

Statistics of utility-scale solar PV, wind and CSP in South Africa in 2018

CSIR Energy Centre

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The logo for the Council for Scientific and Industrial Research (CSIR) of South Africa. It features the letters 'CSIR' in a bold, blue, sans-serif font. The 'C' and 'S' are connected, and the 'I' and 'R' are also connected. The letters are set against a white background.

our future through science

Agenda

- 1 Overview and status of REIPPPP
- 2 Overview actual electricity production data for 2018
- 3 Monthly electricity production
- 4 Weekly electricity production
- 5 Daily electricity production
- 6 Hourly electricity production
- 7 Actual load shedding in 2018

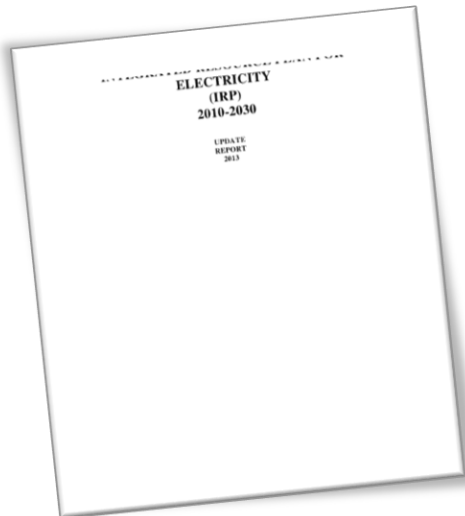
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South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) started in 2011

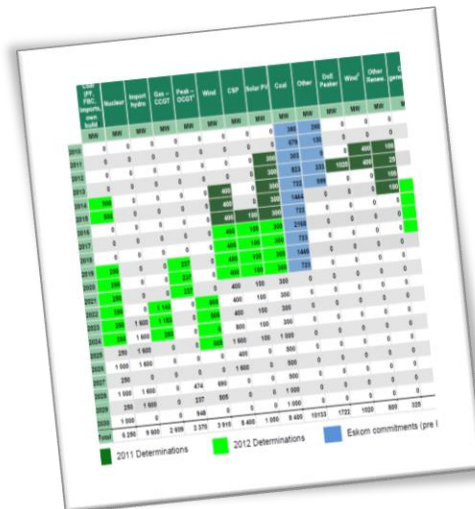
Integrated Resource Plan (IRP) 2010

- Promulgated in 2011, the IRP developed the preferred energy mix with which to meet the forecasted electricity needs over a 20 year horizon
- The plan included 9.2 GW of wind, 8.4 GW of solar PV and 1.2 GW of CSP by 2030 (amongst a range of other new-build capacity)



Ministerial Determination

- In May 2011, the Department of Energy (DoE) gazetted the New Generation Regulations under the Electricity Regulation Act (ERA) and made a determination for new capacity
- Second determination was made on 18 August 2015



IPPPP

- The IPPPP is a key vehicle for securing electricity capacity from the private sector for renewable and non-renewable energy sources as determined by the Minister of Energy
- The DoE, National Treasury (NT) and the Development Bank of Southern Africa (DBSA) established the IPP Office for the specific purpose of delivering on the IPP procurement objectives
- Since 2011, there have been 5 main Bid Windows (BW 1, 2, 3, 3.5, 4) planned to contribute 6.3 GW
- Power Purchase Agreements (PPAs) signed for BW 1,2,3, 3.5 and 4

Overview of South Africa's REIPPPP

The REIPPPP is designed to contribute to meeting the national renewable energy target while encouraging foreign investment and developing socio-economic and environmentally sustainable growth

