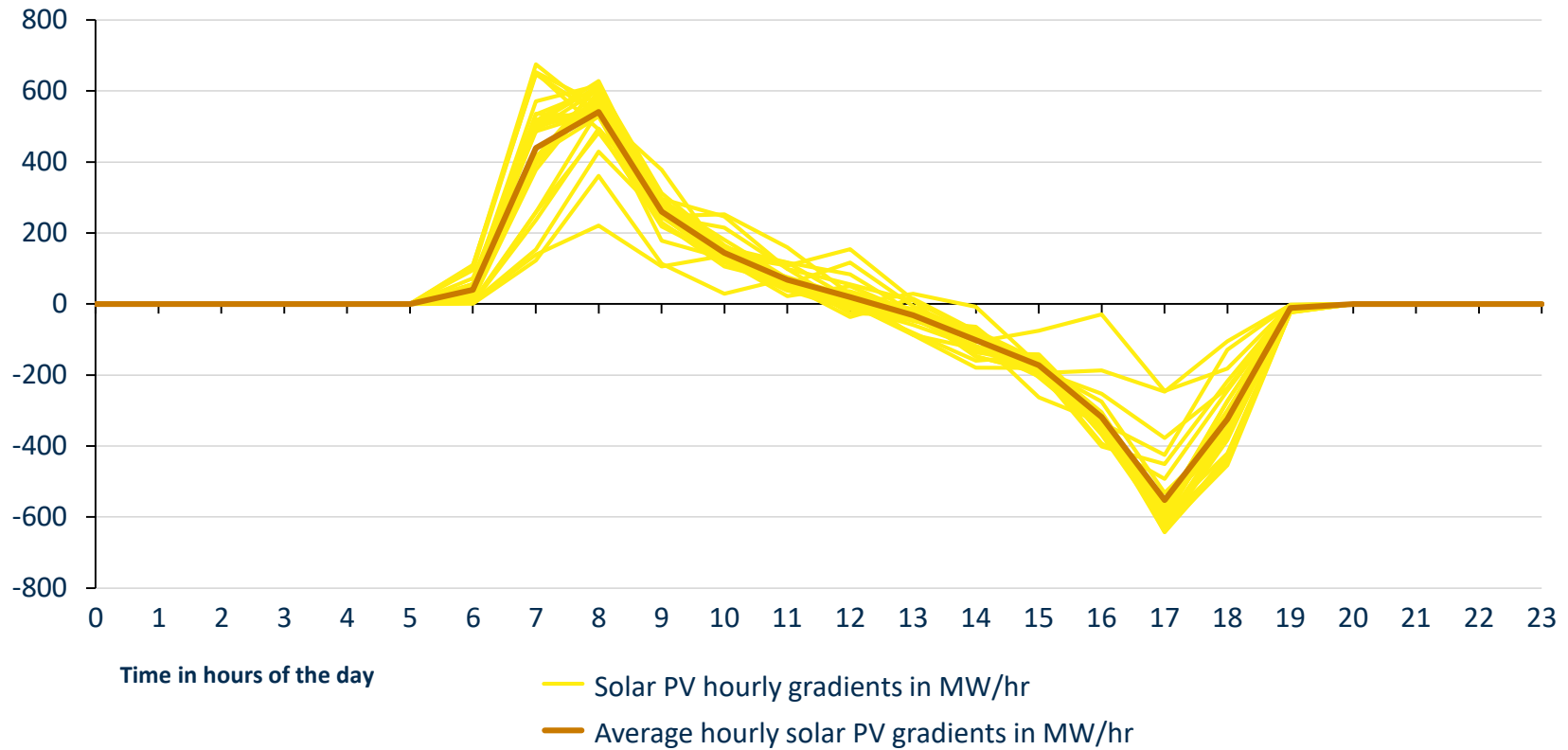


Solar PV 1-hour gradients in September 2020

Capacity operational

1957 MW

Solar PV hourly gradients in MW/h

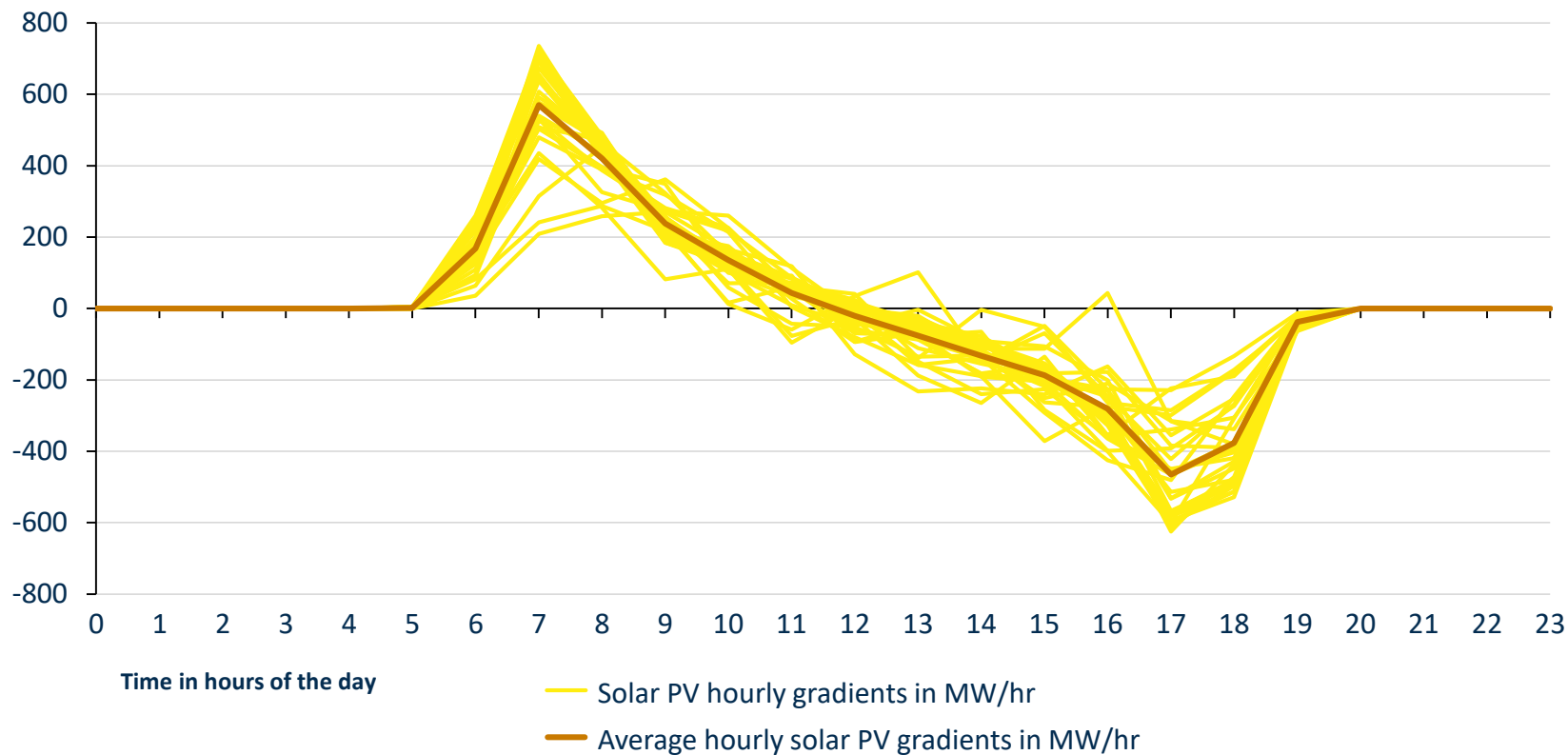


Solar PV 1-hour gradients in October 2020

Capacity operational

1957 MW

Solar PV hourly gradients in MW/h

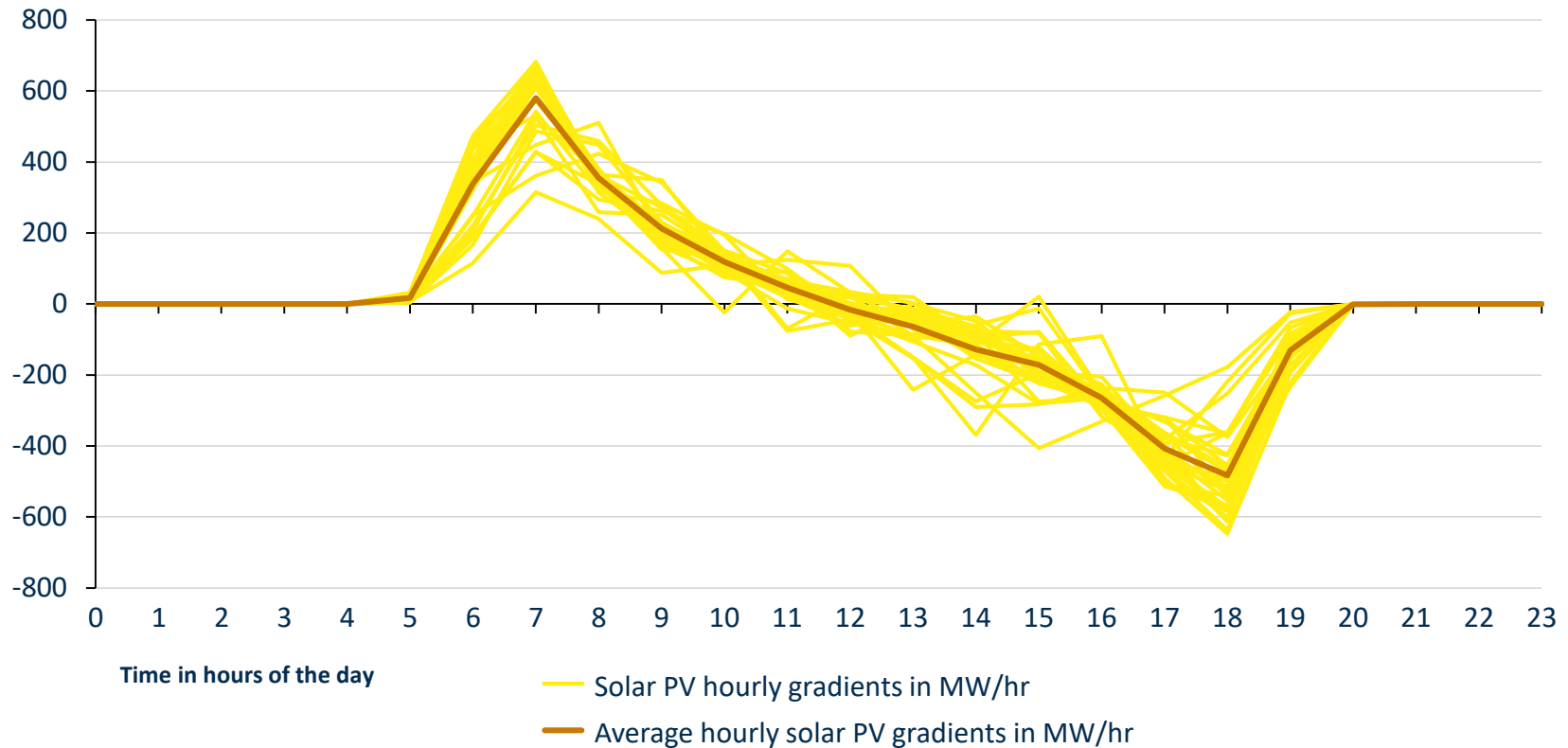


Solar PV 1-hour gradients in November 2020

Capacity operational

2032 MW

Solar PV hourly gradients in MW/h

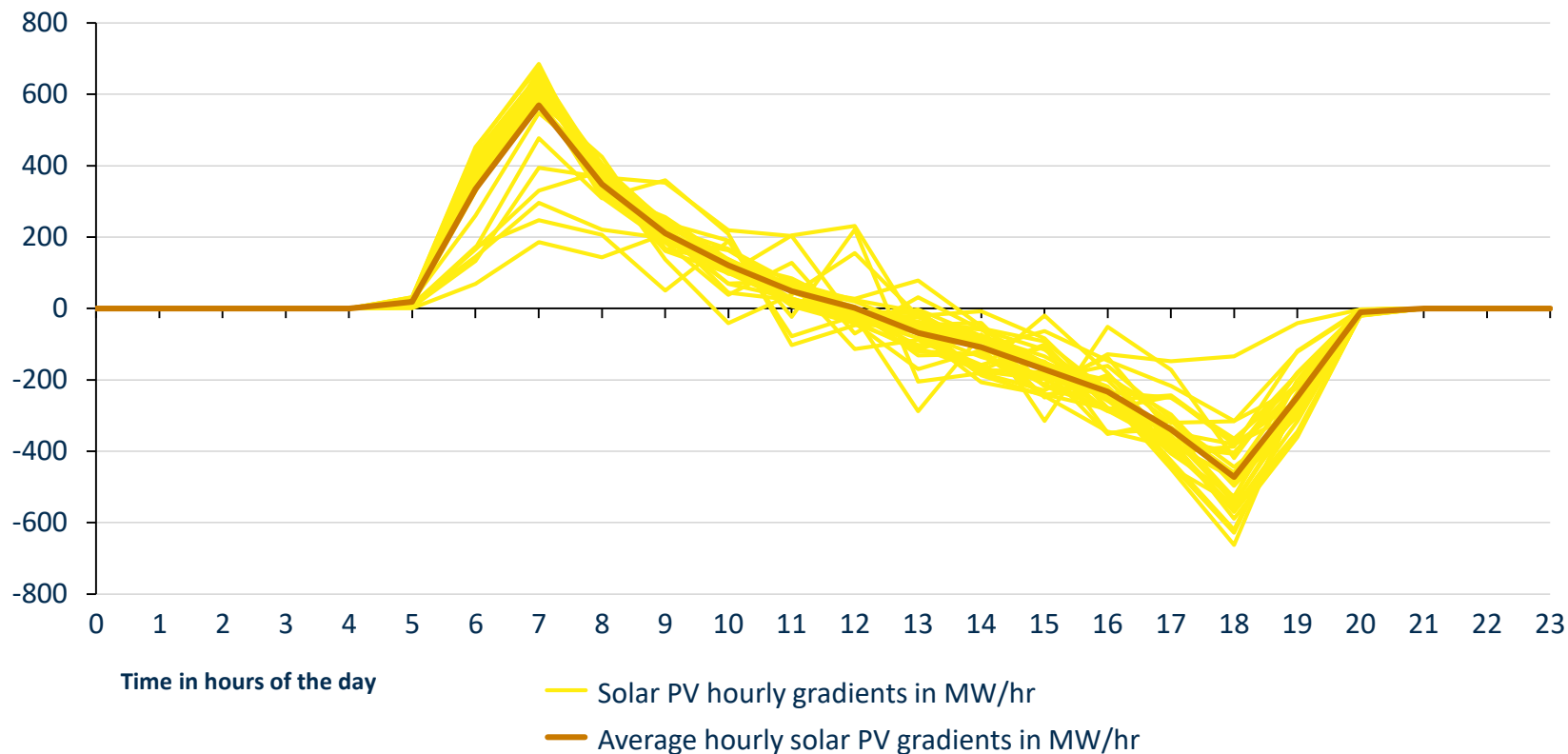


Solar PV 1-hour gradients in December 2020

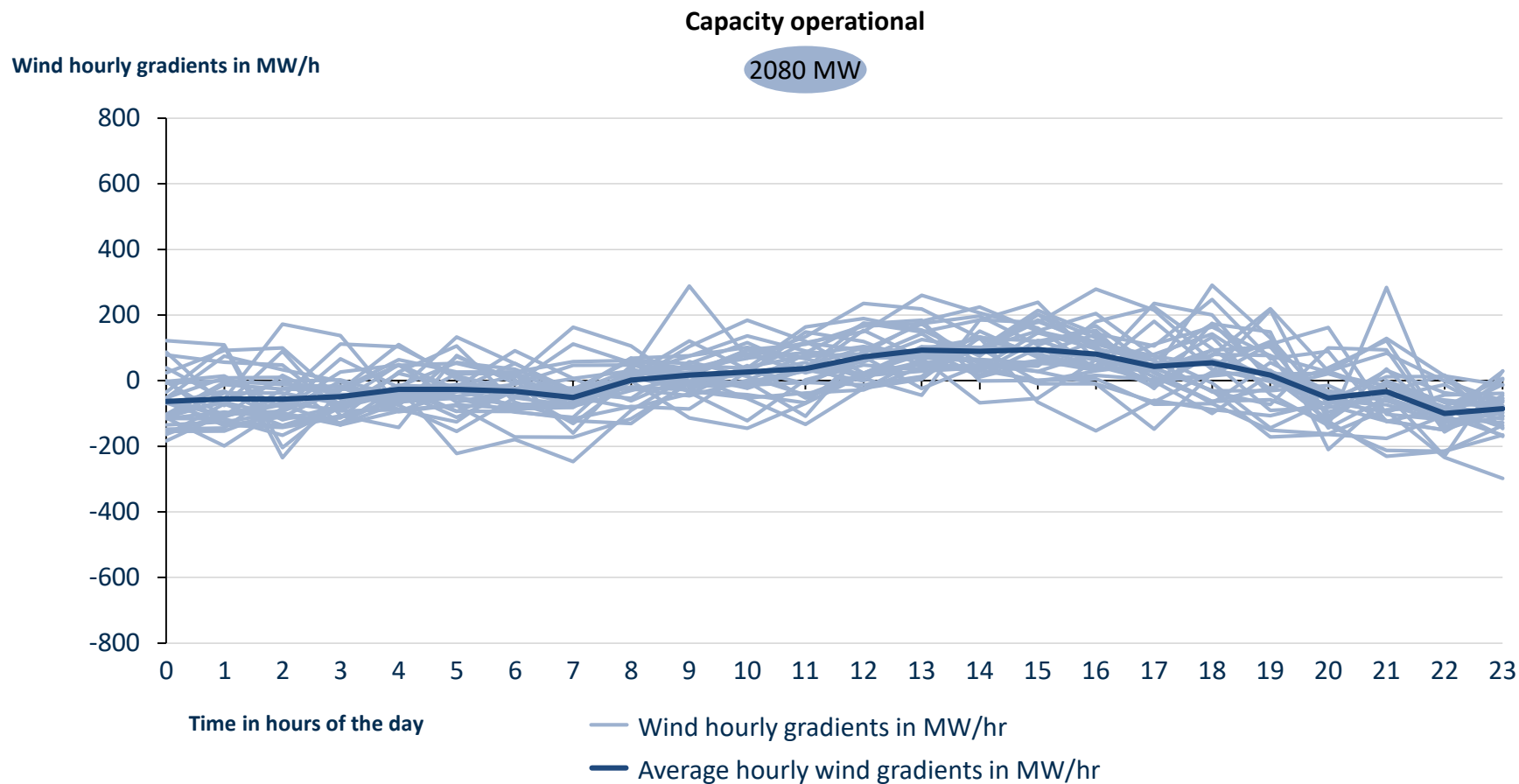
Capacity operational

2032 MW

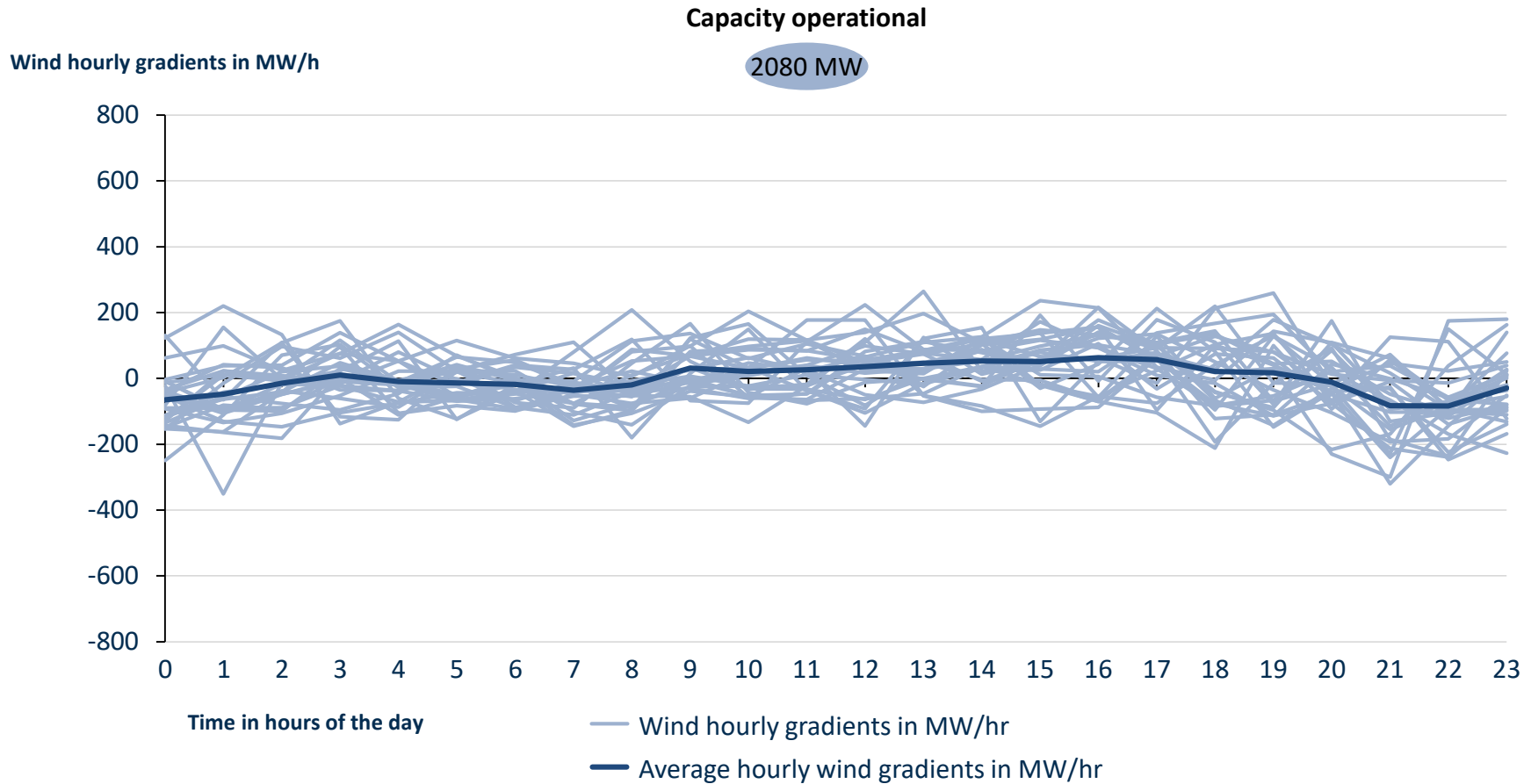
Solar PV hourly gradients in MW/h



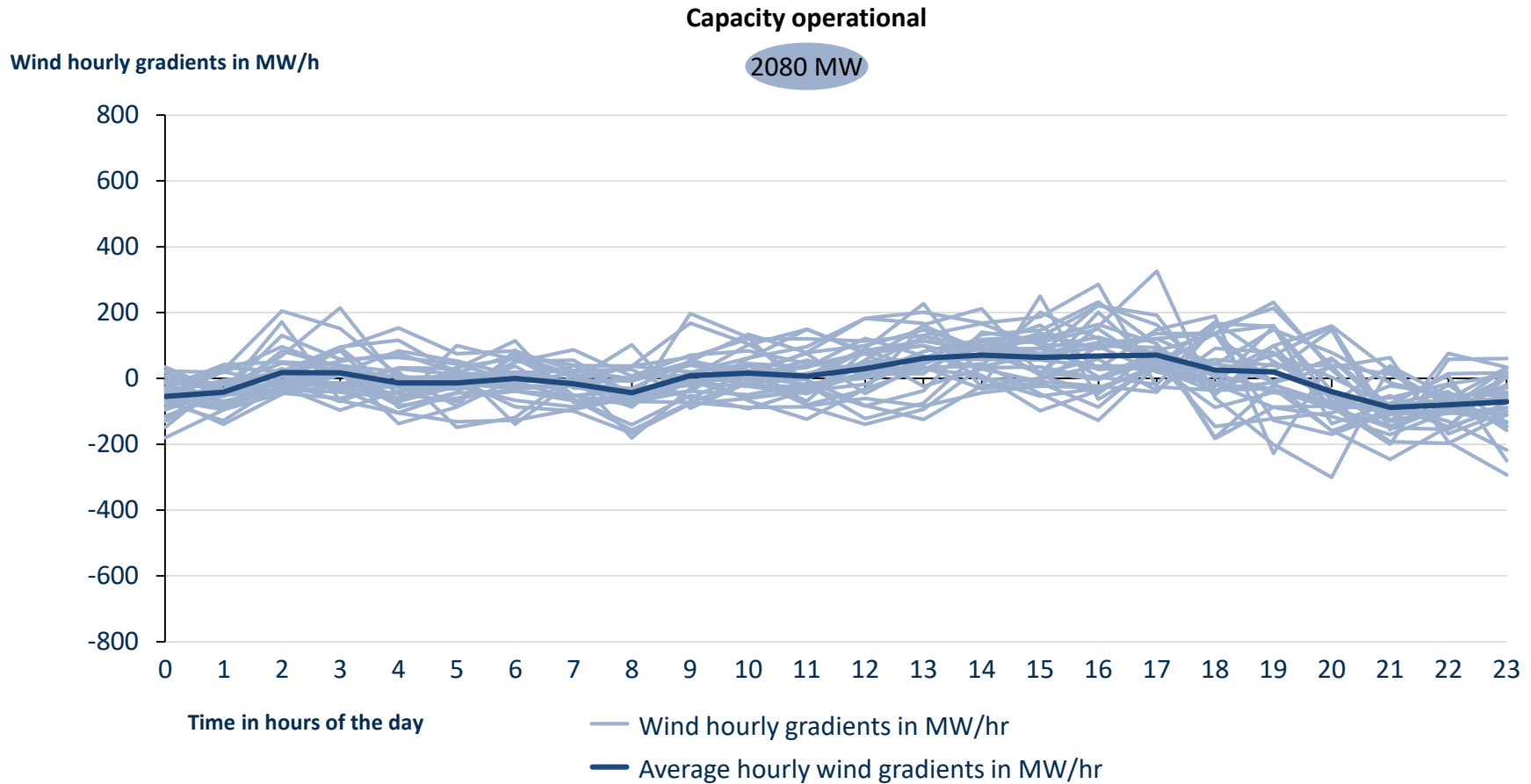