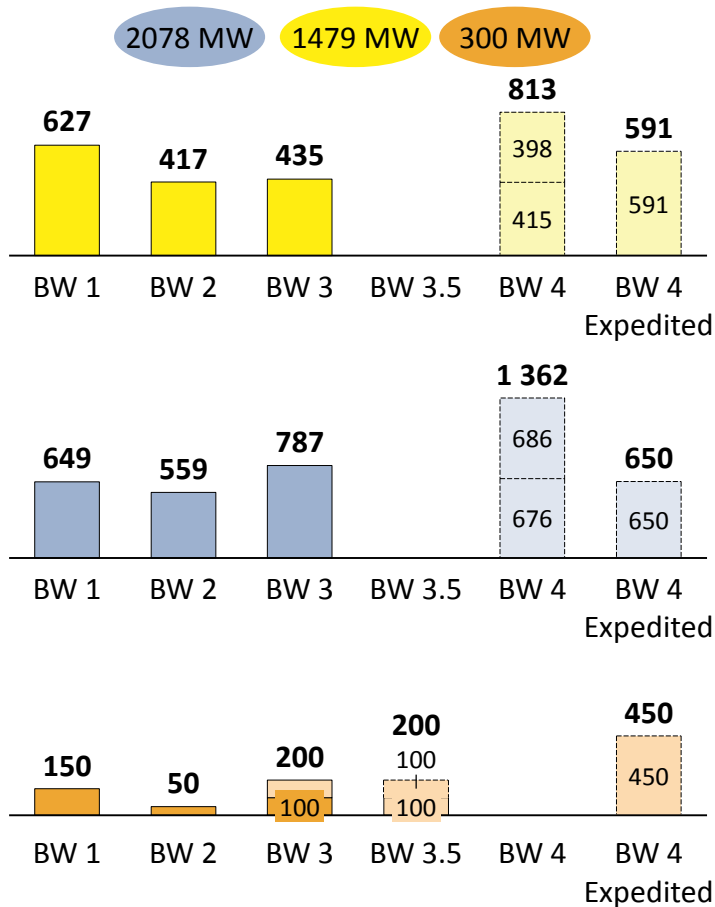
- To date, renewable energy projects as part of the REIPPPP in South Africa have resulted in ≈35 000 jobs for South African citizens and have attracted R 201.8-billion in investment (24% of which is foreign).
- Furthermore, IPPs have committed a total of R 19.1 billion toward socio-economic development initiatives within the communities in which they operate, thereby positively contributing to livelihoods and income generation
- The main evaluation criterion for the bid selection process is pricing (70% weighting) and the remaining 30% weighting for other factors such as job creation, local content and black economic empowerment
- The REIPPPP includes onshore wind, solar PV, CSP, small hydro, biomass, biogas, landfill gas, small hydro and co-generation (from agricultural waste / by-products)
- Prices have dropped over four bid windows with average PV tariffs decreasing by 83%, wind by 59% and CSP by 43%

The South African Department of Energy (DoE) has already allocated a total of 8.1 GW of renewables (mainly wind and solar PV) for procurement from Independent Power Producers (IPPs)

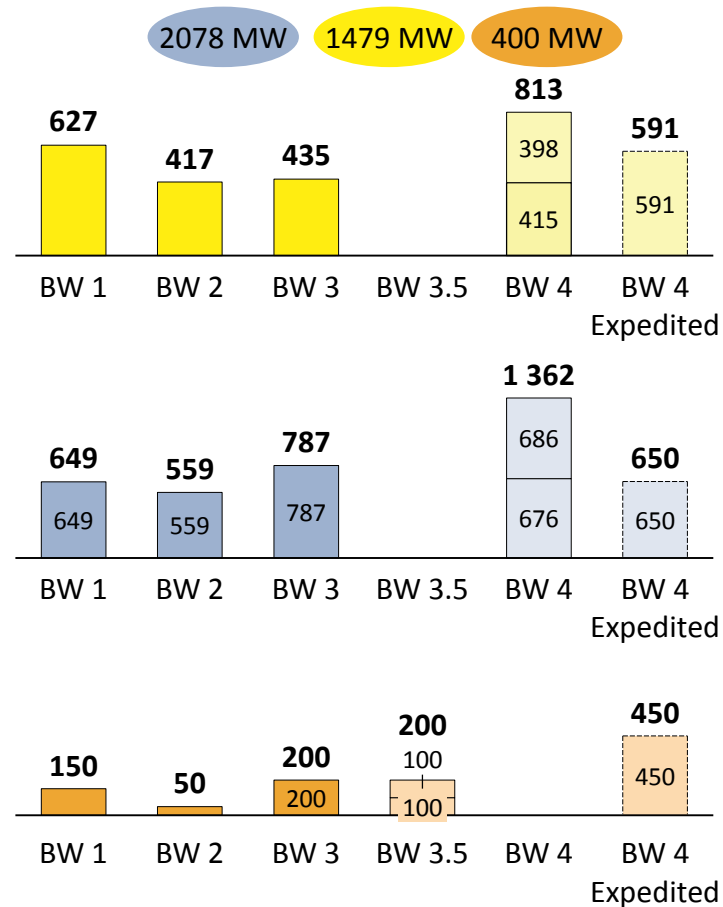
- ... of this, 7.5 GW have achieved preferred bidder status
- ... of this, 6.3 GW have signed Power Purchase Agreements (PPAs) with Eskom
- ... of this, 2.1 GW of wind, 1.5 GW of solar PV and 0.4 GW of CSP were operational by the end of 2018