Wind 1-hour gradients in January 2020



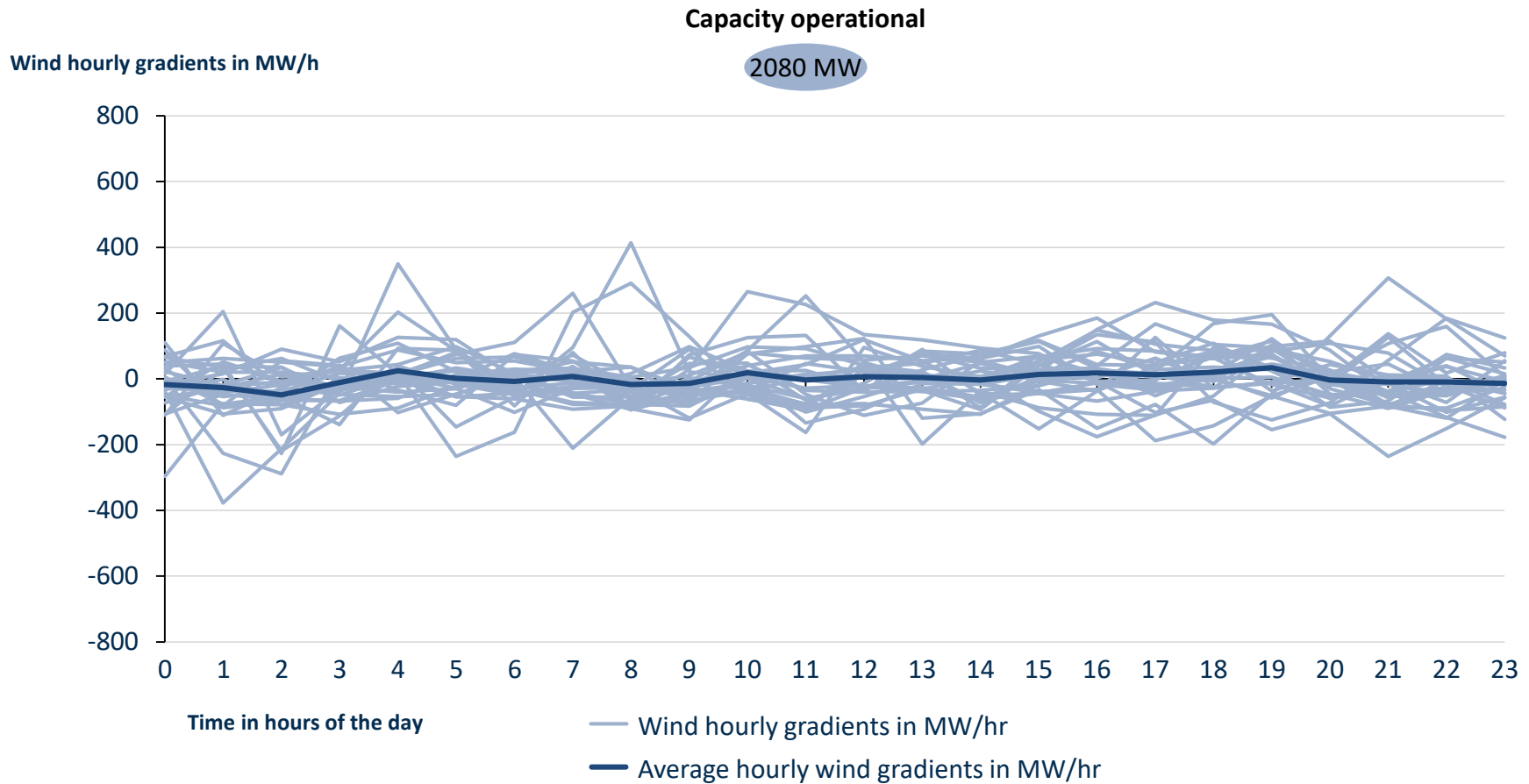
Wind 1-hour gradients in February 2020



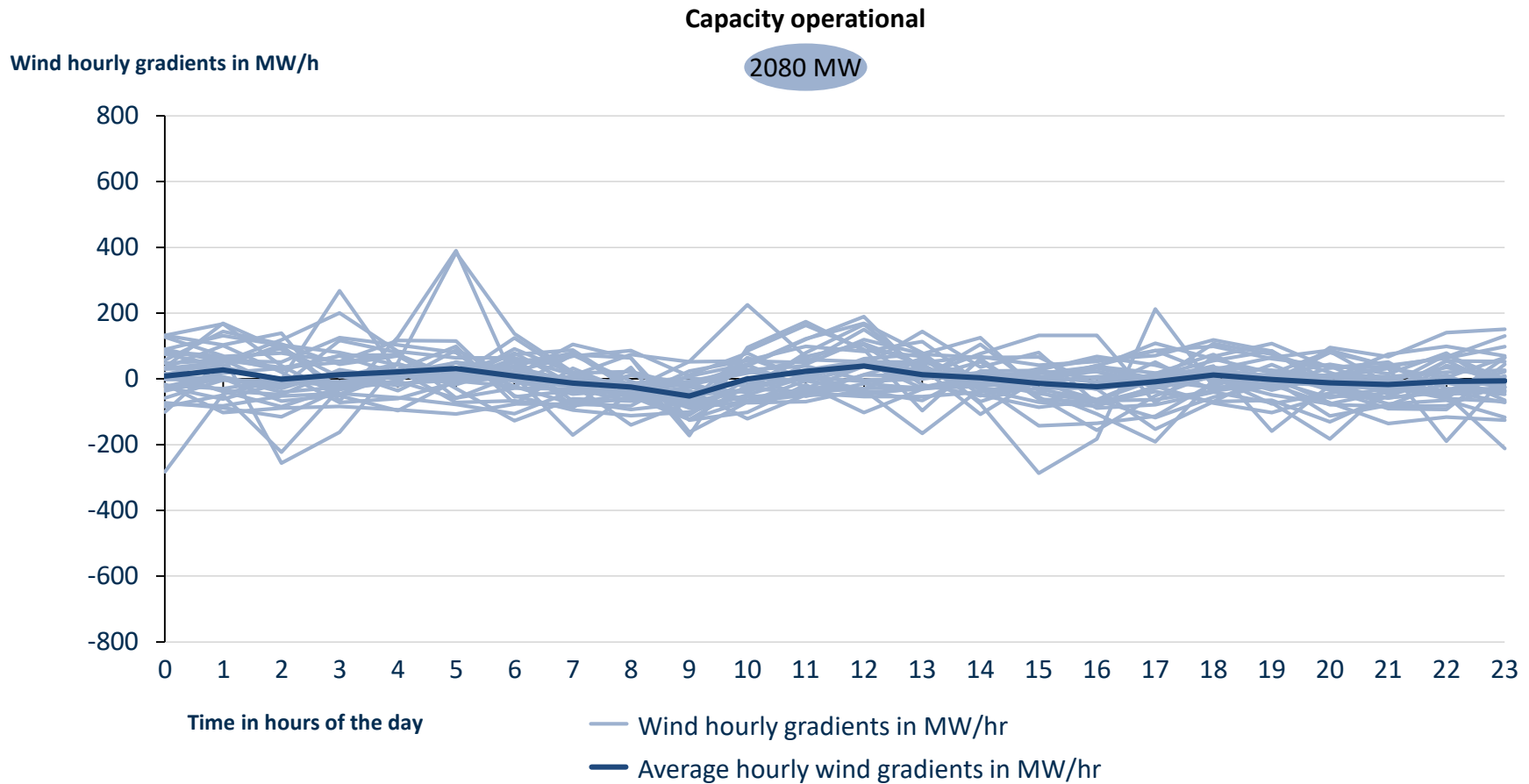
Wind 1-hour gradients in March 2020



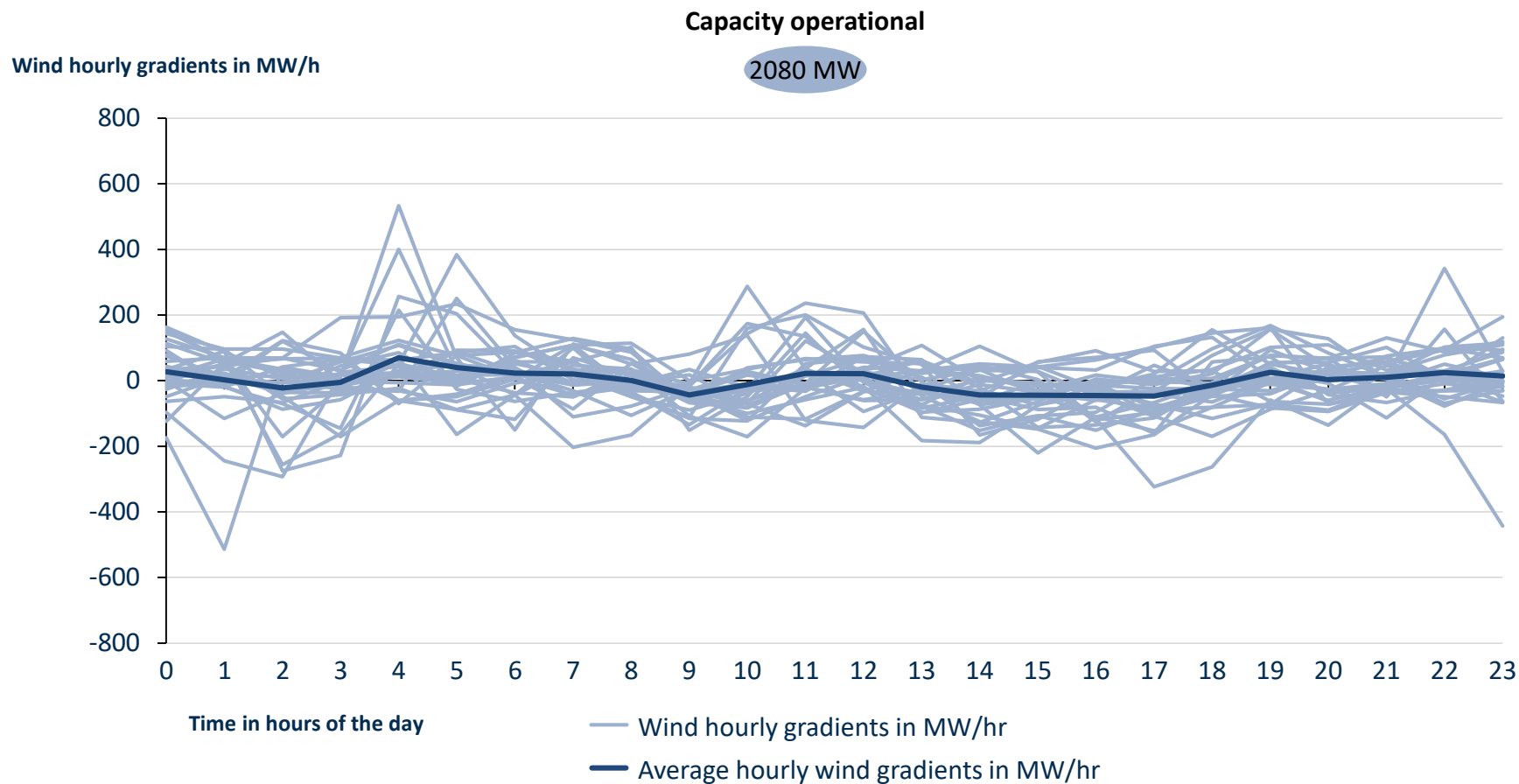
Wind 1-hour gradients in April 2020



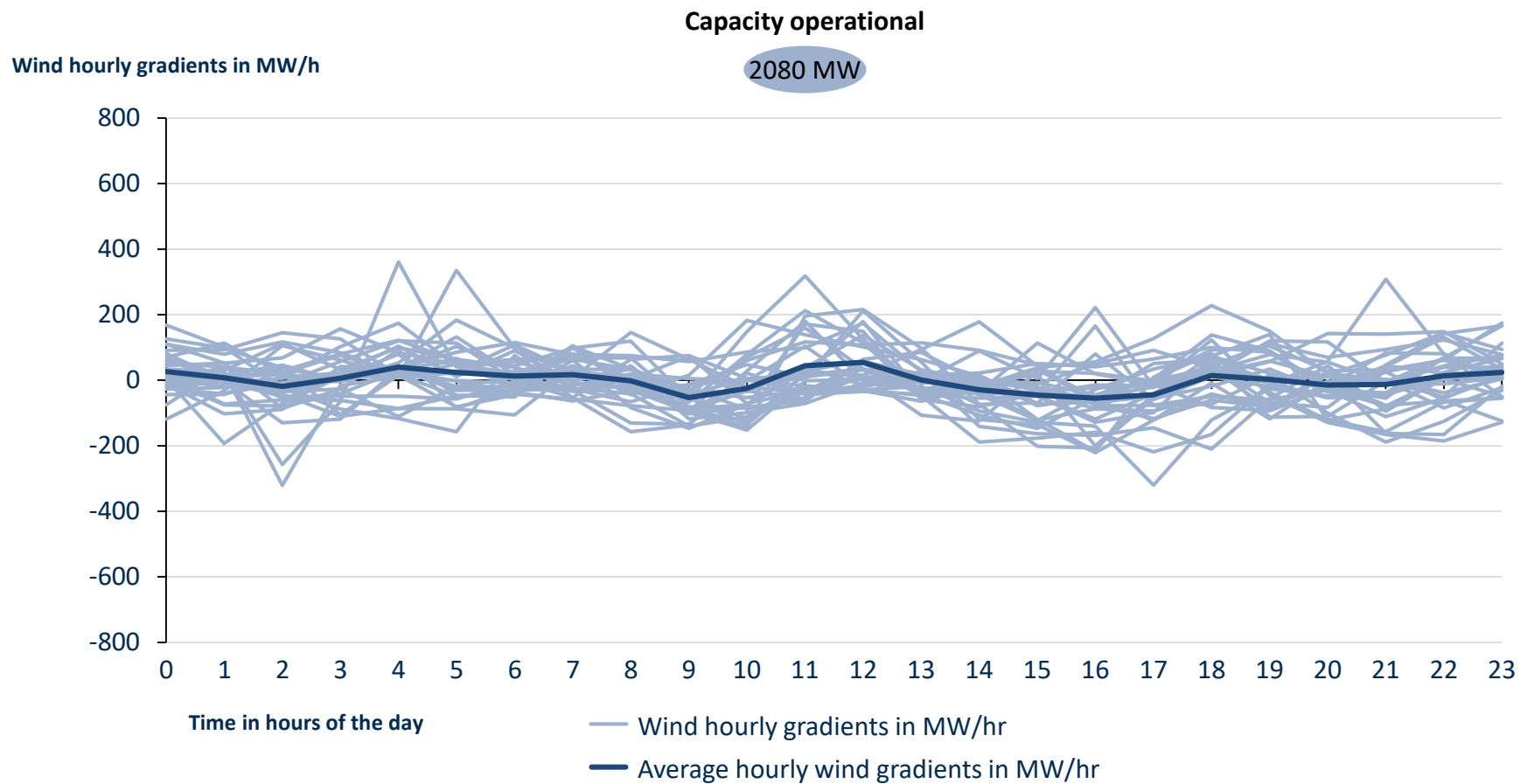
Wind 1-hour gradients in May 2020



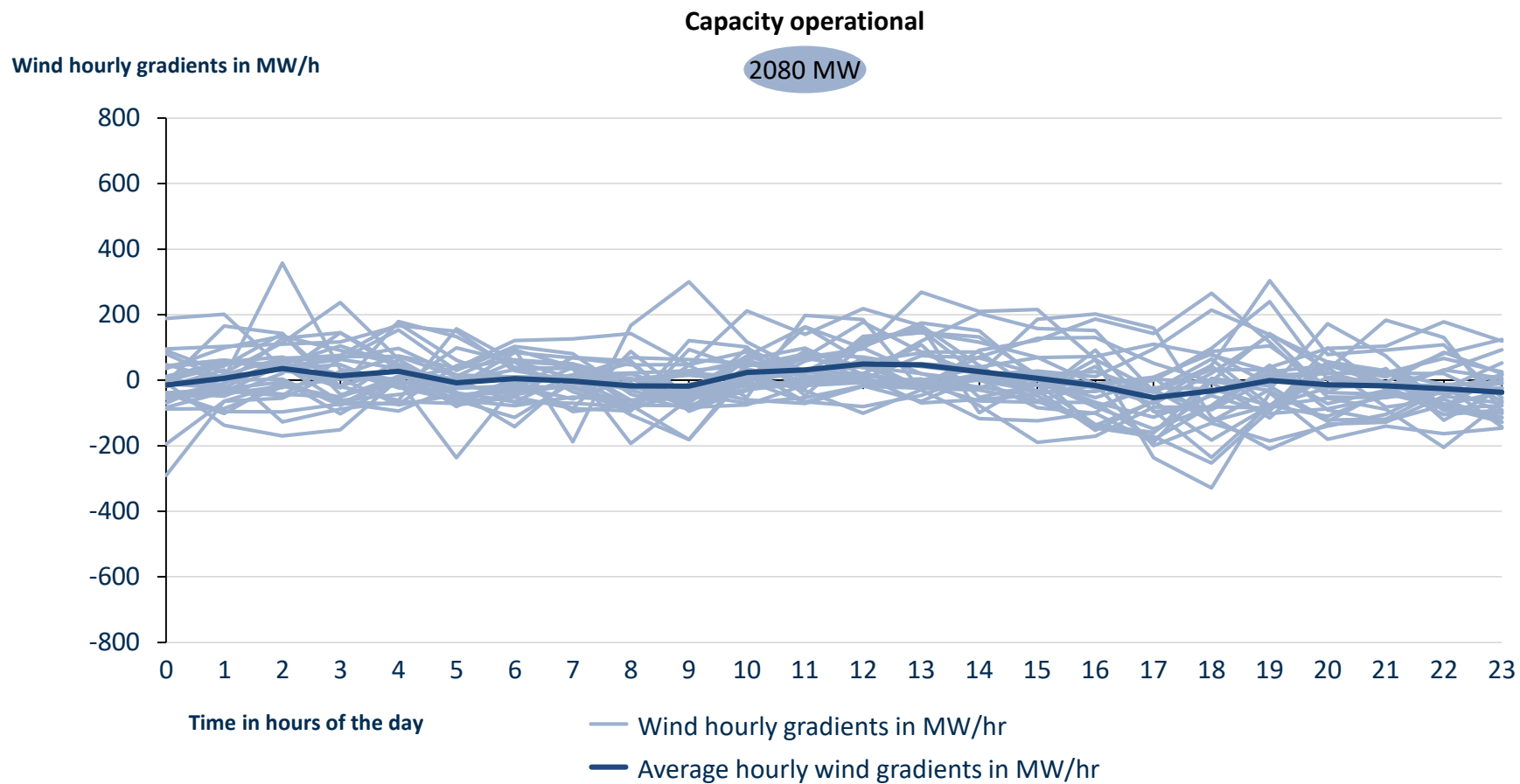
Wind 1-hour gradients in June 2020



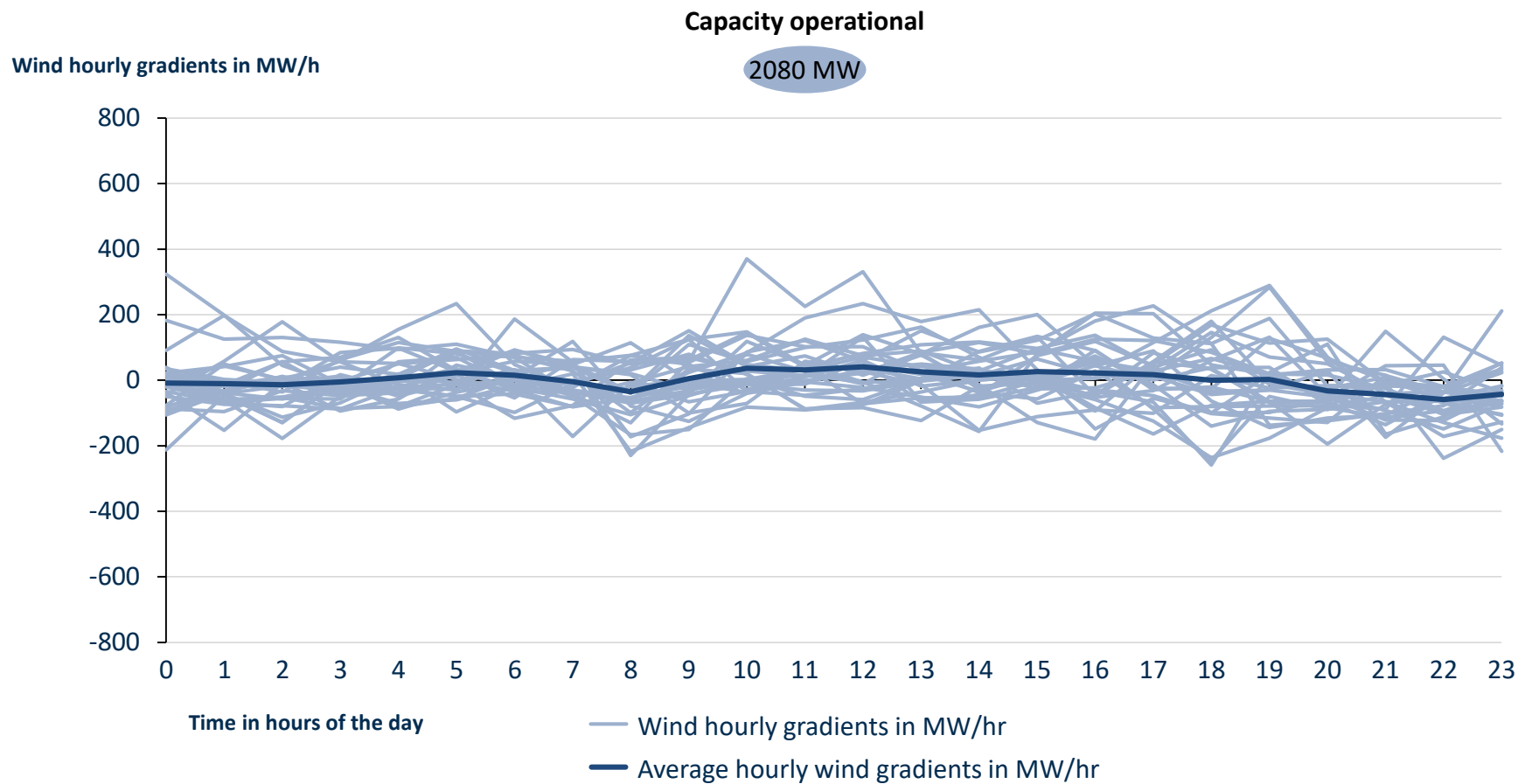
Wind 1-hour gradients in July 2020



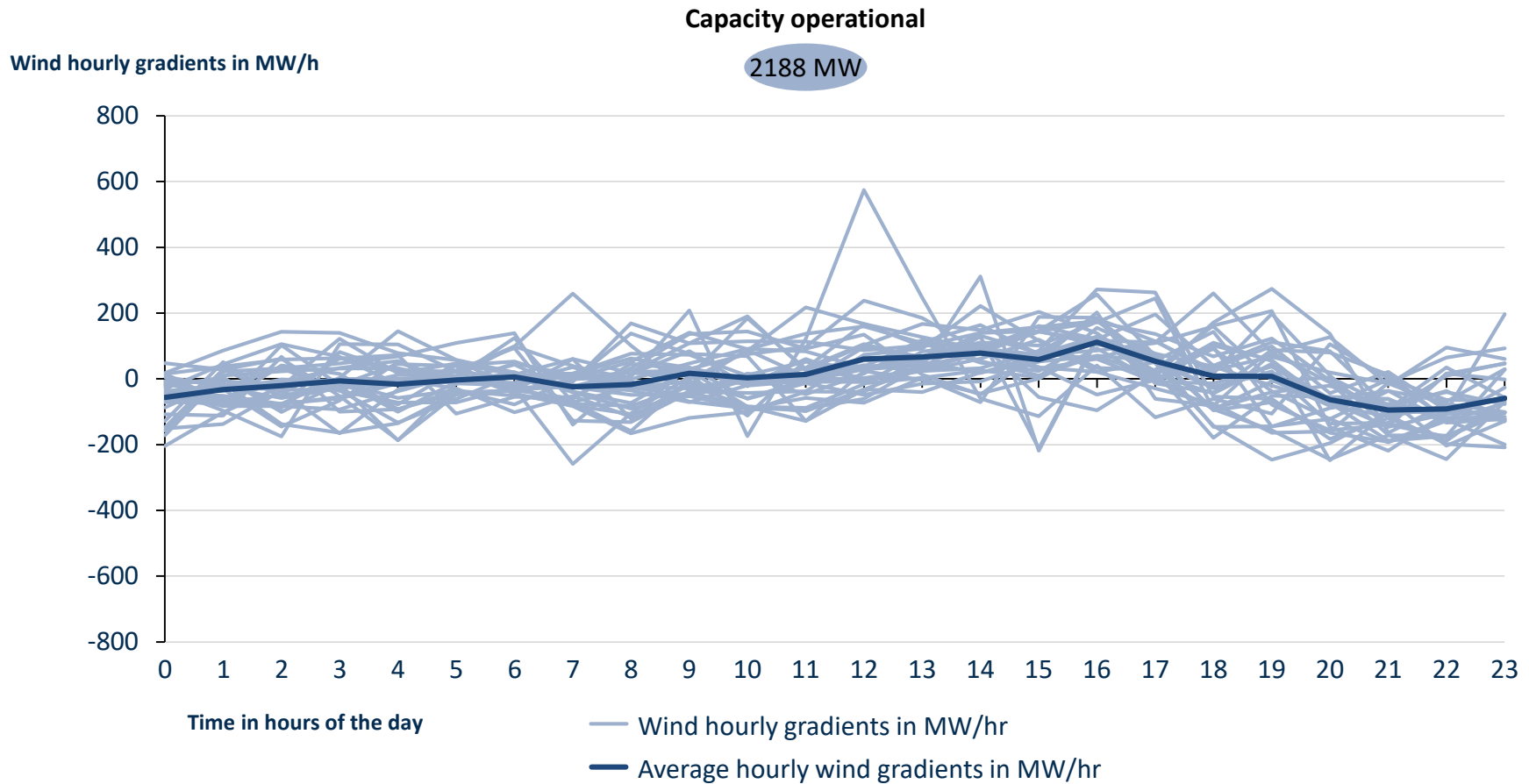
Wind 1-hour gradients in August 2020



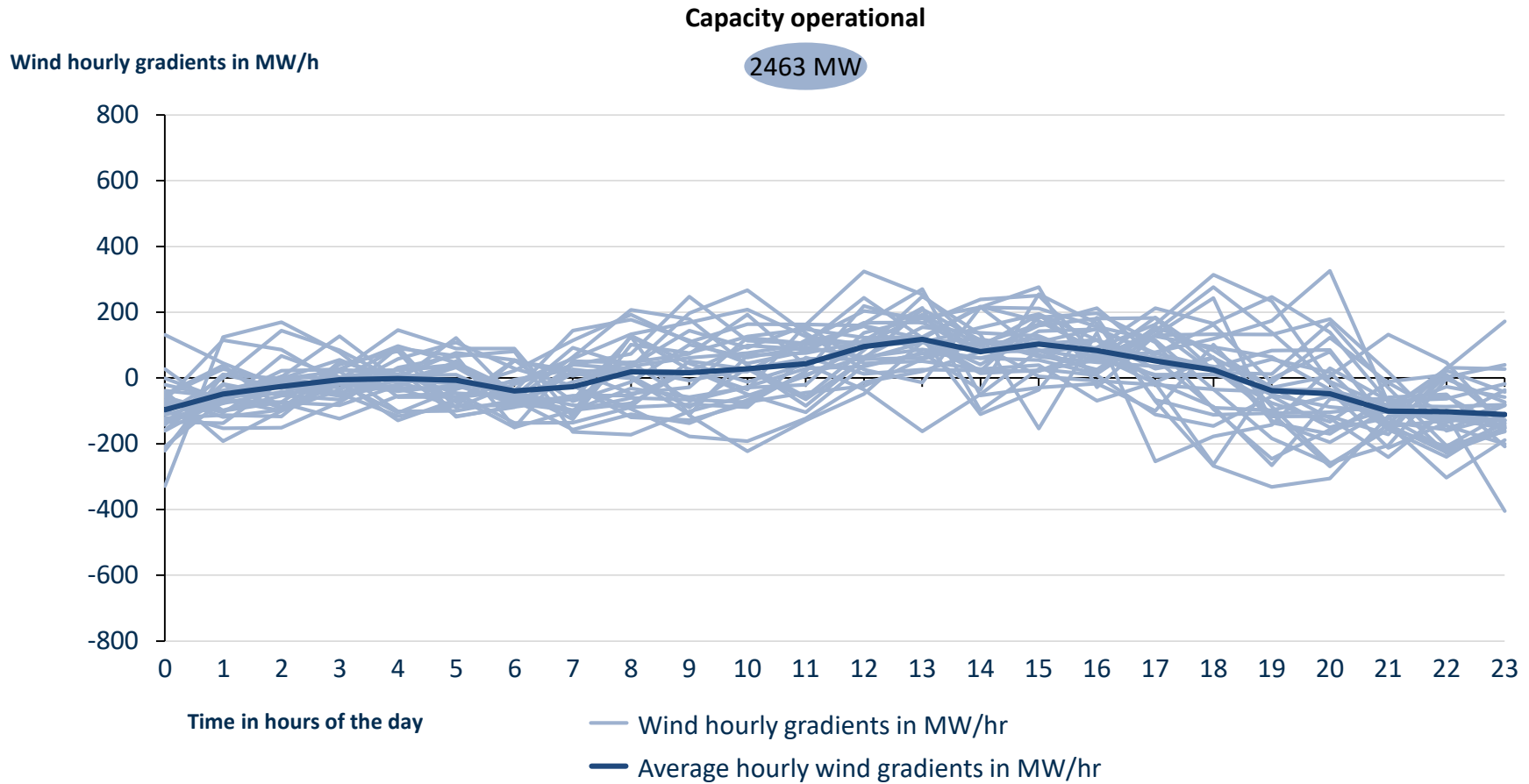
Wind 1-hour gradients in September 2020



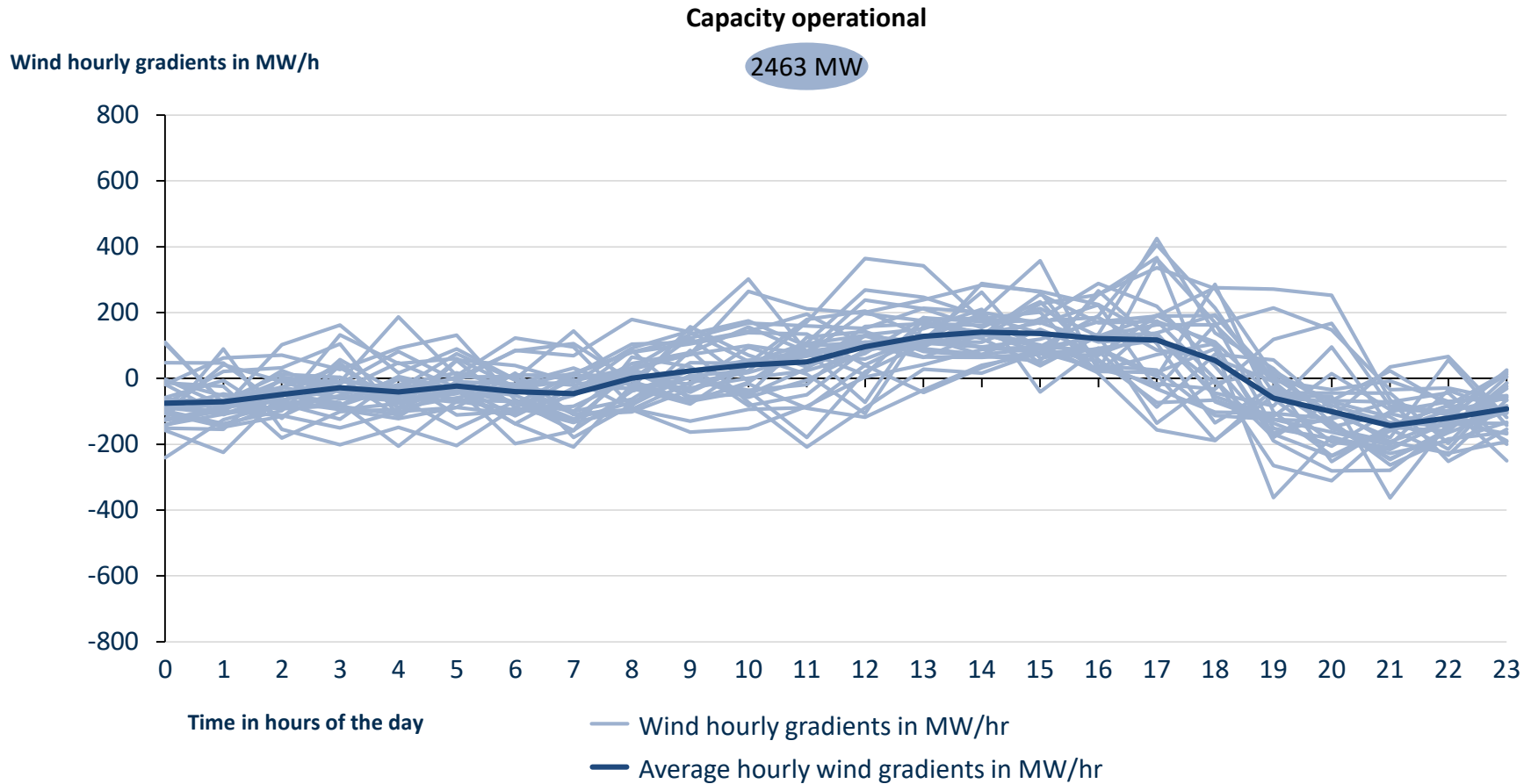
Wind 1-hour gradients in October 2020



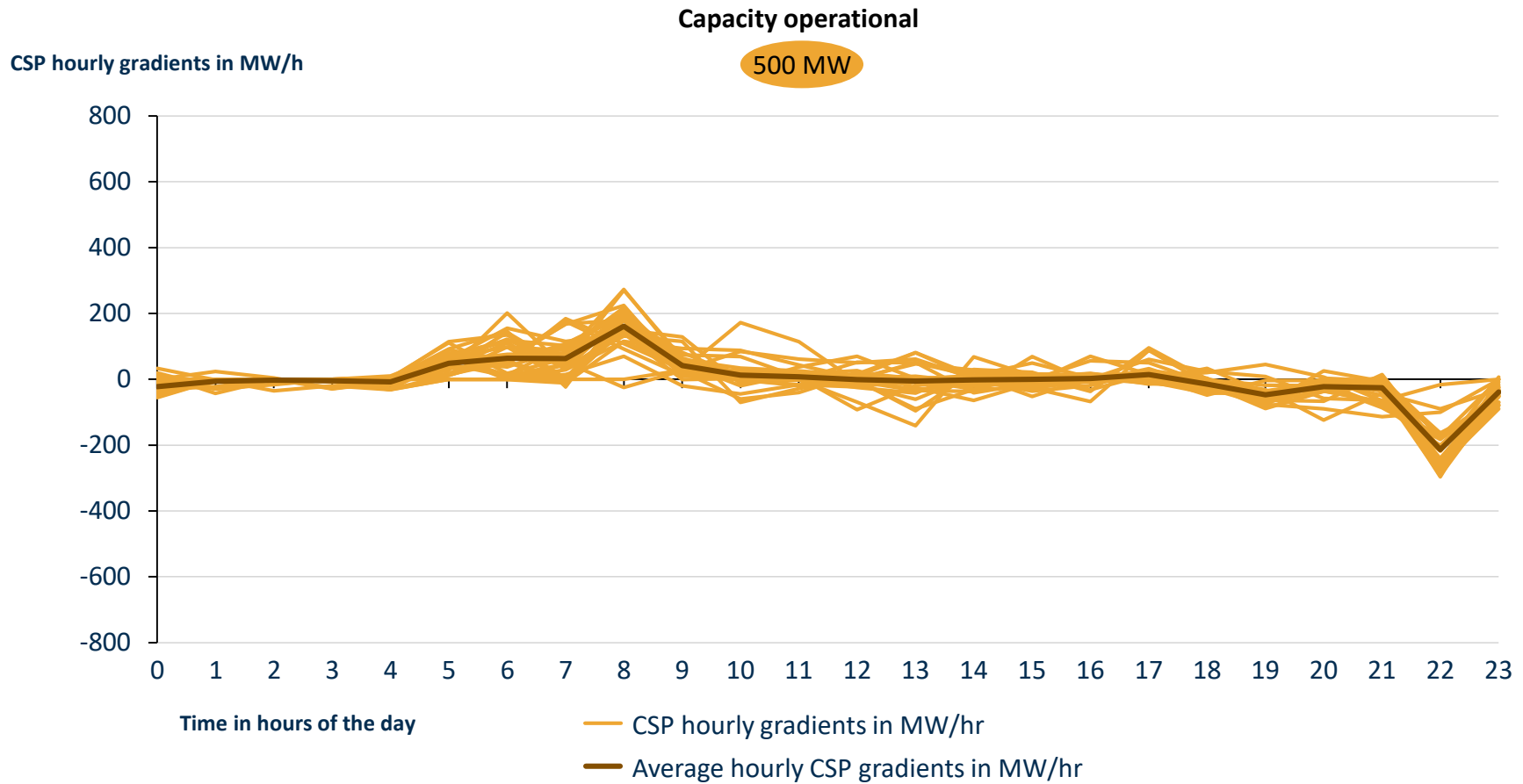
Wind 1-hour gradients in November 2020



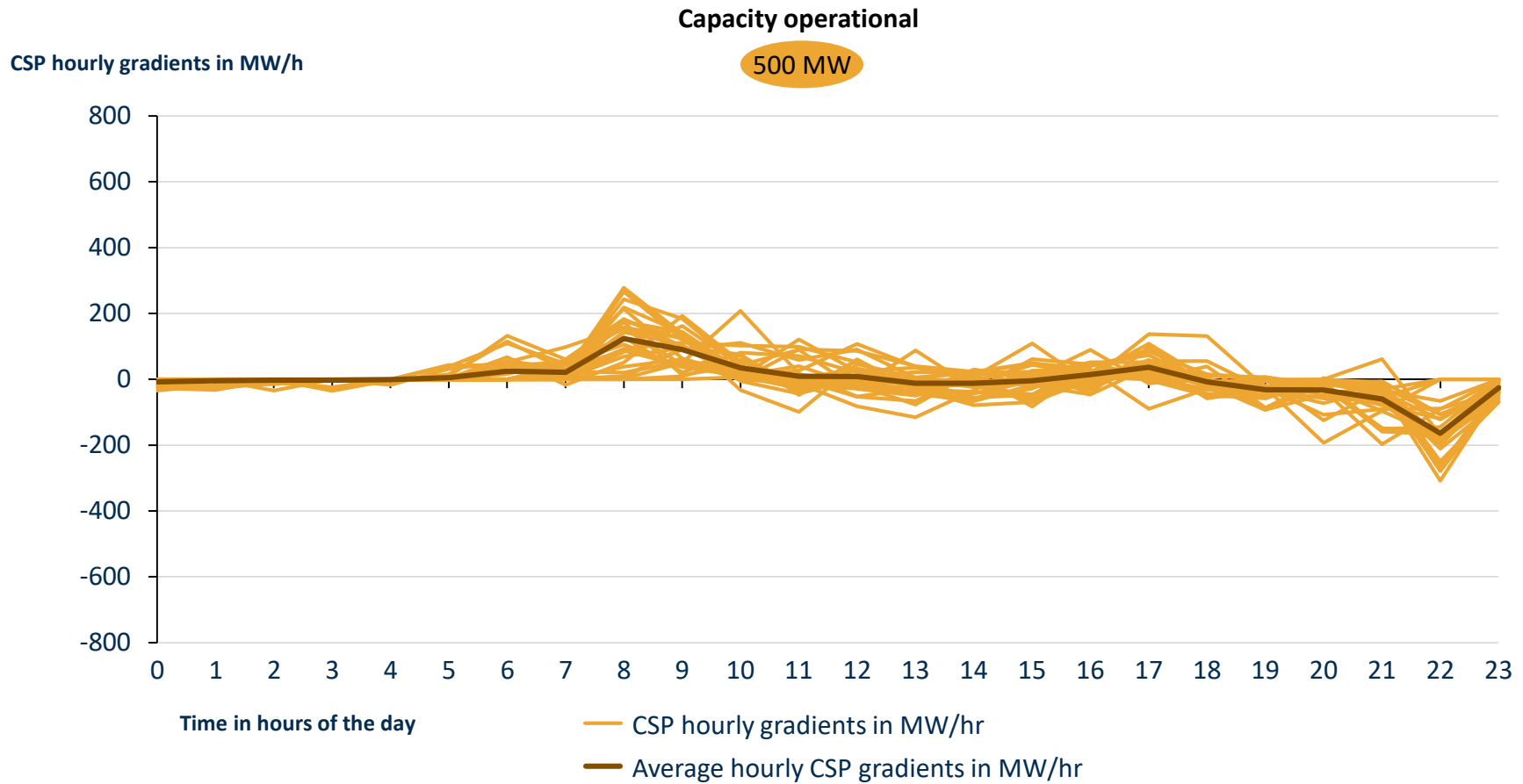
Wind 1-hour gradients in December 2020



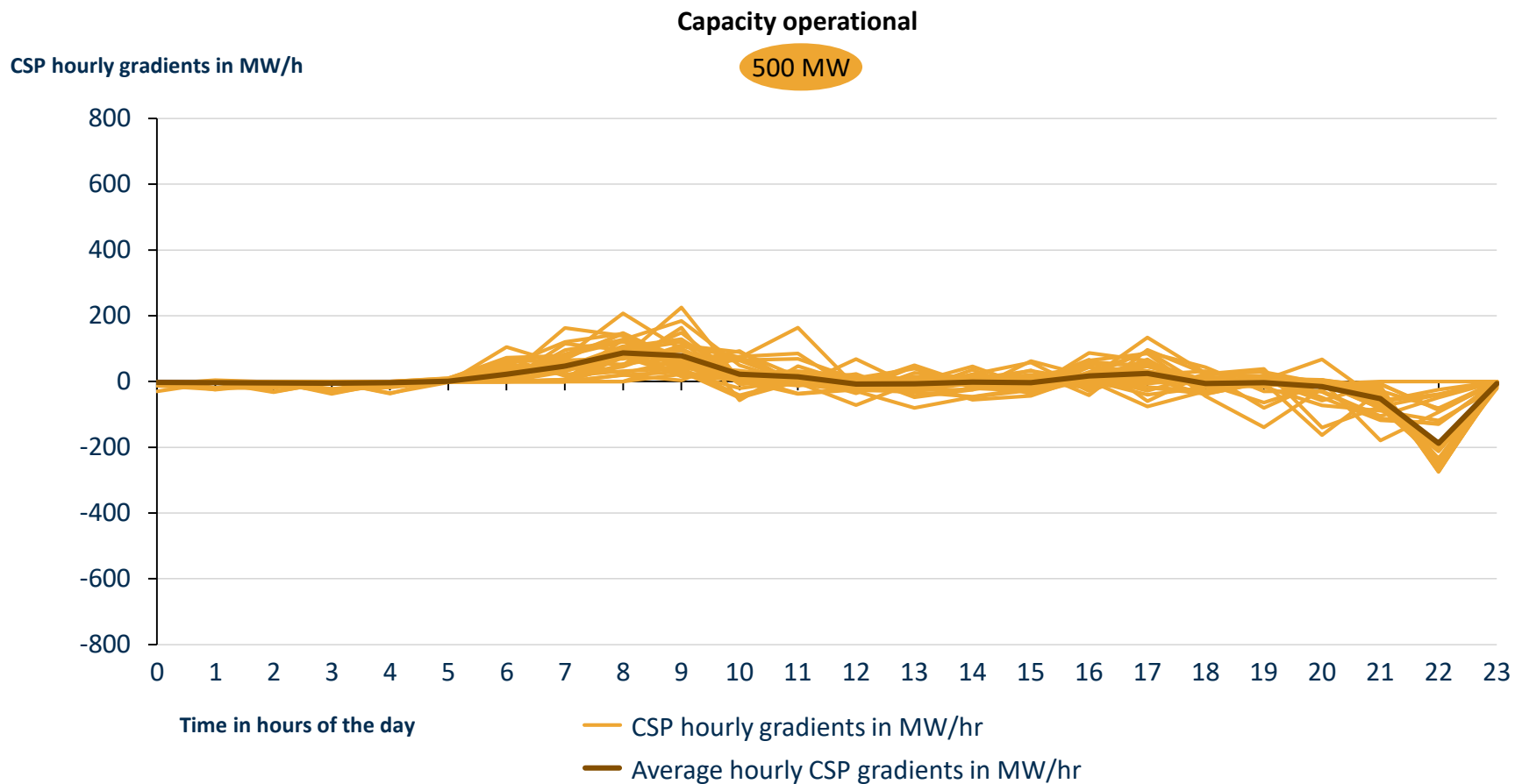
CSP 1-hour gradients in January 2020



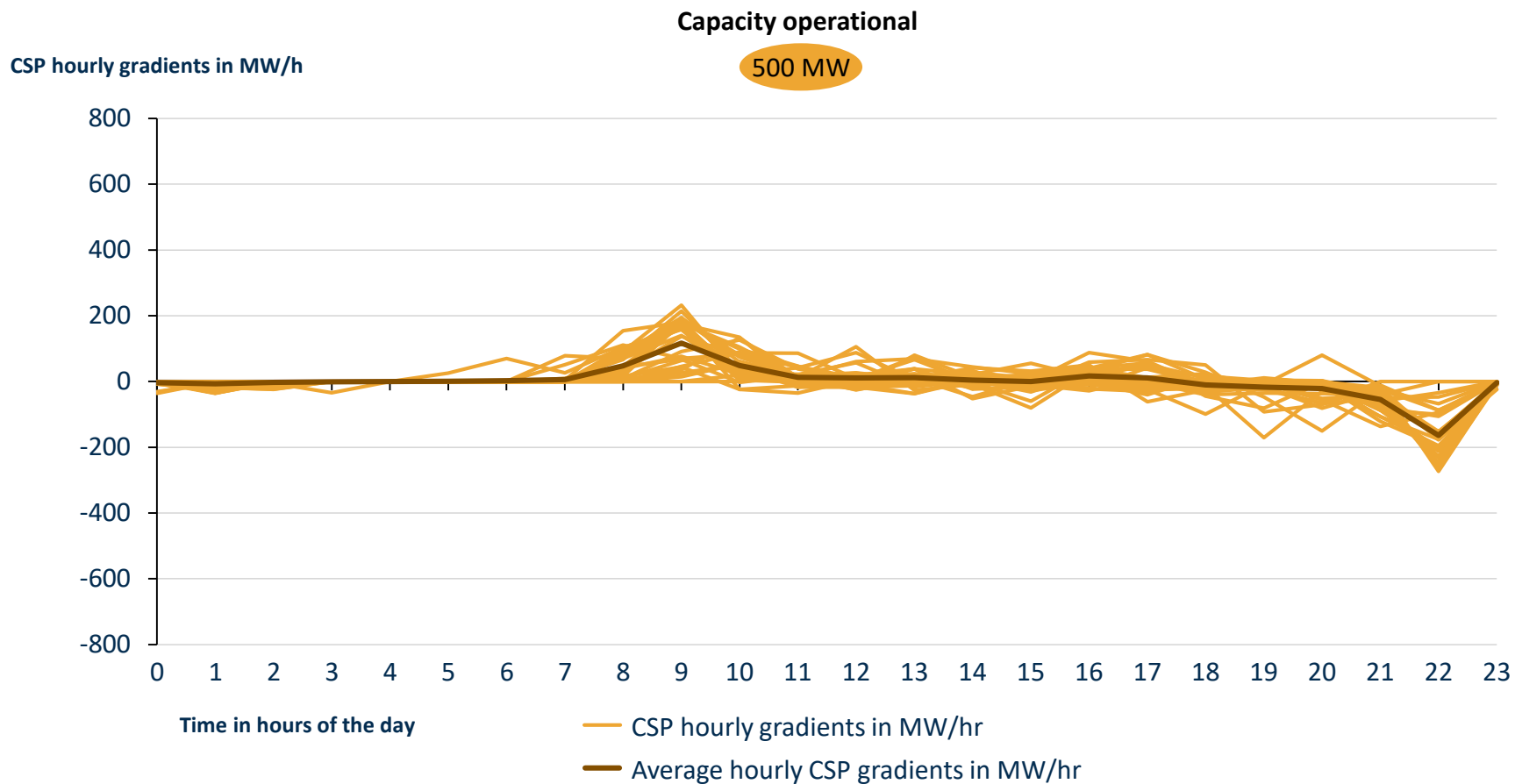
CSP 1-hour gradients in February 2020



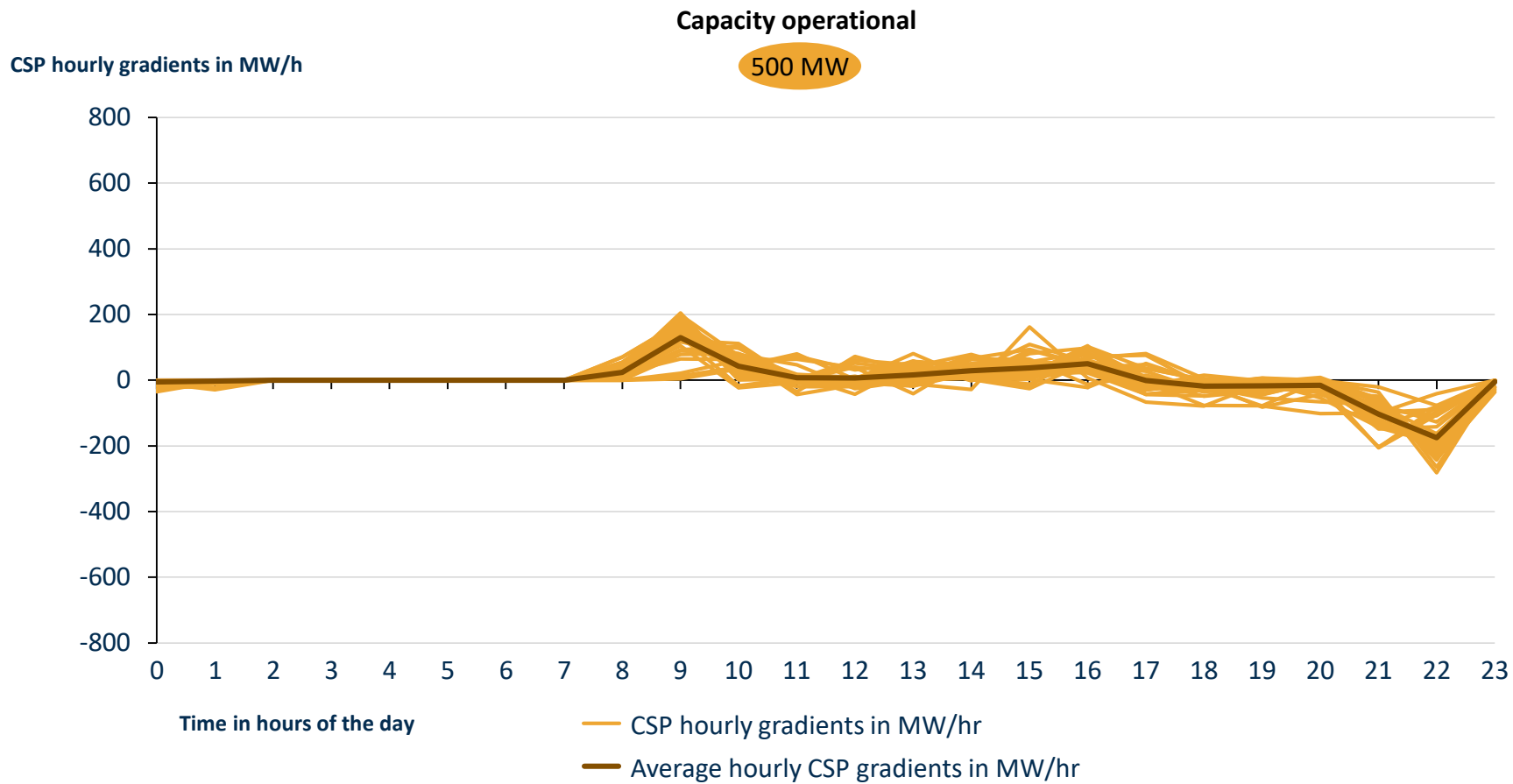
CSP 1-hour gradients in March 2020



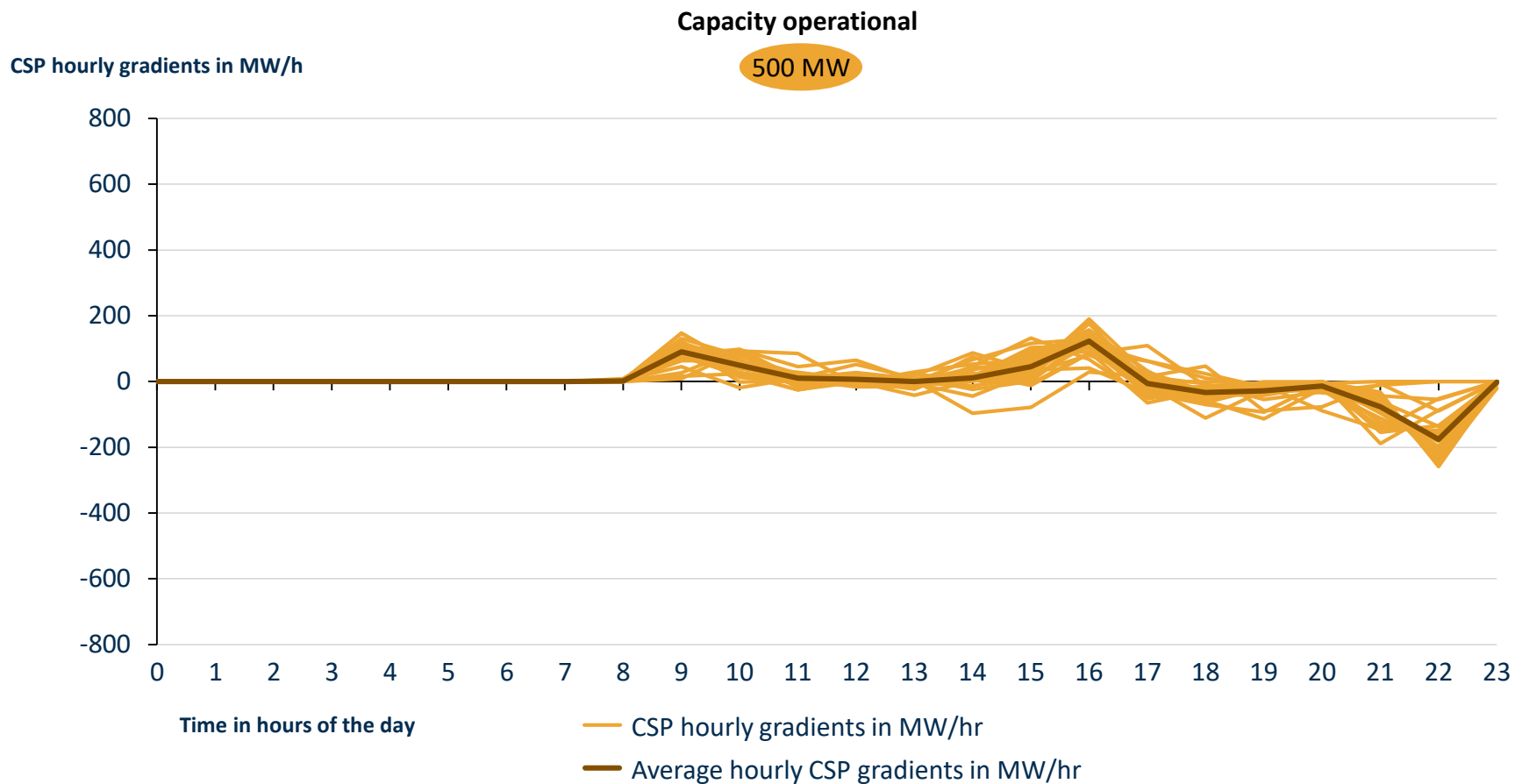
CSP 1-hour gradients in April 2020



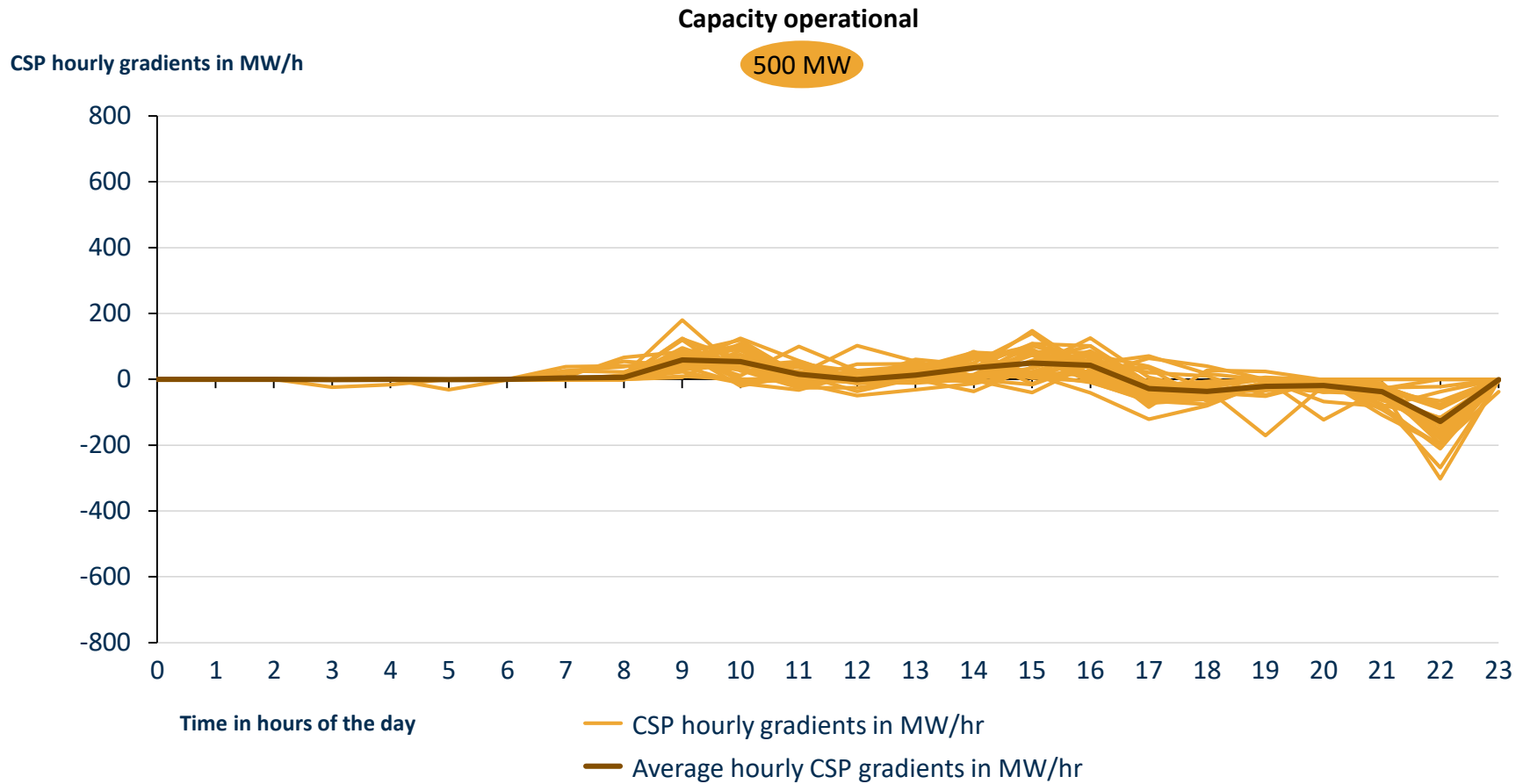
CSP 1-hour gradients in May 2020



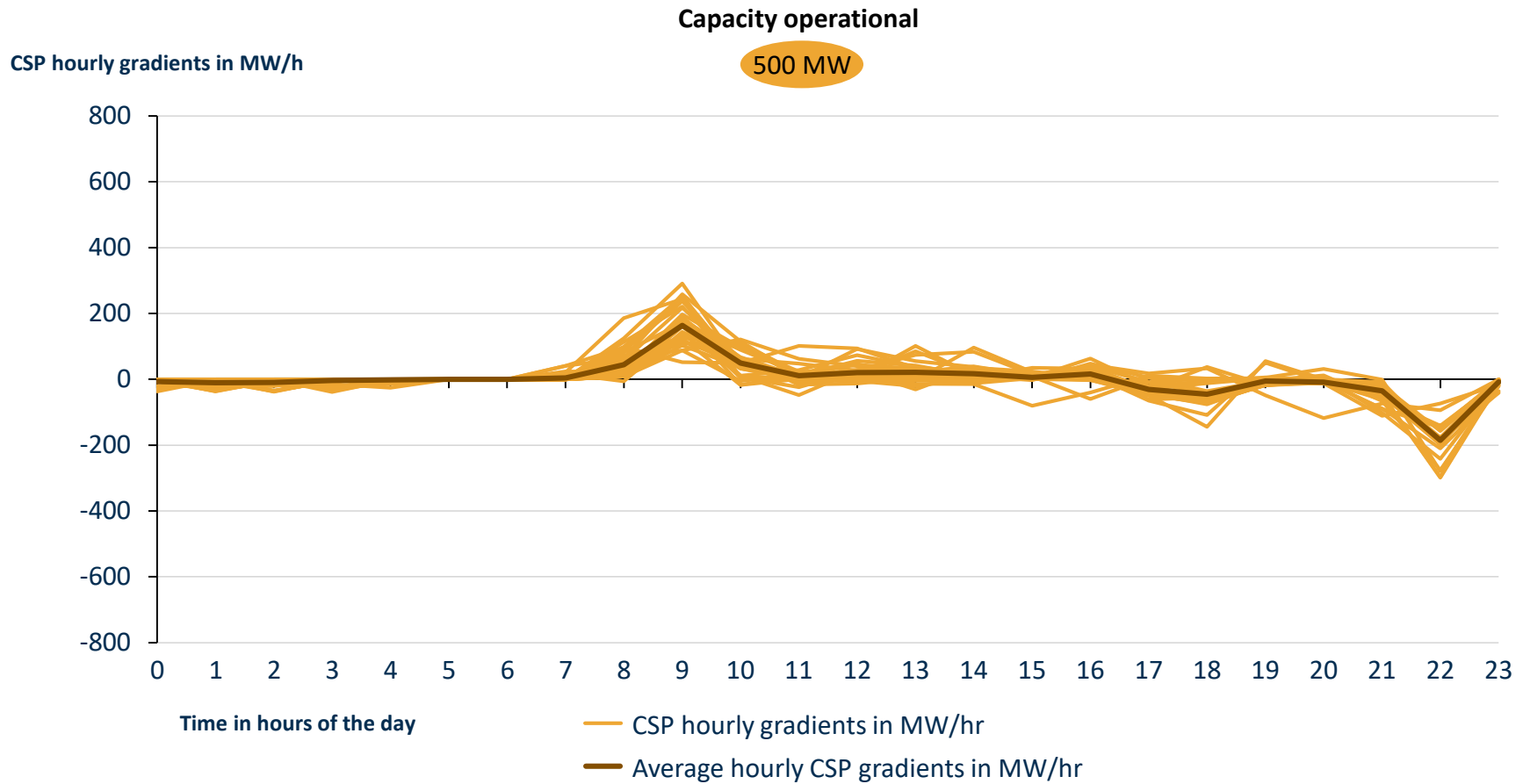
CSP 1-hour gradients in June 2020



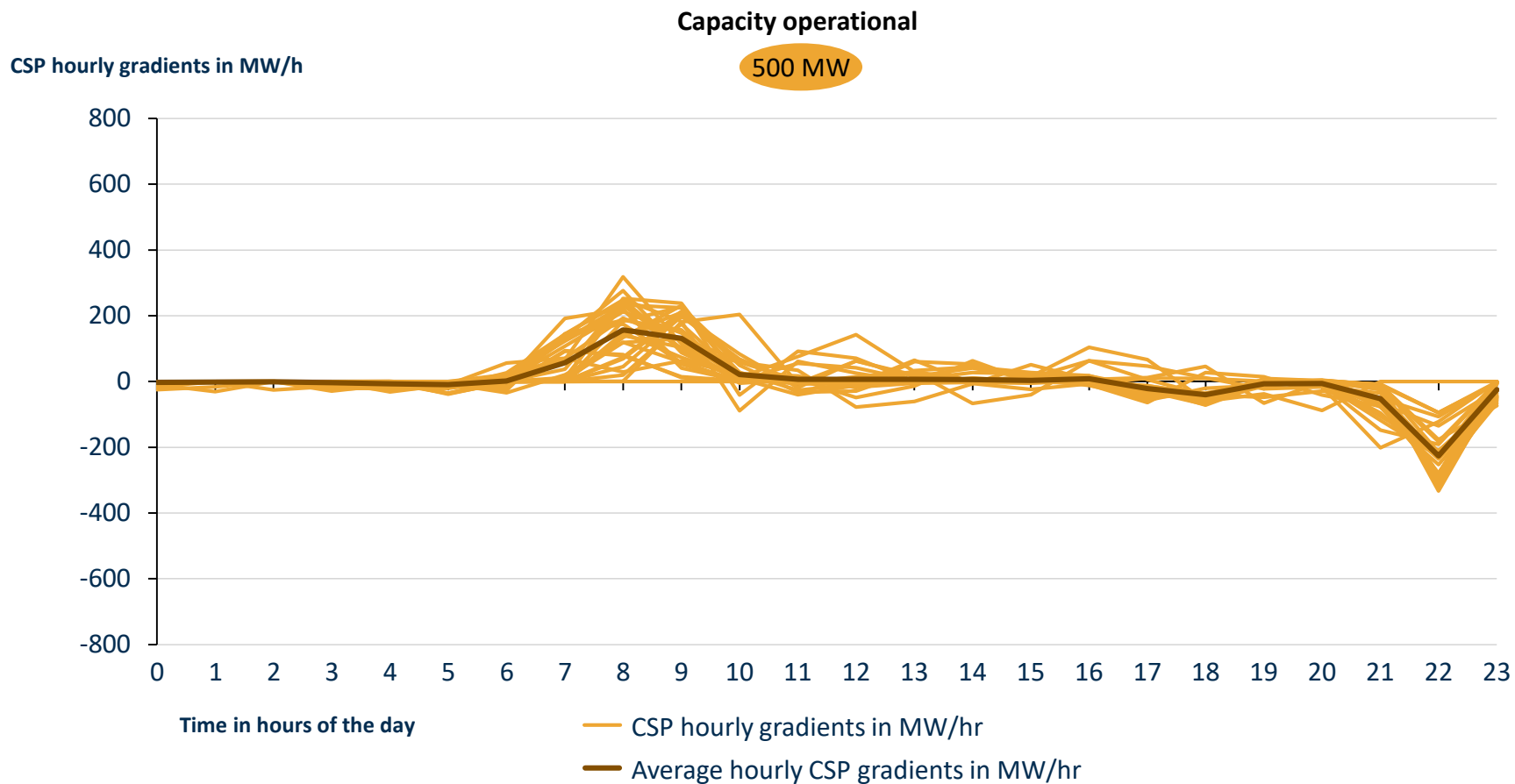