Procured and operational capacity under RSA's RE IPP Procurement Programme (REIPPPP) in 2018

Capacity operational
(1 January 2018)



Capacity operational
(31 December 2018)



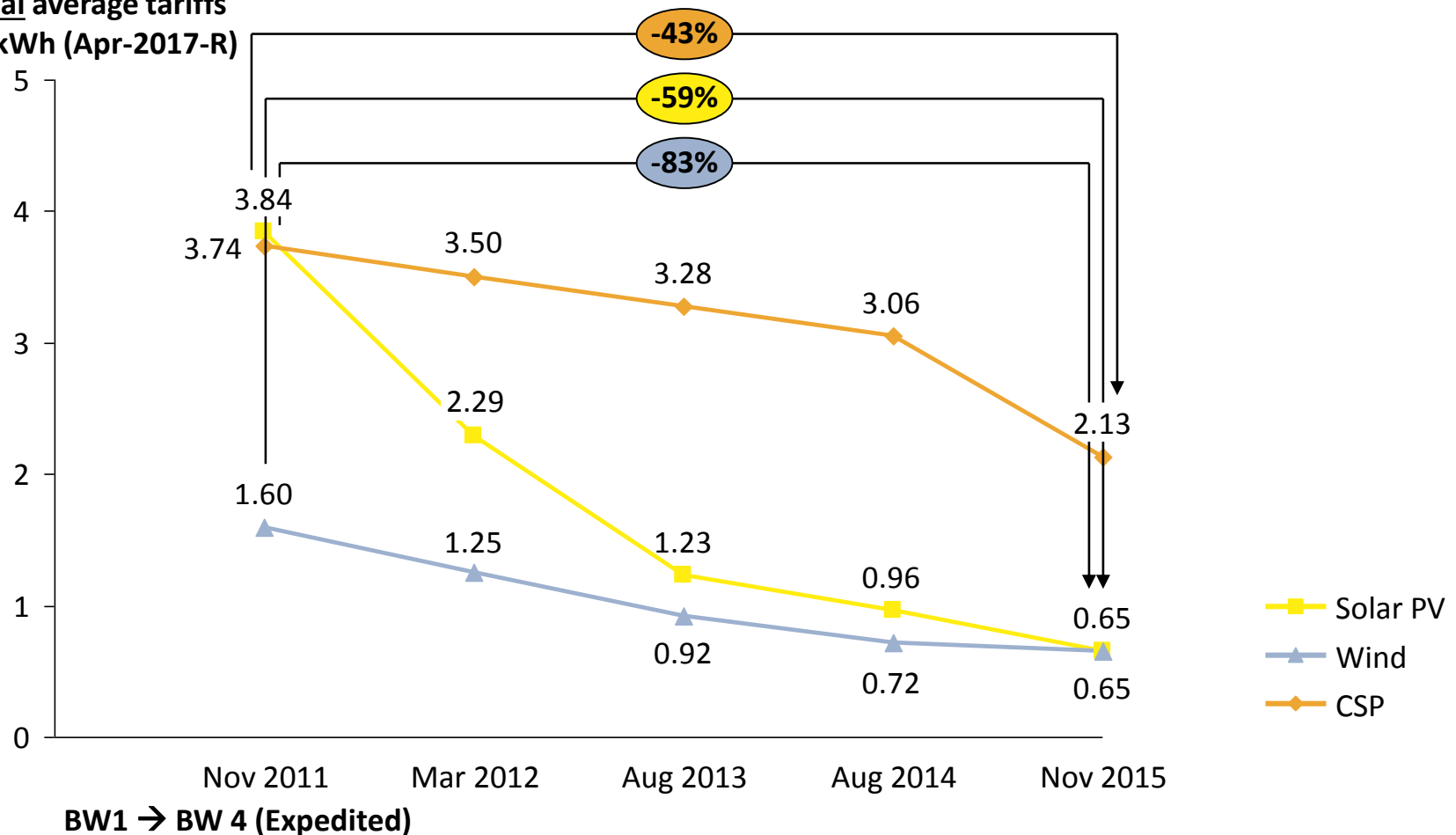
Supply Sources

- Solar PV procured, PPAs not signed yet
- Solar PV procured, PPAs signed
- Solar PV operational
- Wind procured, PPAs not signed yet
- Wind procured, PPAs signed
- Wind operational
- CSP procured, PPAs not signed yet
- CSP procured, PPAs signed
- CSP operational