CSP 1-hour gradients in July 2020



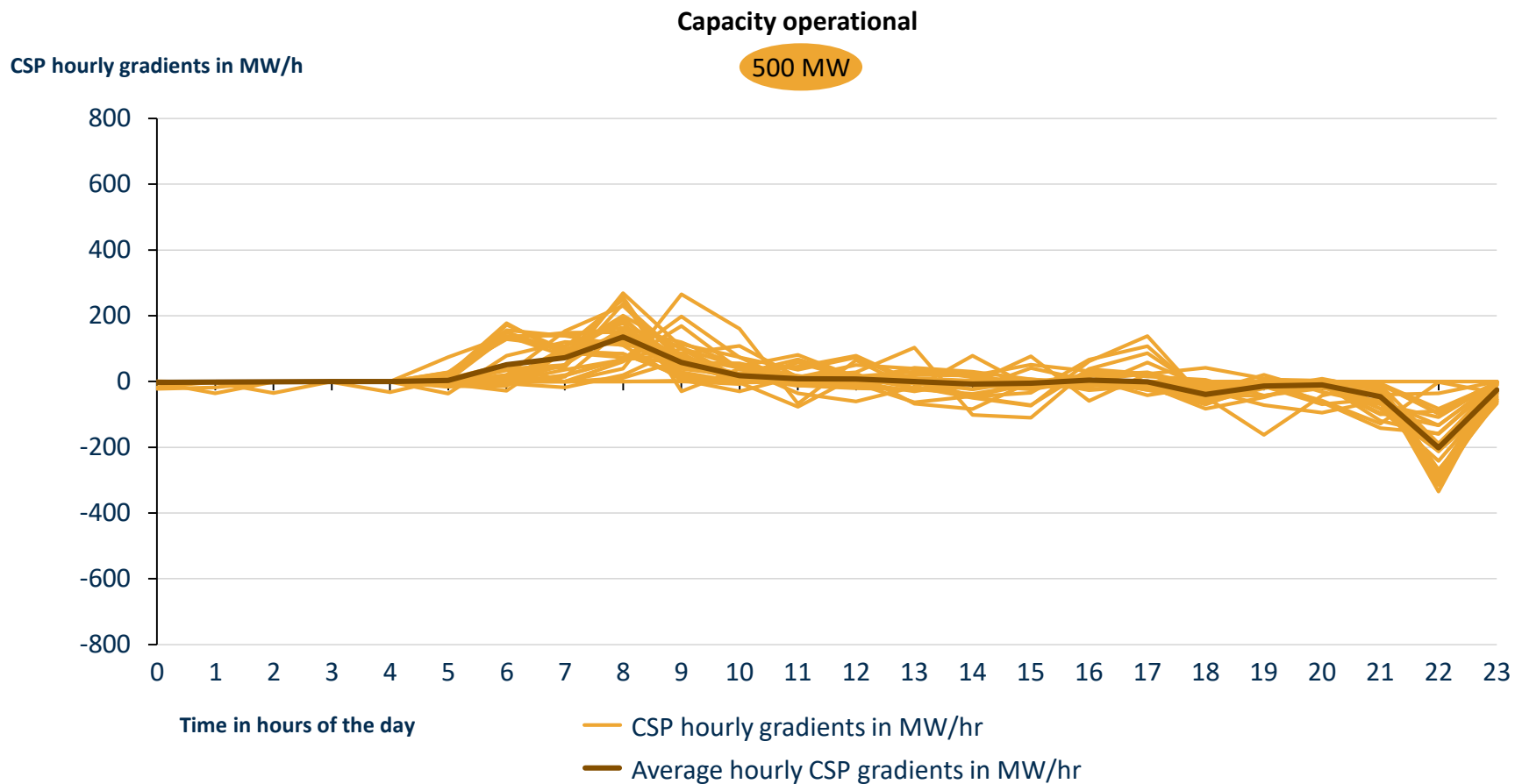
CSP 1-hour gradients in August 2020



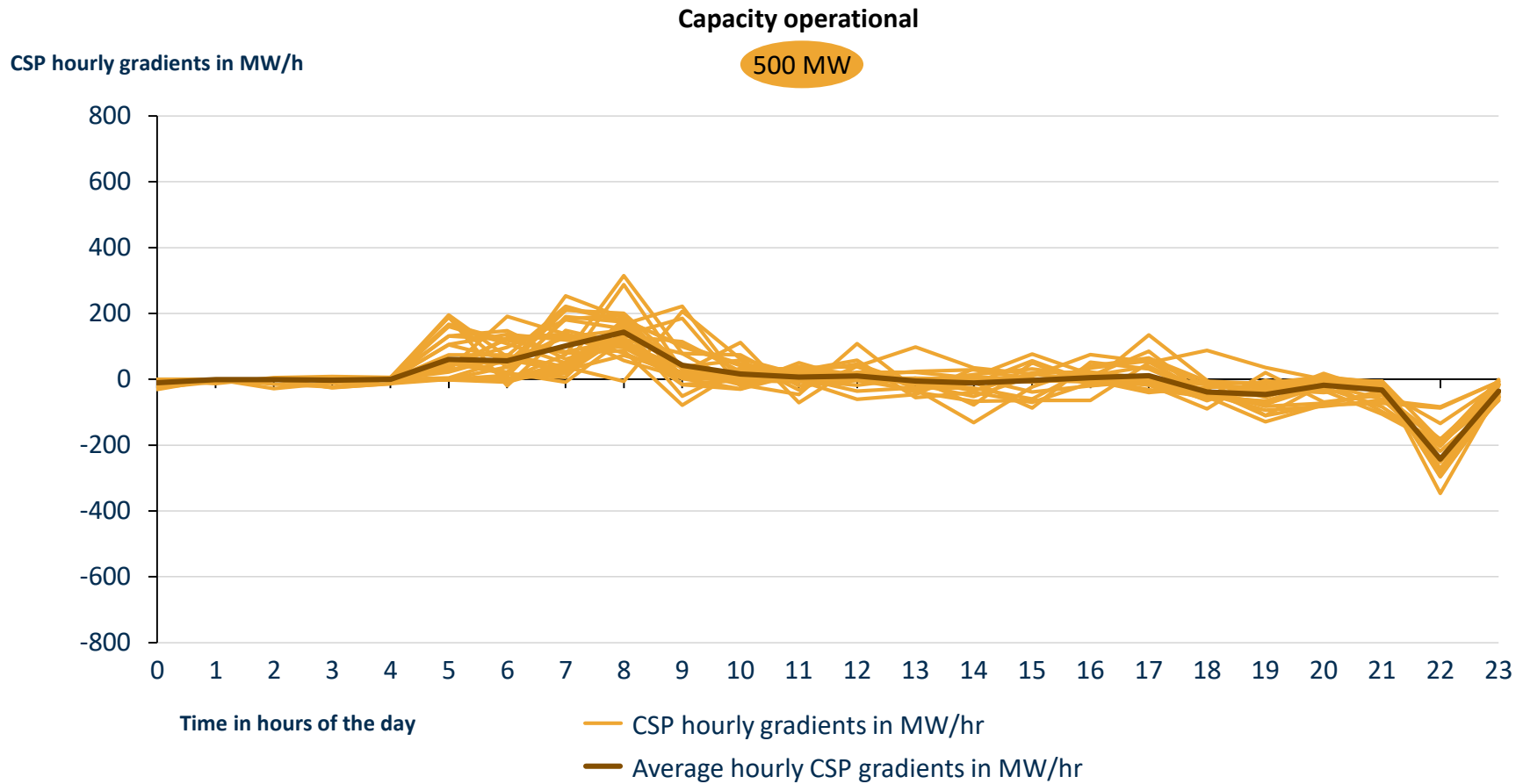
CSP 1-hour gradients in September 2020



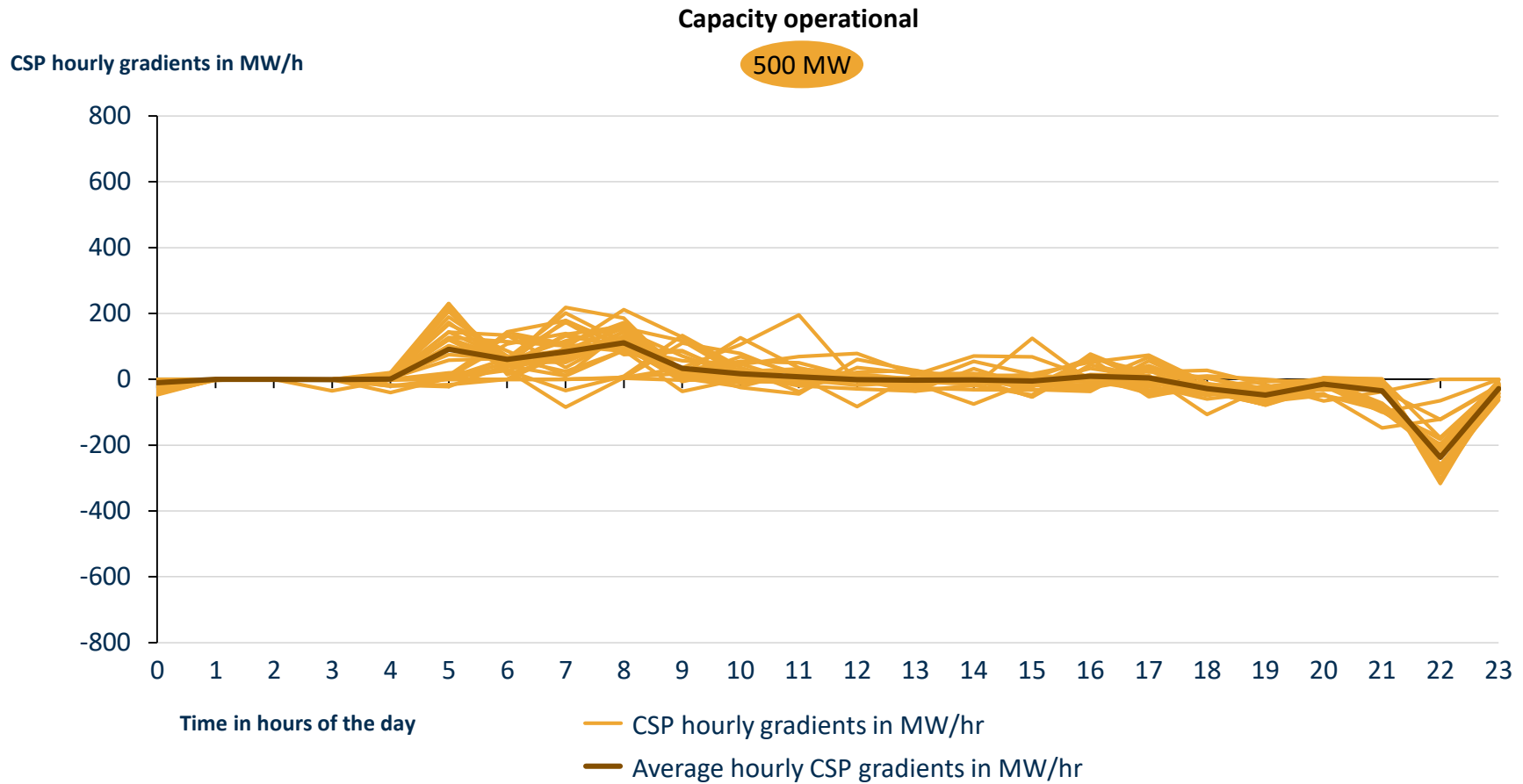
CSP 1-hour gradients in October 2020



CSP 1-hour gradients in November 2020



CSP 1-hour gradients in December 2020

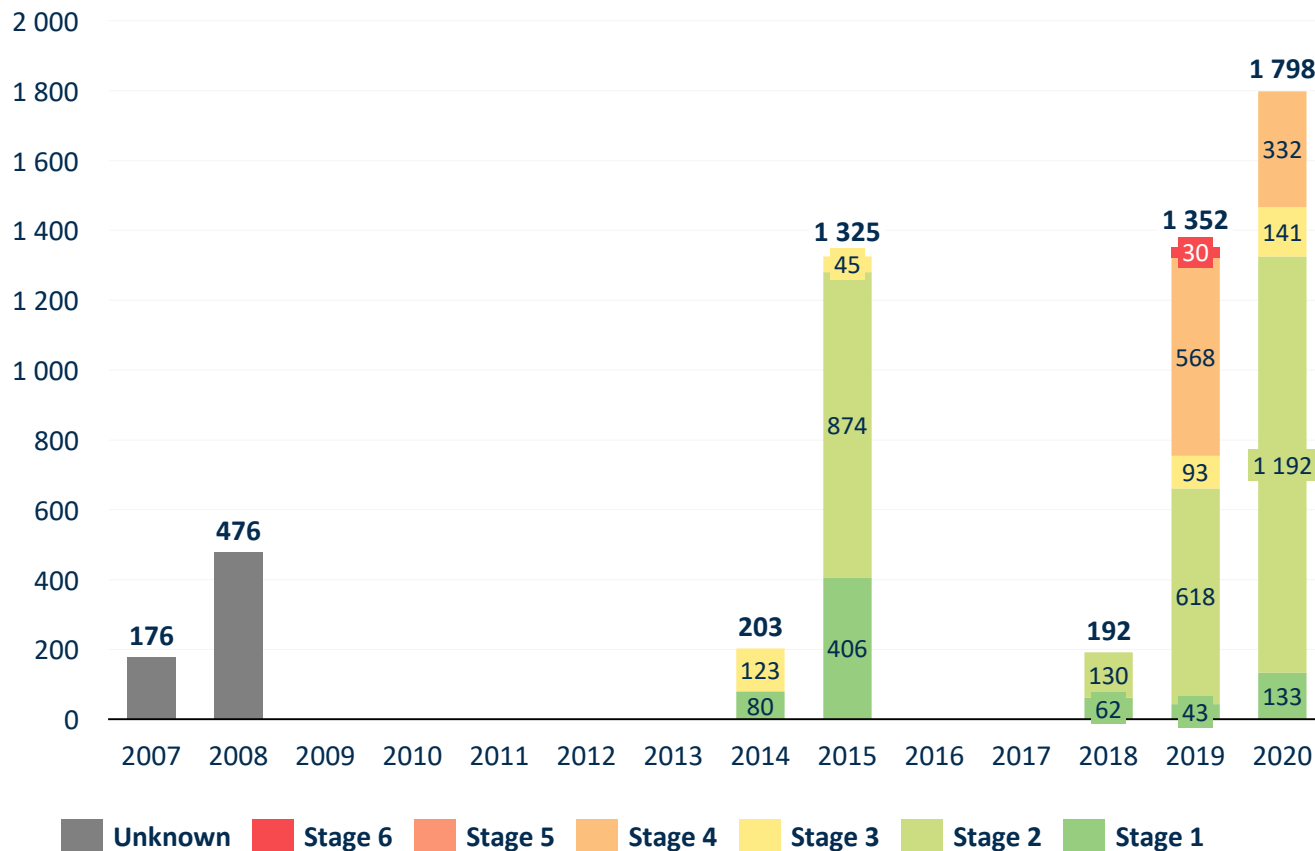


Agenda

- 1 Overview actual electricity production (2020)
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-
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2020 seemingly the most intensive loadshedding year yet –calculated based on upper limit of loadshedding (as in previous publications)

Load shed, upper-limit [GWh]

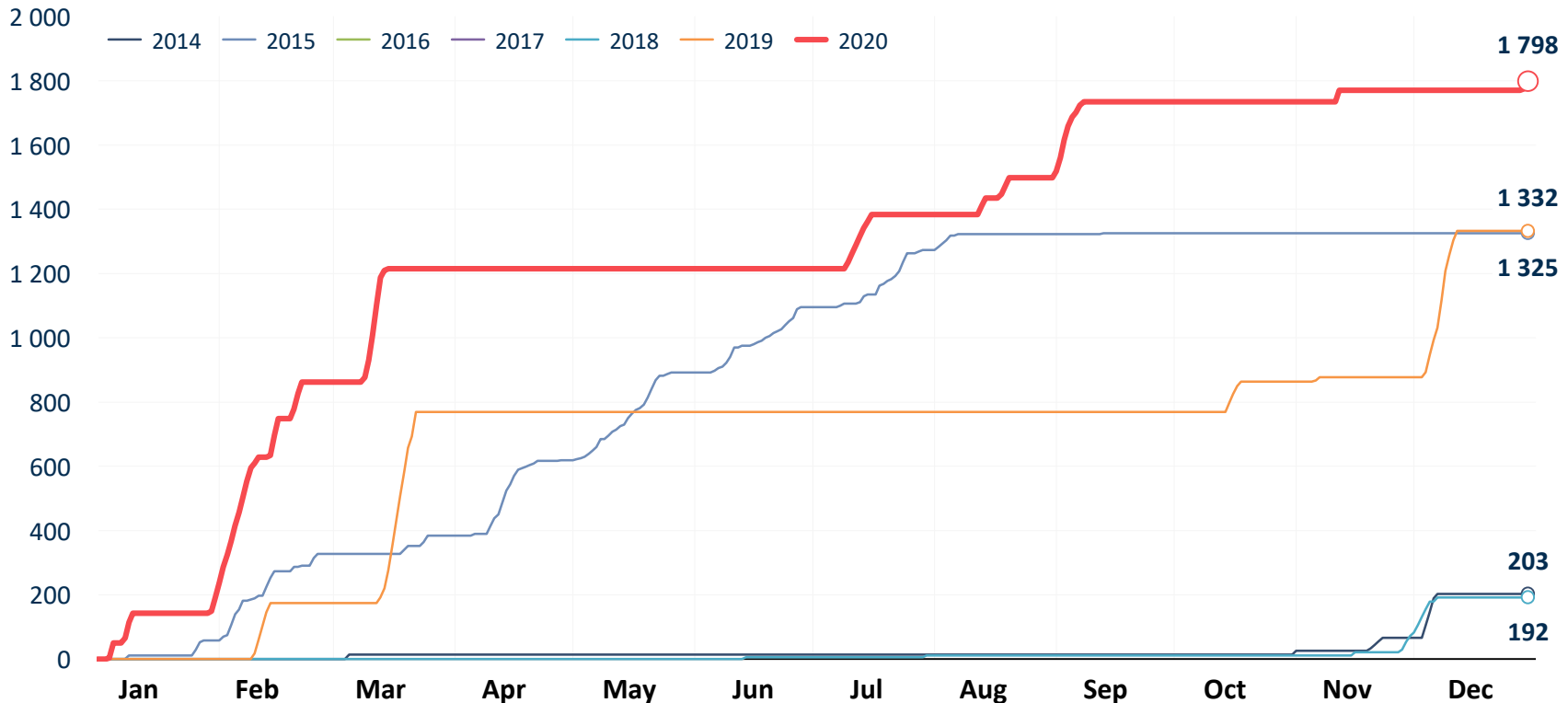


Year	Duration of outages (hours)	Energy shed (GWh)
2007	-	176
2008	-	476
....
2014	121	203
2015	852	1325
2016	-	-
2017	-	-
2018	127	192
2019	530	1352
2020	859	1798

Notes: Loadshedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occasionally 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 se Push (mobile app); Nersa; CSIR analysis

Cumulative build-up of loadshedding 2015-2020 (as in previous publications)

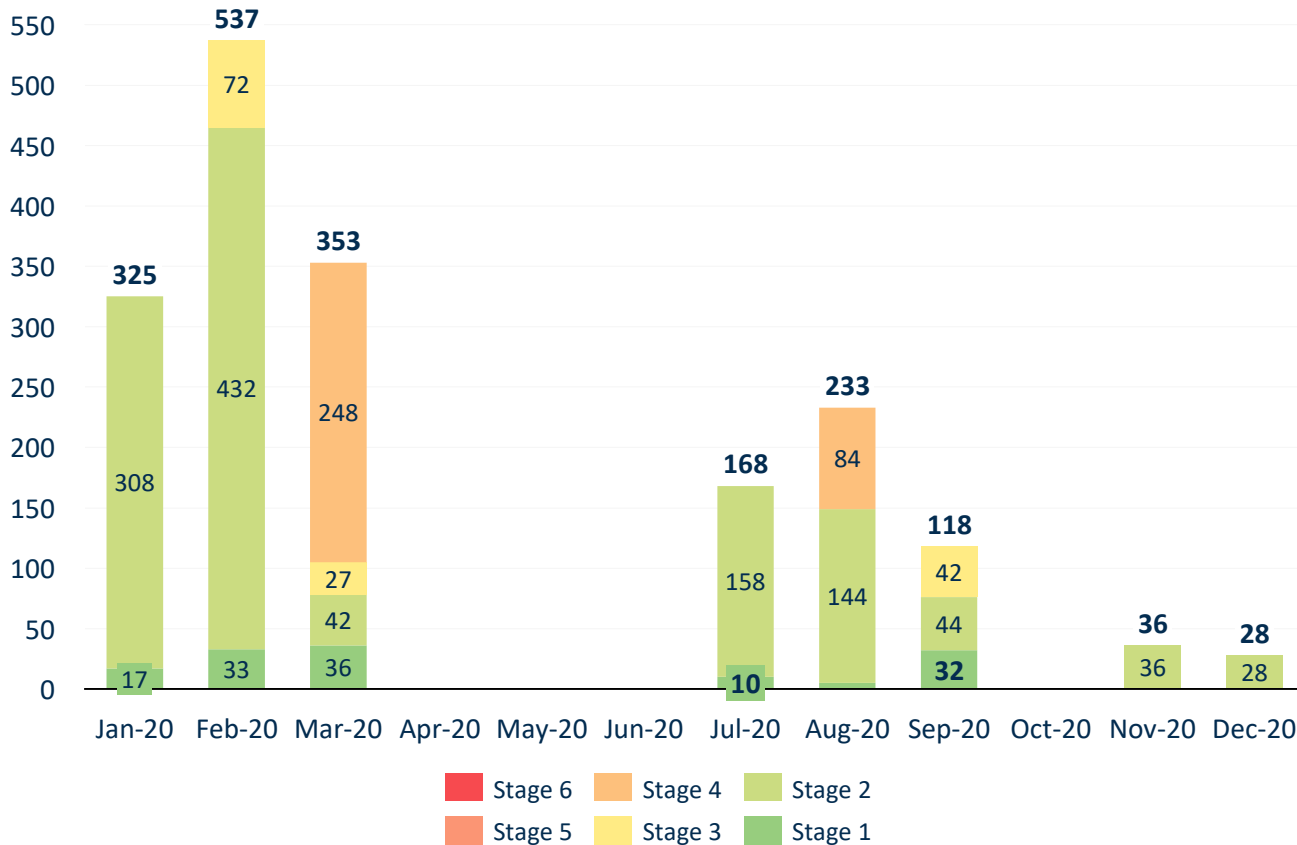
Load shed, upper-limit [GWh]



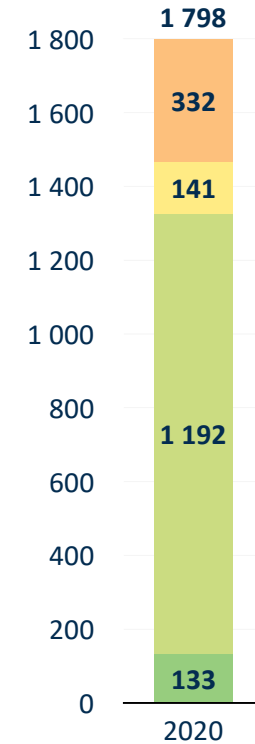
Notes: Loadshedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occasionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000 MW,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