Actual tariffs: Reductions in tariff for new wind, solar PV and CSP

Results of Department of Energy's RE IPP Procurement Programme

**Actual average tariffs
in R/kWh (Apr-2017-R)**



Sources: <http://www.energy.gov.za/files/renewable-energy-status-report/Market-Overview-and-Current-Levels-of-Renewable-Energy-Deployment-NERSA.pdf>;

<http://www.saippa.org.za/Portals/24/Documents/2017/Coal%20IPP%20factsheet.pdf>; http://www.ee.co.za/wp-content/uploads/2017/10/New_Power_Generators_RSA-CSIR-14Oct2017.pdf;

StatsSA on CPI; BW = Bid Window; Dates shown are the bid submission dates; CSIR analysis

Summary of 2018 statistics:

4.6 % of system load was supplied by wind, solar PV & CSP in RSA

By end 2018 - a total of 2 078 MW wind, 1 479 MW of solar PV and 400 MW of CSP capacity were operational

- No additional wind or solar PV became operational in 2018 whilst 100 MW of additional CSP became operational

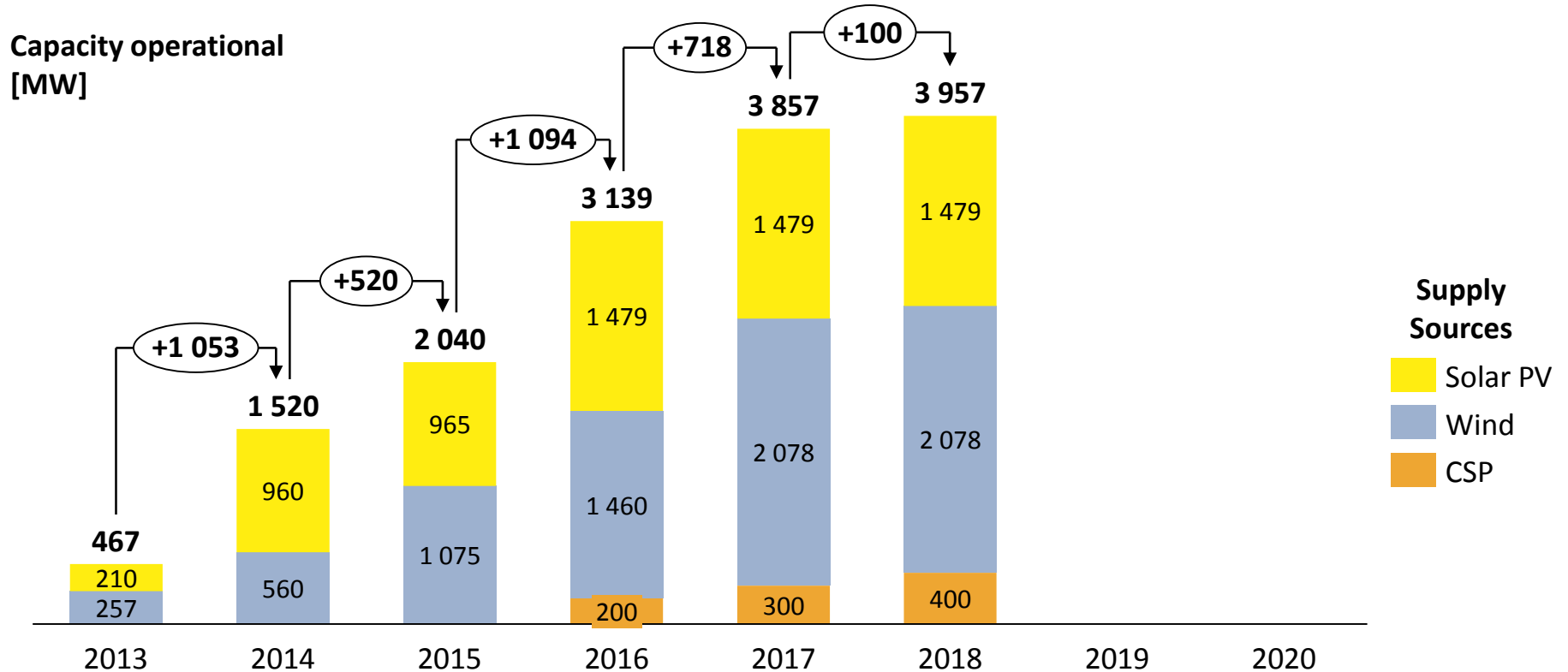
By end 2018- total wind, solar PV and CSP production was 10.8 TWh, supplying 4.6% of SA's system load

- Maximum daily total energy from solar PV, wind & CSP combined was 49 GWh (21 Oct 2018), 8.0% of system load
- Wind power achieved a maximum peak power production of 1 902 MW between 16h00-17h00 (2 Oct 2018)
- Solar PV power reached a maximum peak power production of 1 392 MW between 12h00-13h00 (3 Oct 2018)
- CSP power reached a maximum peak power production of 400 MW between 15h00-16h00 (4 Dec. 2018)
- Maximum instantaneous contribution of wind, solar PV & CSP was 13.1% between 14h00-15h00 (1 Jan 2018)
- Maximum instantaneous power contribution of wind alone was 8.2% between 03h00-04h00 (26 Aug 2018)
- Maximum instantaneous power contribution of solar PV alone was 5.8% between 14h00-15h00 (1 Jan 2018)
- Maximum instantaneous power contribution of CSP alone was 1.6% between 17h00-18h00 (25 Dec 2018)

By end 2018 - monthly wind, solar PV and CSP production combined varied between 742 GWh and 1047 GWh

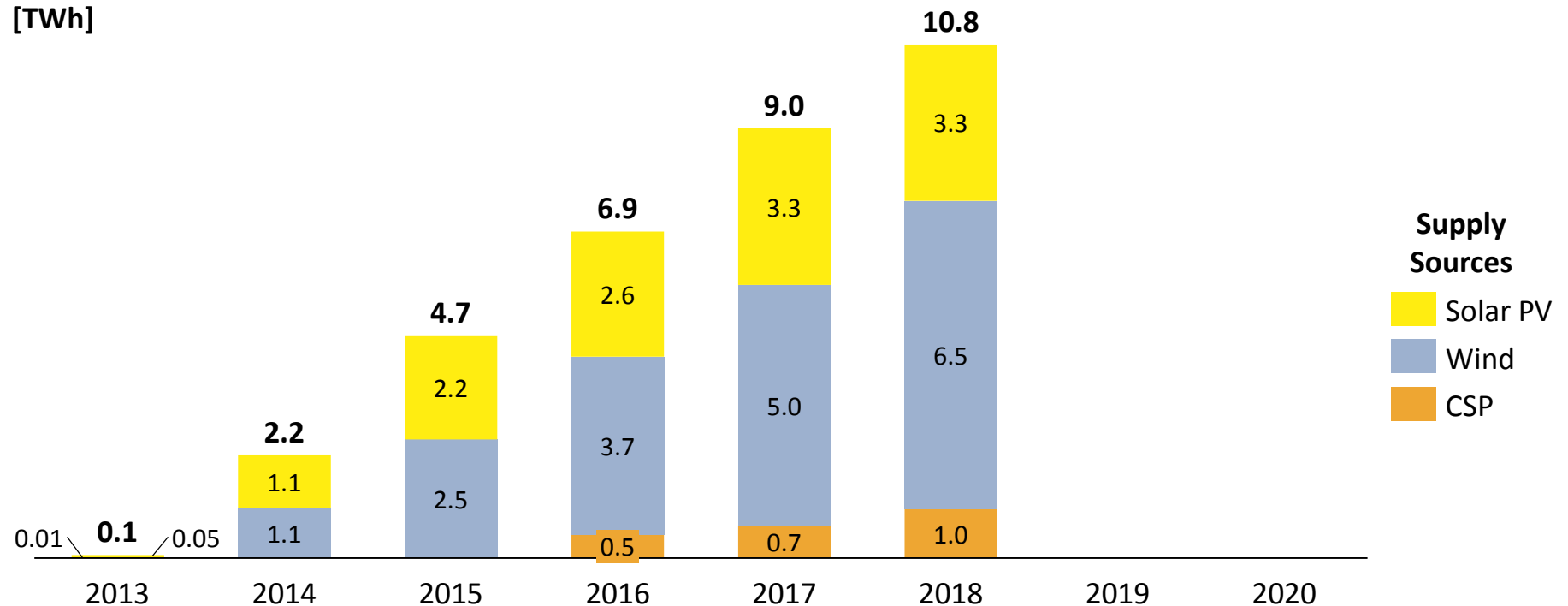
- Monthly wind production from Jan to Dec 2018 varied between 431-618 GWh
- Monthly solar PV production from Jan to Dec 2018 varied between 220-334 GWh
- Monthly CSP production from Jan to Dec 2018 varied between 55-139 GWh