Loadshedding to March halted after COVID-19 lockdown but returned by winter and remained for most of H2-2020

Monthly load shed, 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 occasionally 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 se Push (mobile app); Nersa; CSIR analysis



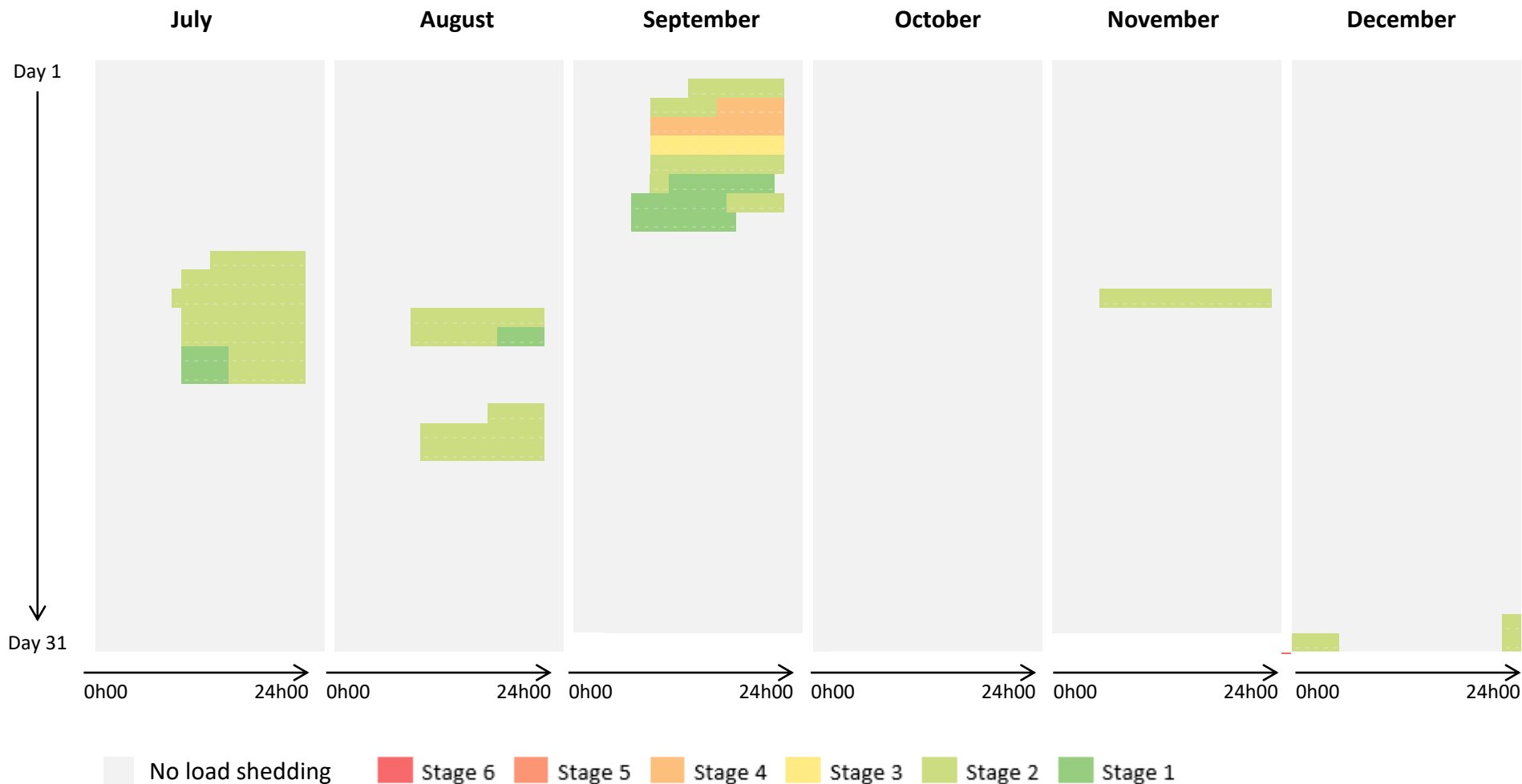
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Hourly distribution of loadshedding Jan – Jun 2020



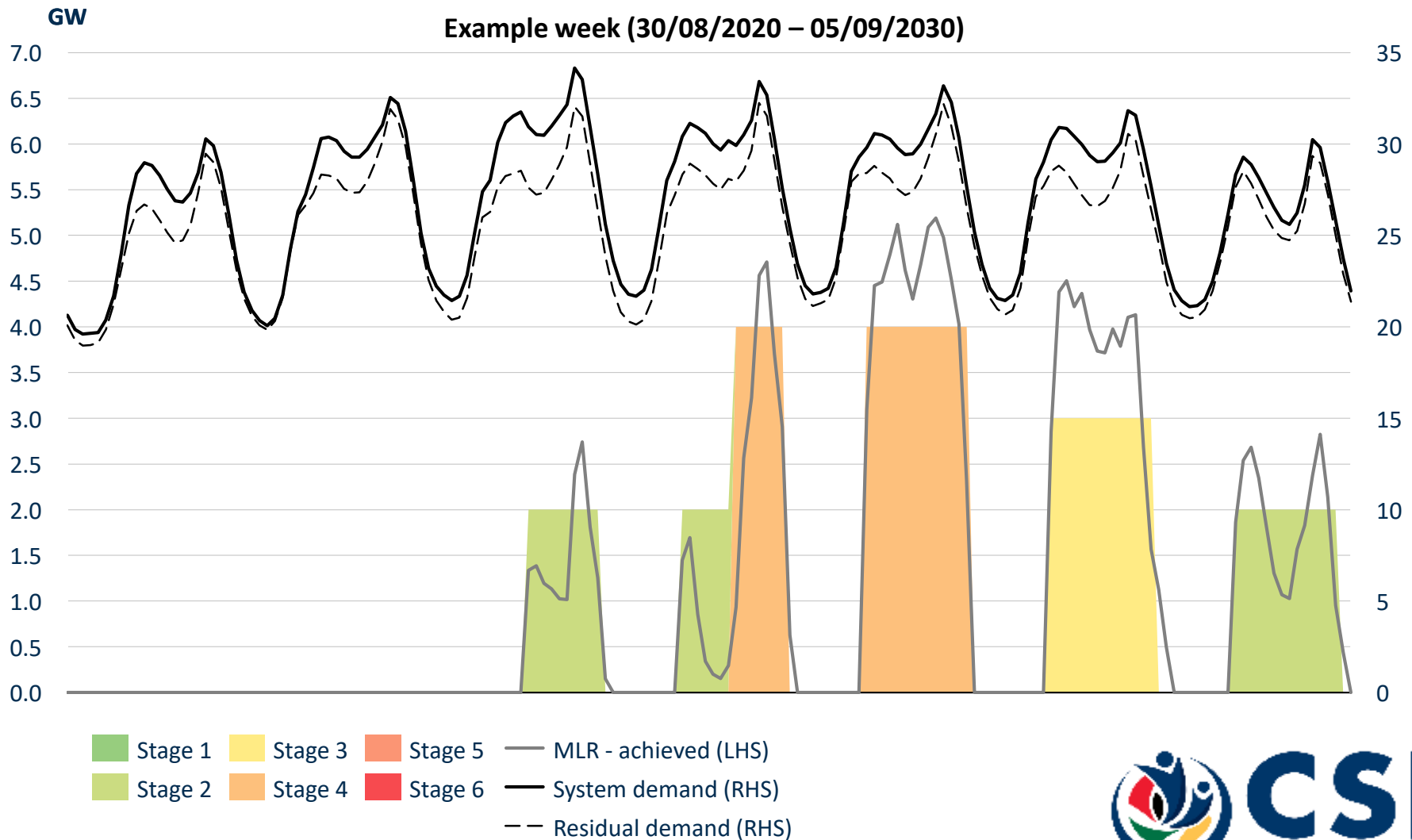
Notes: Load shedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occasionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000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