From 1 November 2013 to 31 Dec 2018, 2 078 MW of wind, 1 479 MW of large-scale solar PV and 400 MW of CSP became operational in RSA



In 2018, 10.8 TWh of wind, solar PV and CSP energy produced in RSA

Annual energy produced
[TWh]

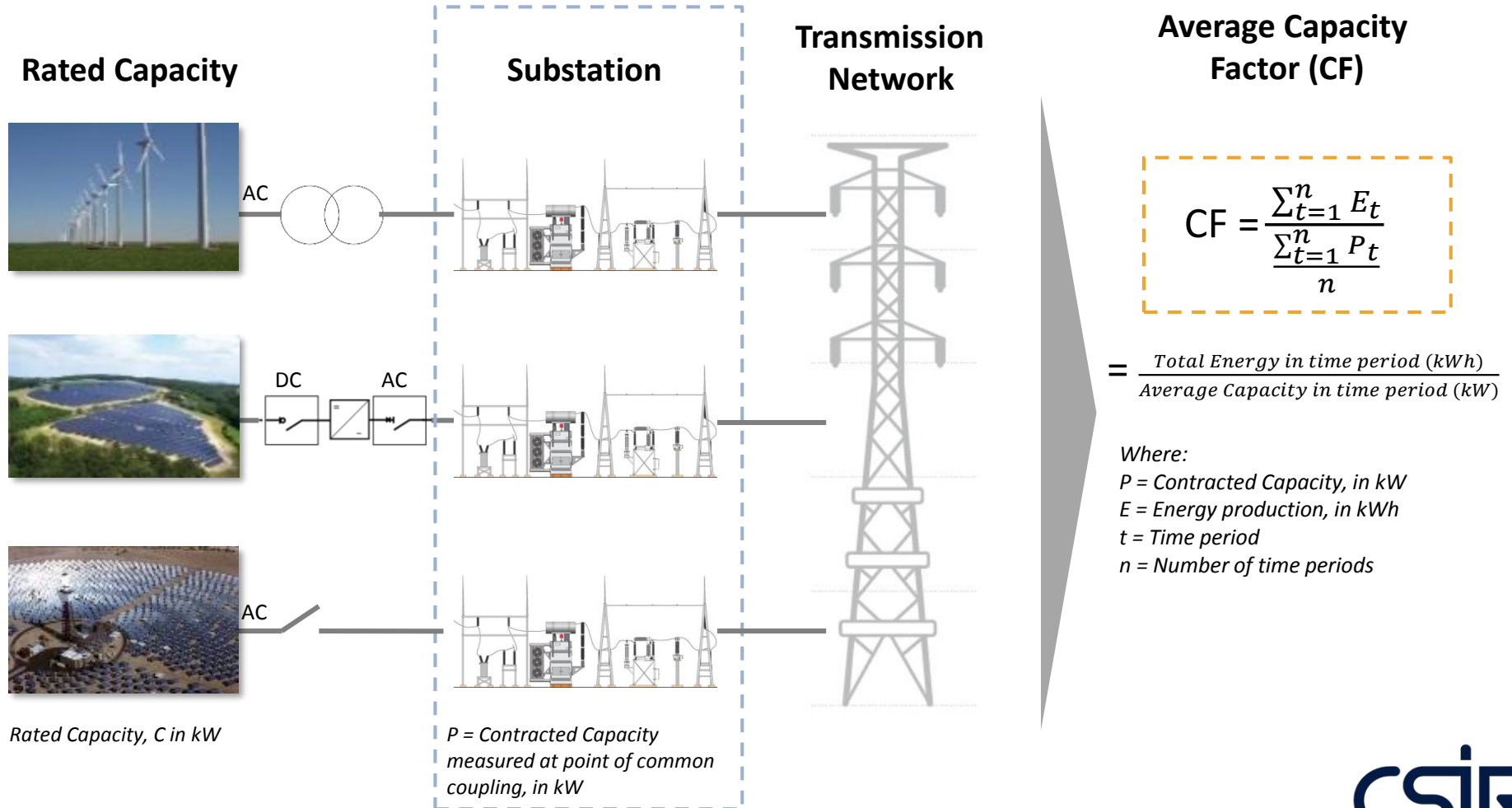


Notes: Wind includes Eskom's Sere wind farm (100 MW). CSP energy measured from date when more than two CSP plant were commissioned.

Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation

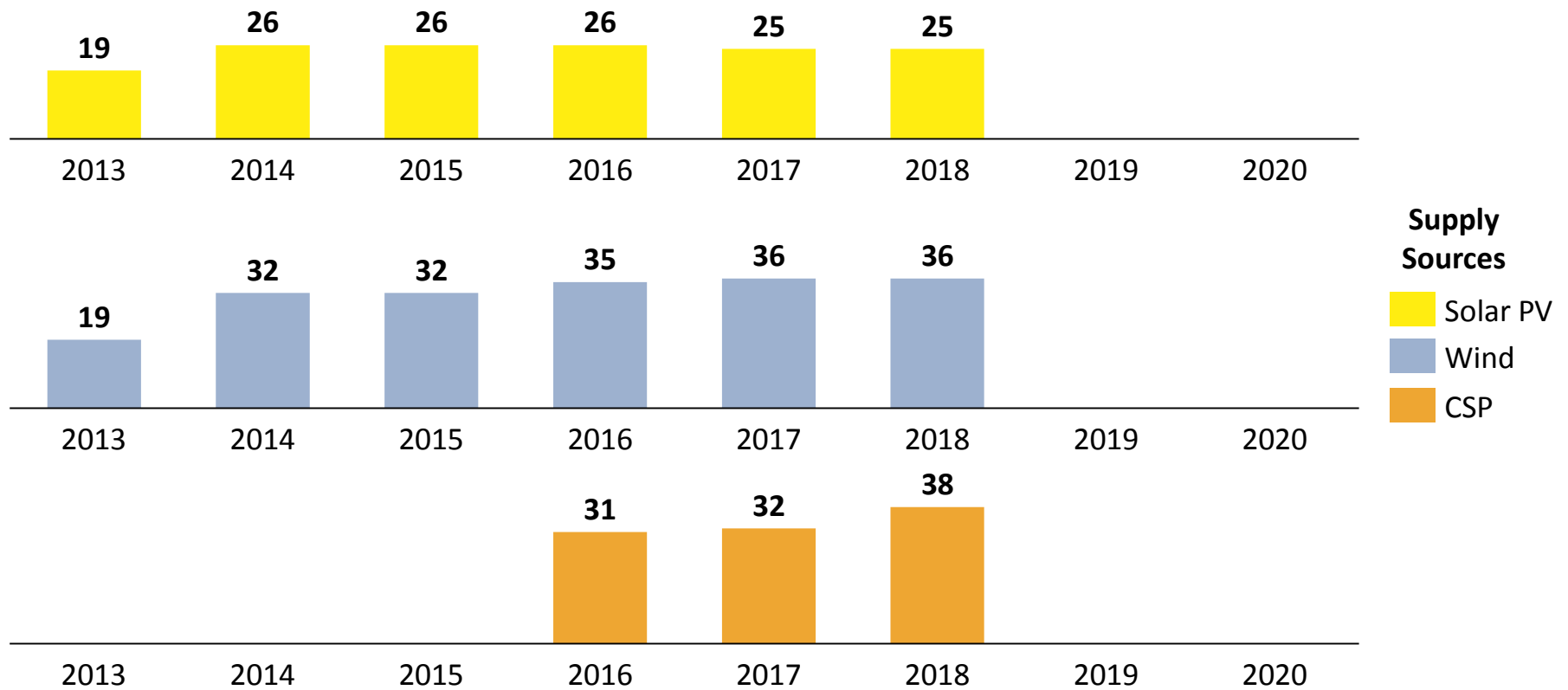
Sources: Eskom; DoE IPP Office

Illustration: Calculation of average capacity factor of operational wind, solar PV and CSP in RSA