Hourly distribution of loadshedding Jul – Dec 2020



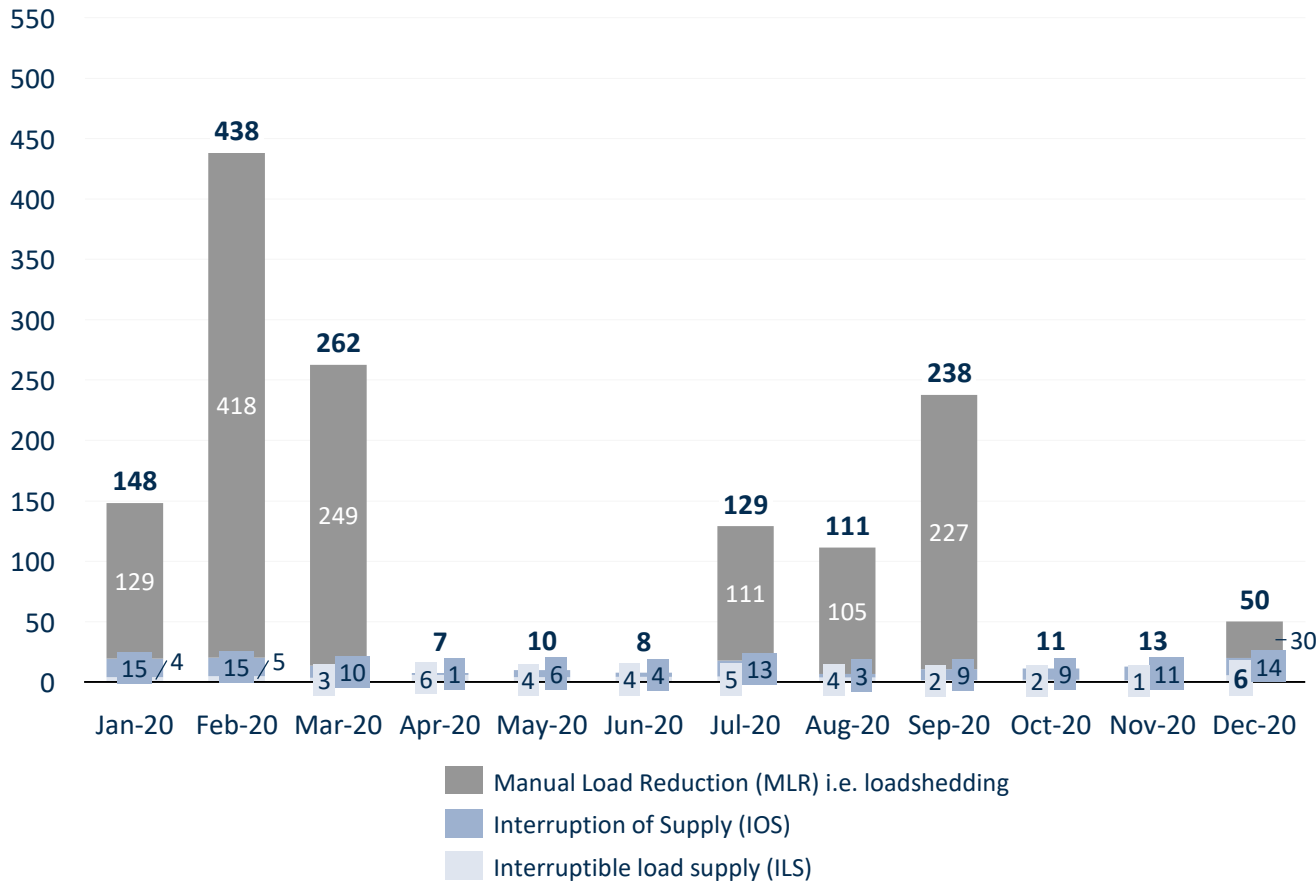
Notes: Load shedding assumed to have taken place for the full hours in which it was implemented. Practically, load shedding (and the Stage) may occasionally change/ end during a particular hour; Total GWh calculated assuming Stage 1 = 1 000 MW, Stage 2 = 2 000 MW, Stage 3 = 3 000 MW, Stage 4 = 4 000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

Demonstration of MLR relative to announced loadshedding reveals what is achieved from MLR interventions

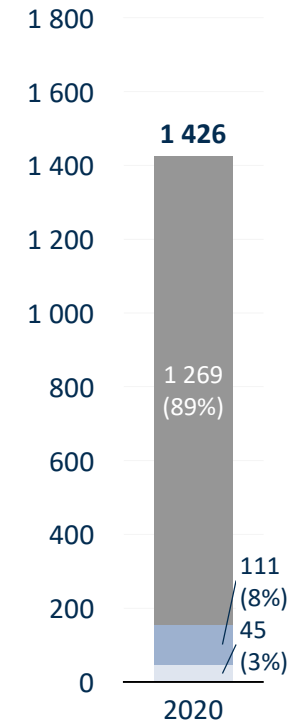


Actual demand side response (DSR) in 2020 reveals how actual MLR (loadshedding) dominates over other DSR

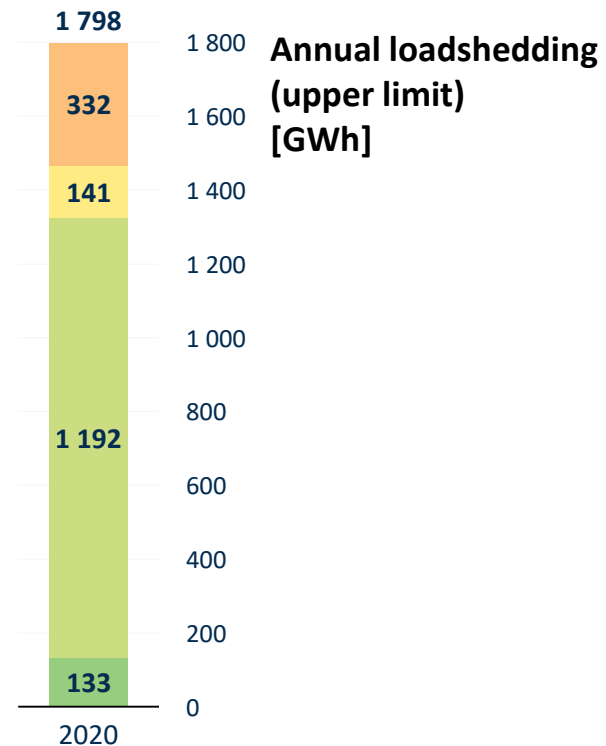
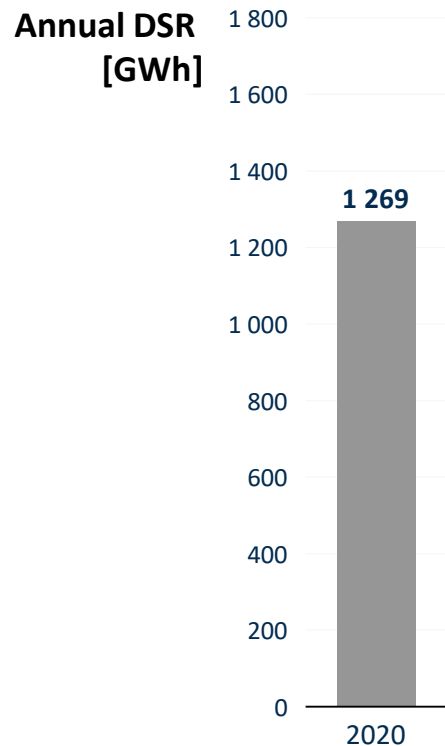
Monthly demand side response (DSR) [GWh]



Annual DSR [GWh]



Similarly - actual demand side response (DSR) in 2020 was ~70% of announced levels of loadshedding



■ Load Shedding (Manual Load Reduction)

■ Stage 6 ■ Stage 4 ■ Stage 2
 ■ Stage 5 ■ Stage 3 ■ Stage 1

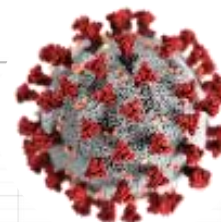
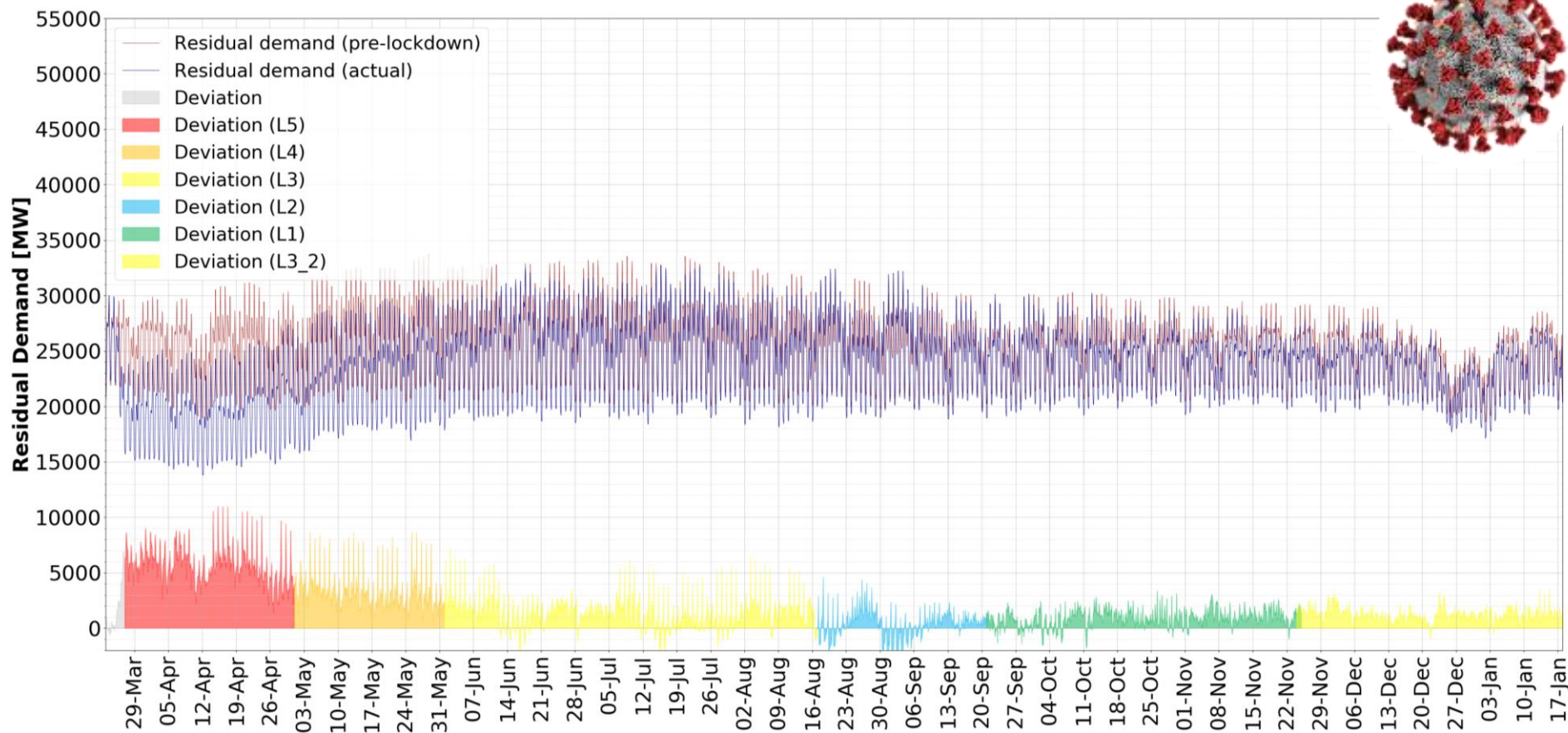


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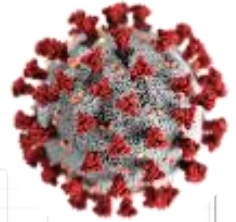
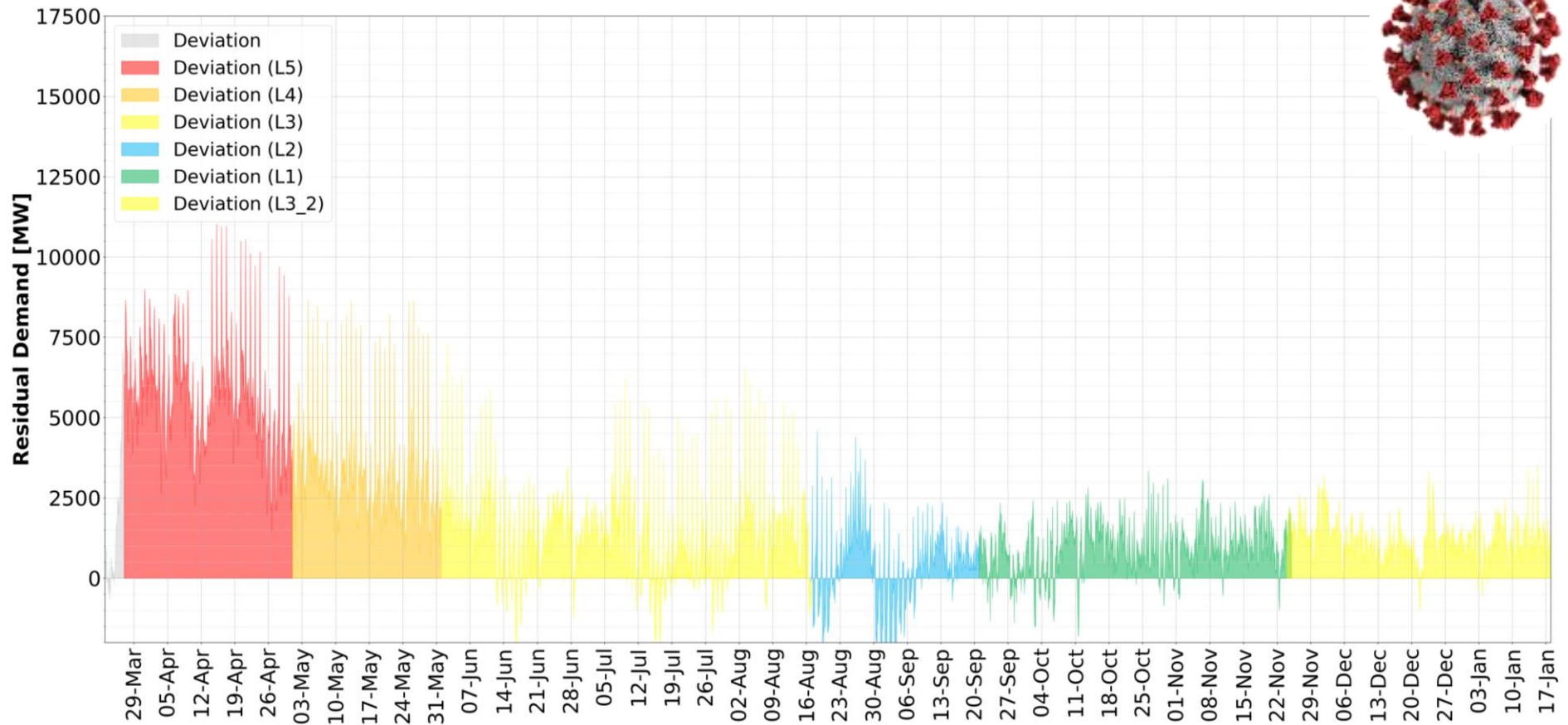
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Lockdown in South Africa had a significant impact on electricity demand

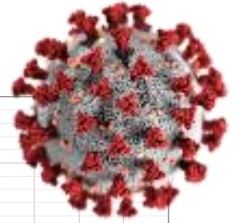
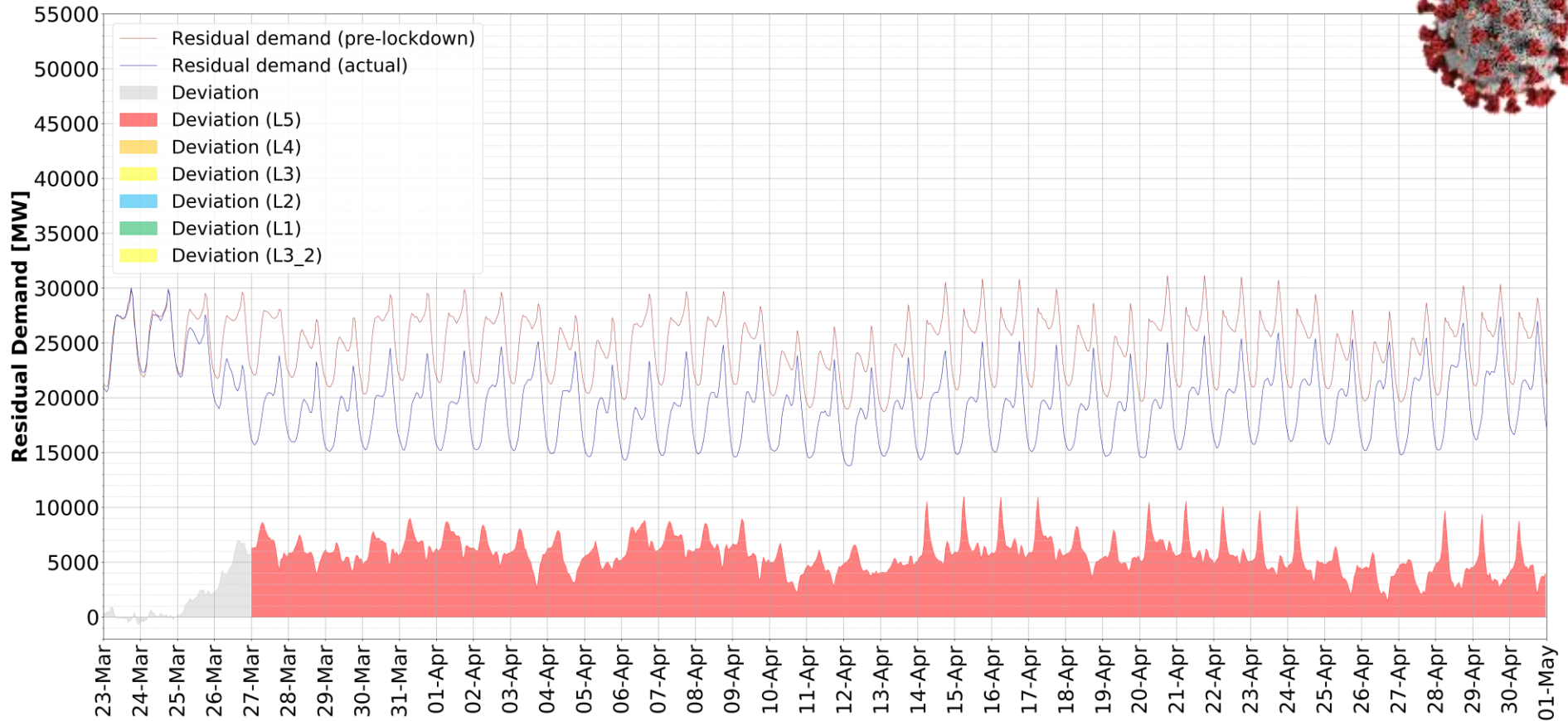


Up to 11 GW (L5) and 8.5 GW (L4) deviation whilst returning quickly back to 'normal' under Level 2 and Level 1 of lockdown (& 2nd Level 3)



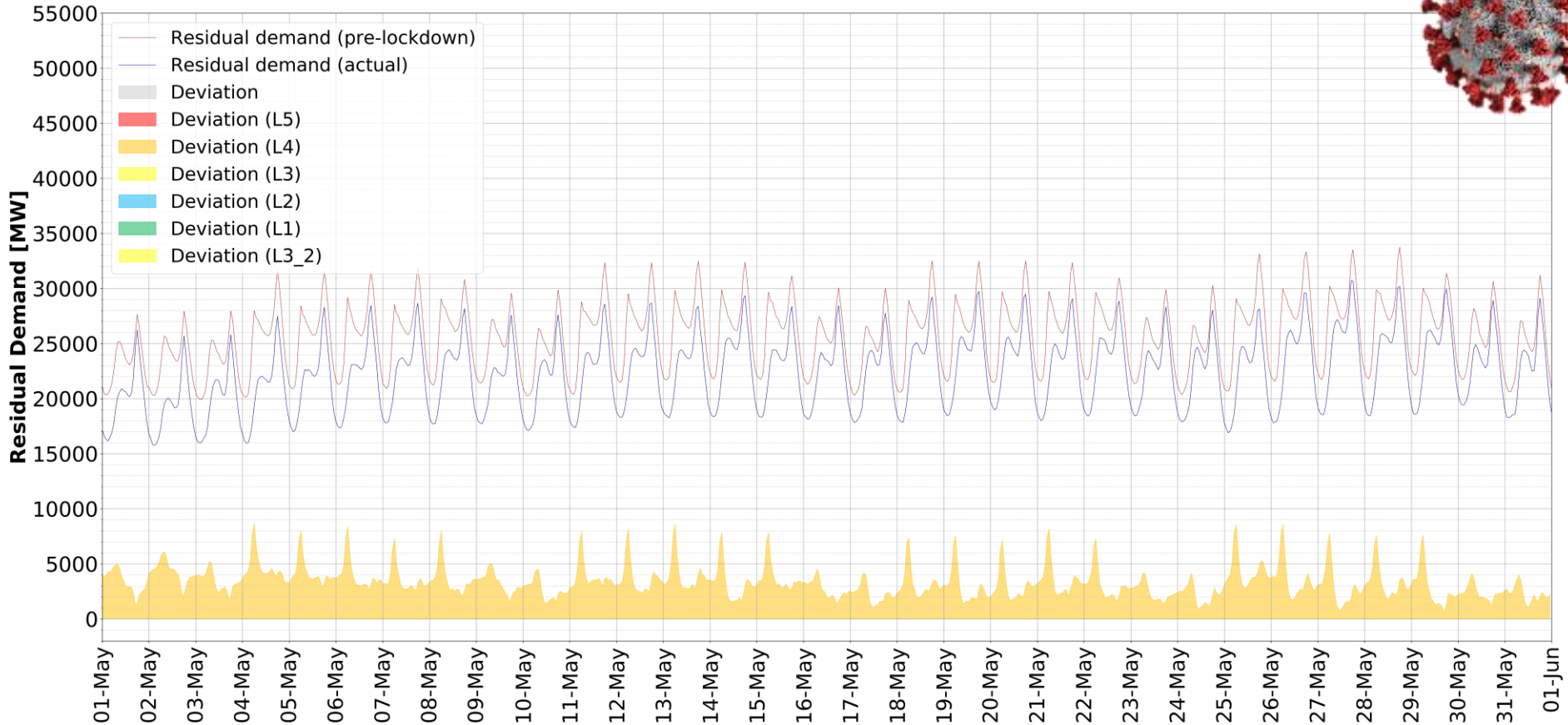
Under Level 5 – Peak demand dropped from expected 31.2 GW to 27.4 GW (-3.8 GW) whilst minimum demand dropped to 13.8 GW

Level 5 (35 days)



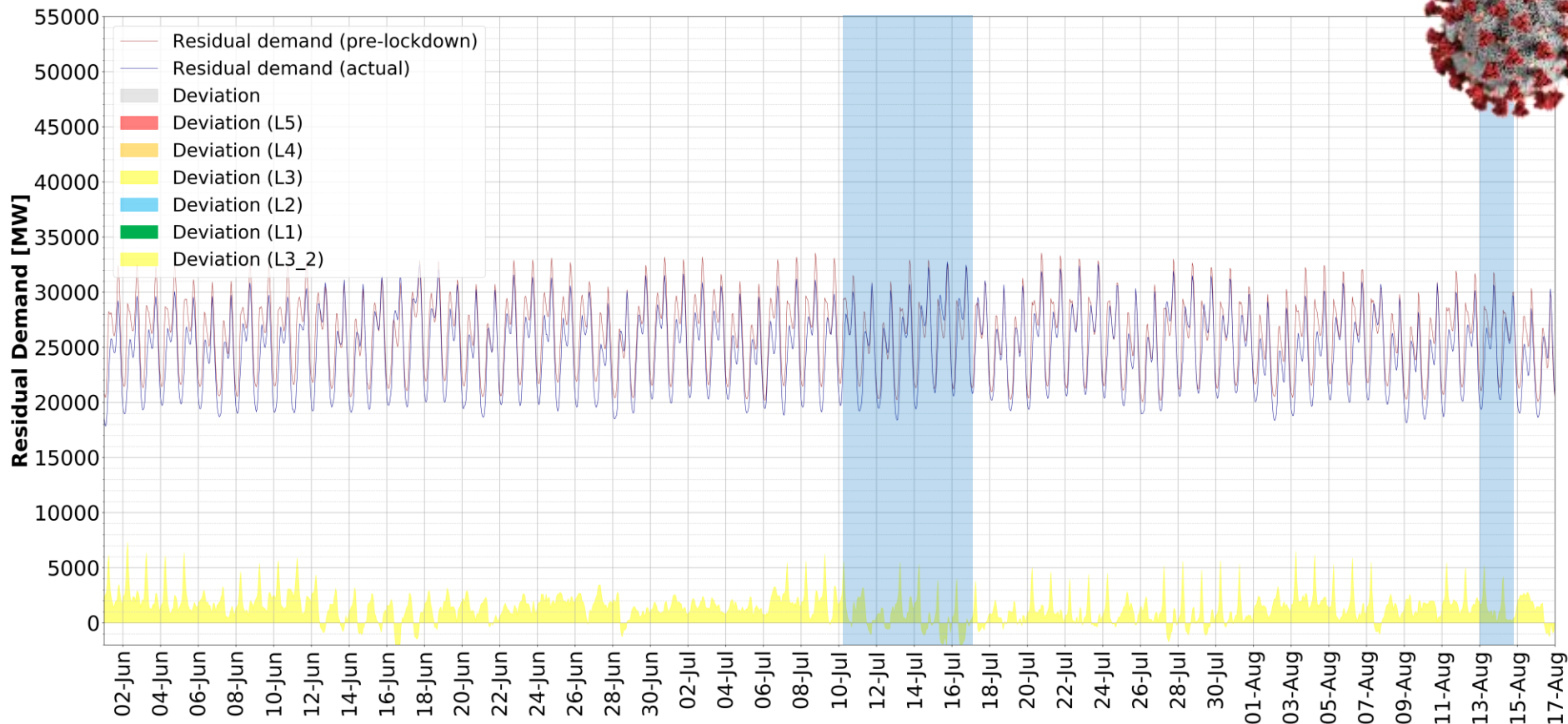
Under Level 4 of lockdown – Peak demand dropped from expected 33.6 GW to 30.7 GW (-3.1 GW), morning peak shifted notably

Level 4 (31 days)



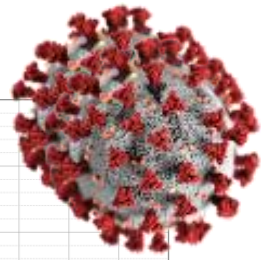
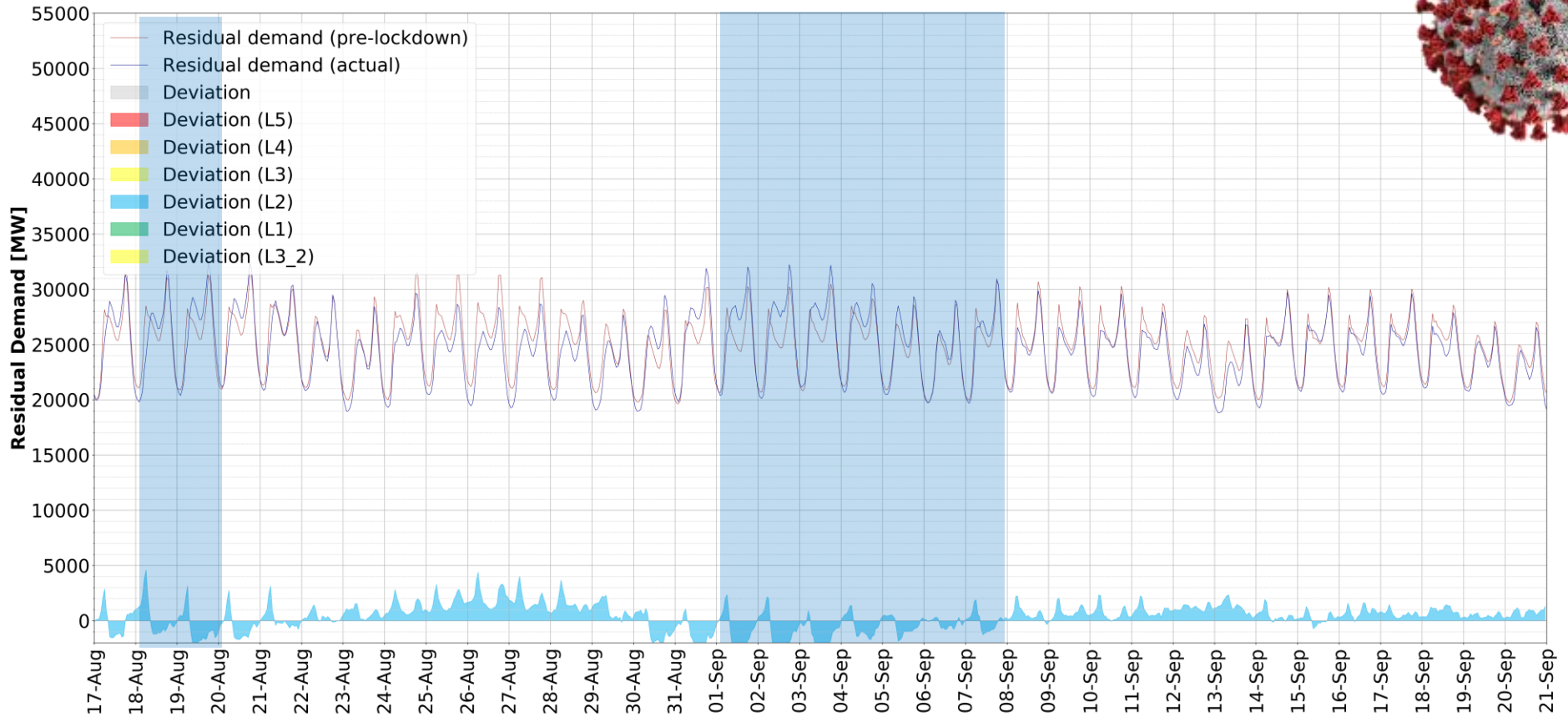
Under Level 3 of lockdown – demand returning back to ‘normal’ in scale with loadshedding returning (10-16 Jul., 13-14 Aug.)

Level 3 (80 days)



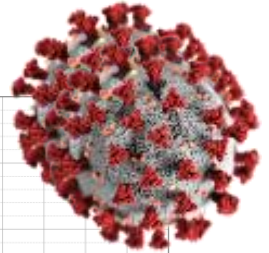
Under Level 2 of lockdown – demand back to ‘normal’ with loadshedding returning (18-20 Aug., 1-8 Sept.)

Level 2 (35 days)

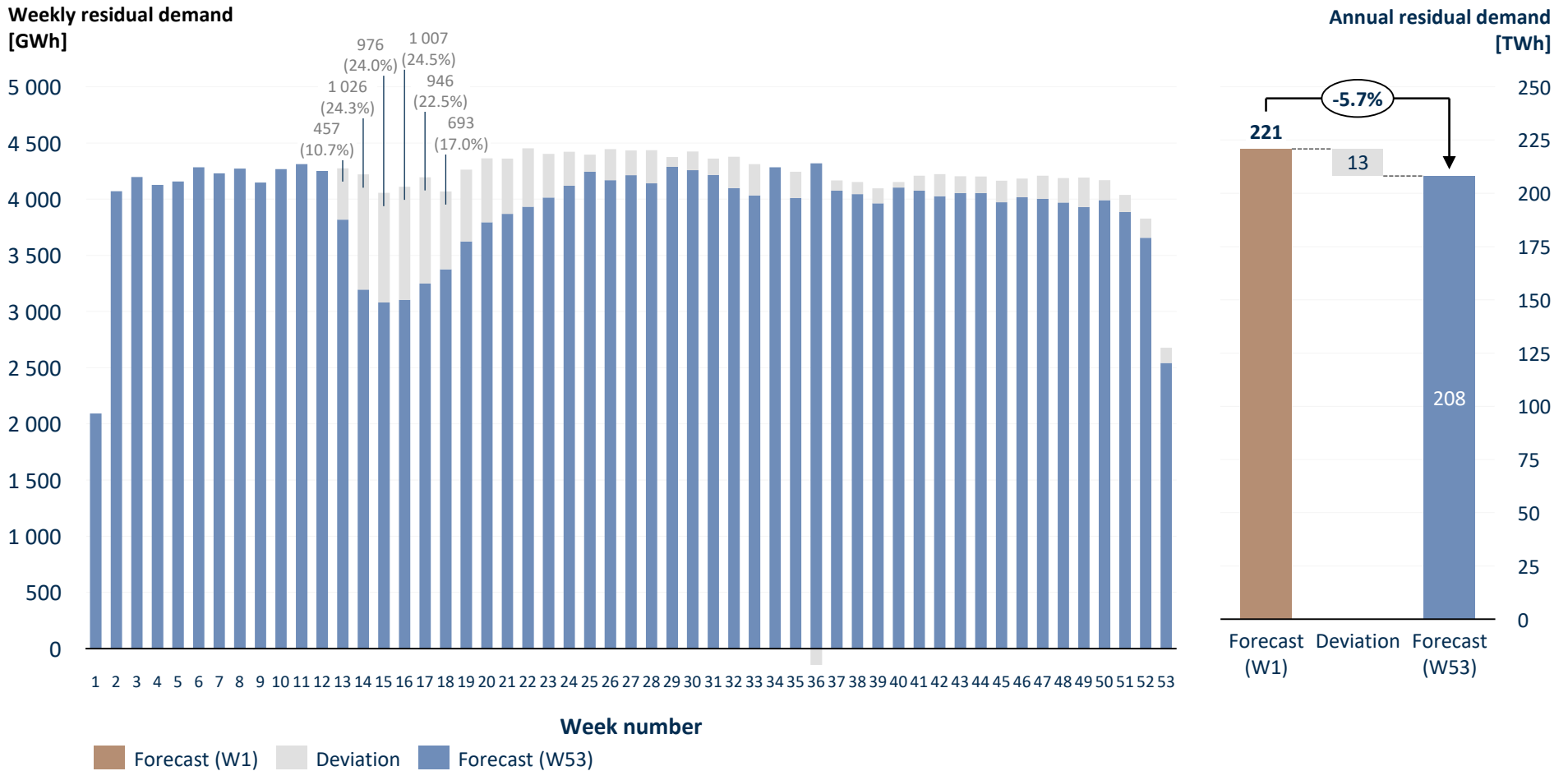


Under Level 1 of lockdown – no loadshedding was seen

Level 2 (35 days)



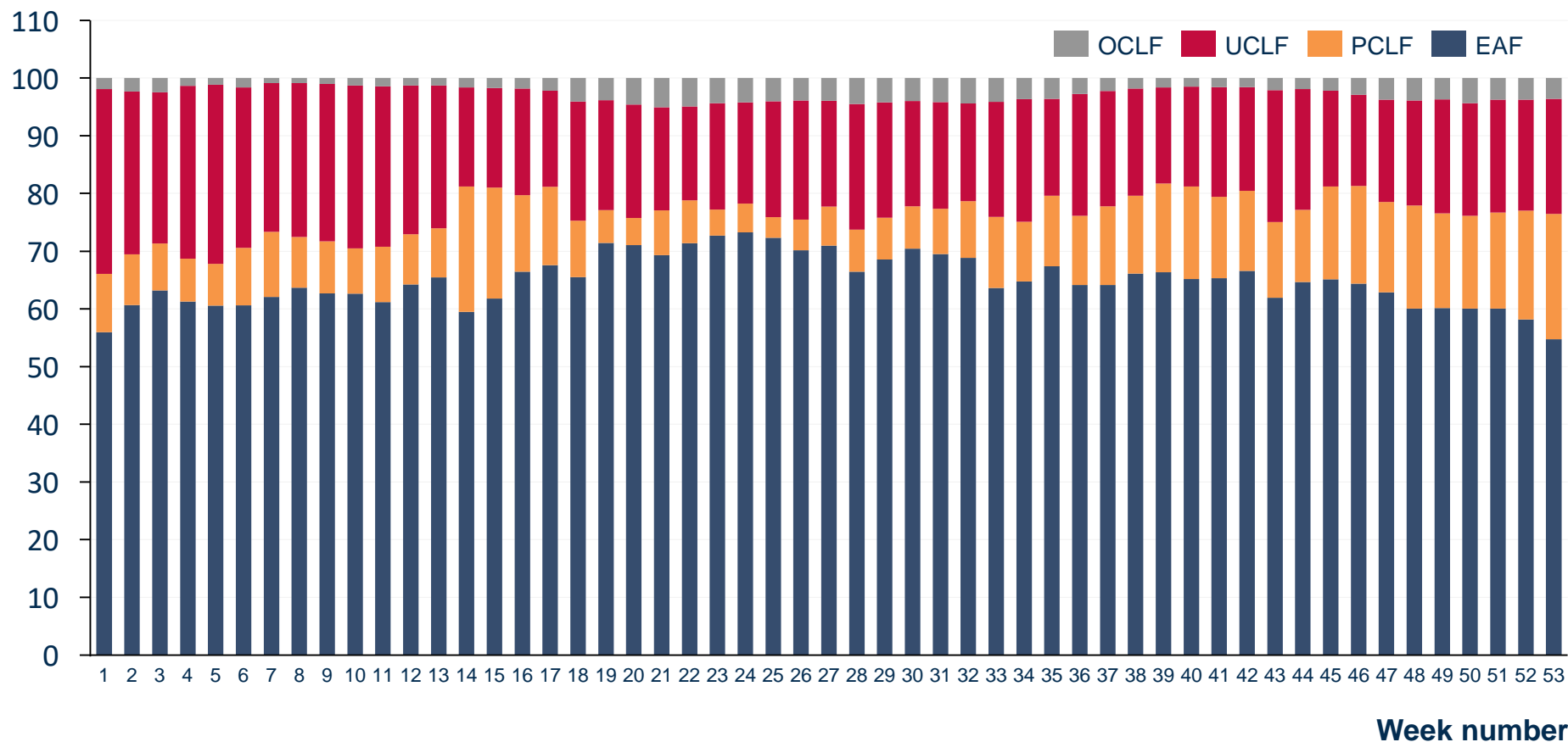
For 2020 – primarily driven by Covid-19 lockdown, residual energy demand reduced by ~13 TWh (-5.7%) relative to expectations at the beginning of 2020



Notes: Week 1 and 53 not full weeks
 Sources: Eskom; CSIR Energy Centre analysis

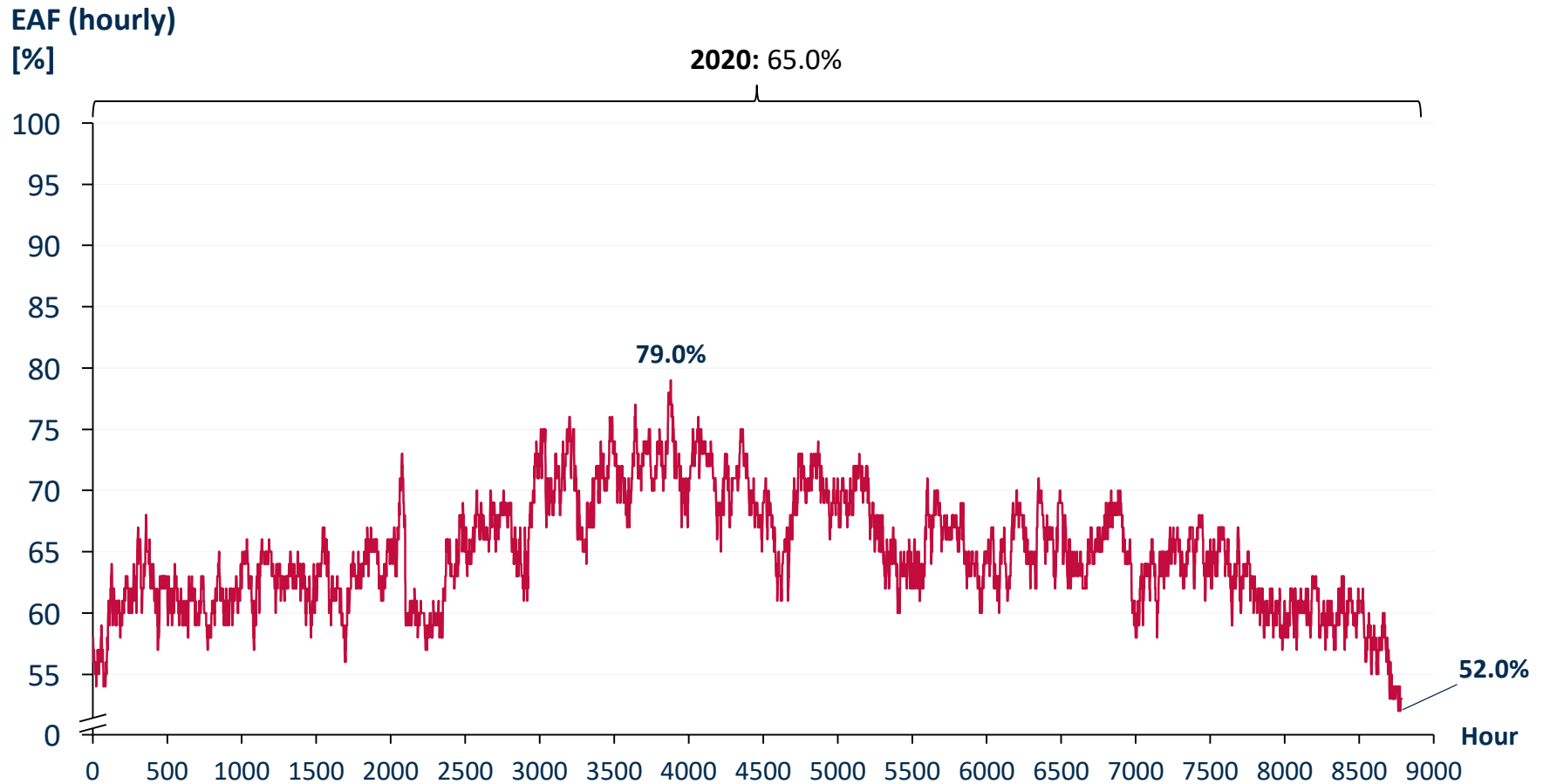
Eskom fleet performance for 2020 (weekly) reveals overall EAF of 65% comprising planned maintenance of 11.2%, unplanned of 20.9% & other at 2.8%

Plant performance (weekly)
[%]



207 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 2020 (hourly) exhibits similar seasonality as in other years but with notably higher levels at start of Covid-19 lockdown



Declining EAF trend continues for the year 2020 to an average EAF 65%

EAF (weekly)



Thank you



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References

Eskom Holdings SOC Limited (2020), *Eskom Data Portal*, <https://www.eskom.co.za/sites/publicdata/>

Eskom Holdings SOC Limited. (2020). *Integrated Report 2020*.
https://www.eskom.co.za/IR2020/Documents/Eskom_2020_integrated_report_secured.pdf

Eskom Holdings SOC Limited (2021), Official Twitter Account Announcements, https://twitter.com/Eskom_SA