In 2018, the average annual capacity factor of the solar PV, wind and CSP fleet was 25%, 36% and 38% respectively

Average Capacity Factor



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). 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

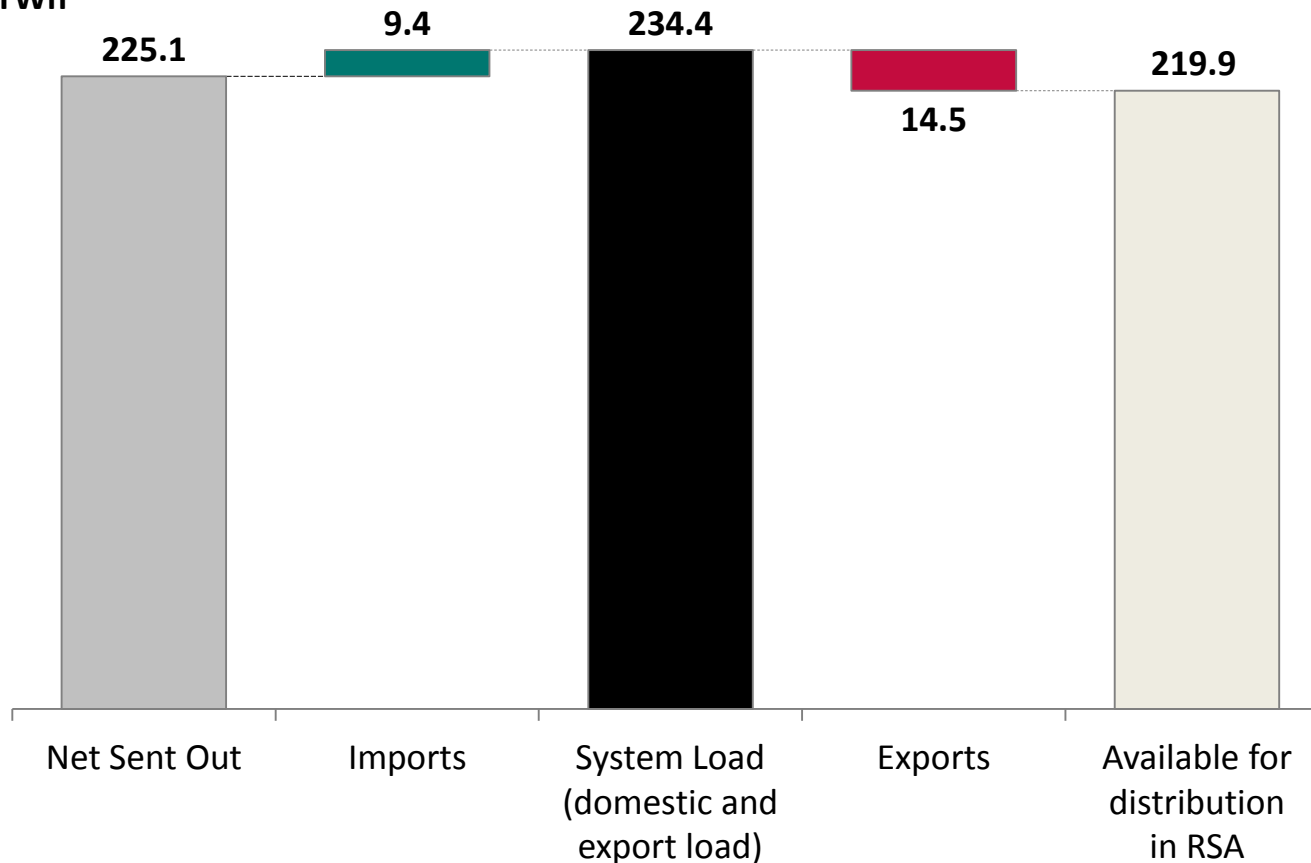
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From Jan-Dec 2018, 225 TWh of net electricity was produced in SA

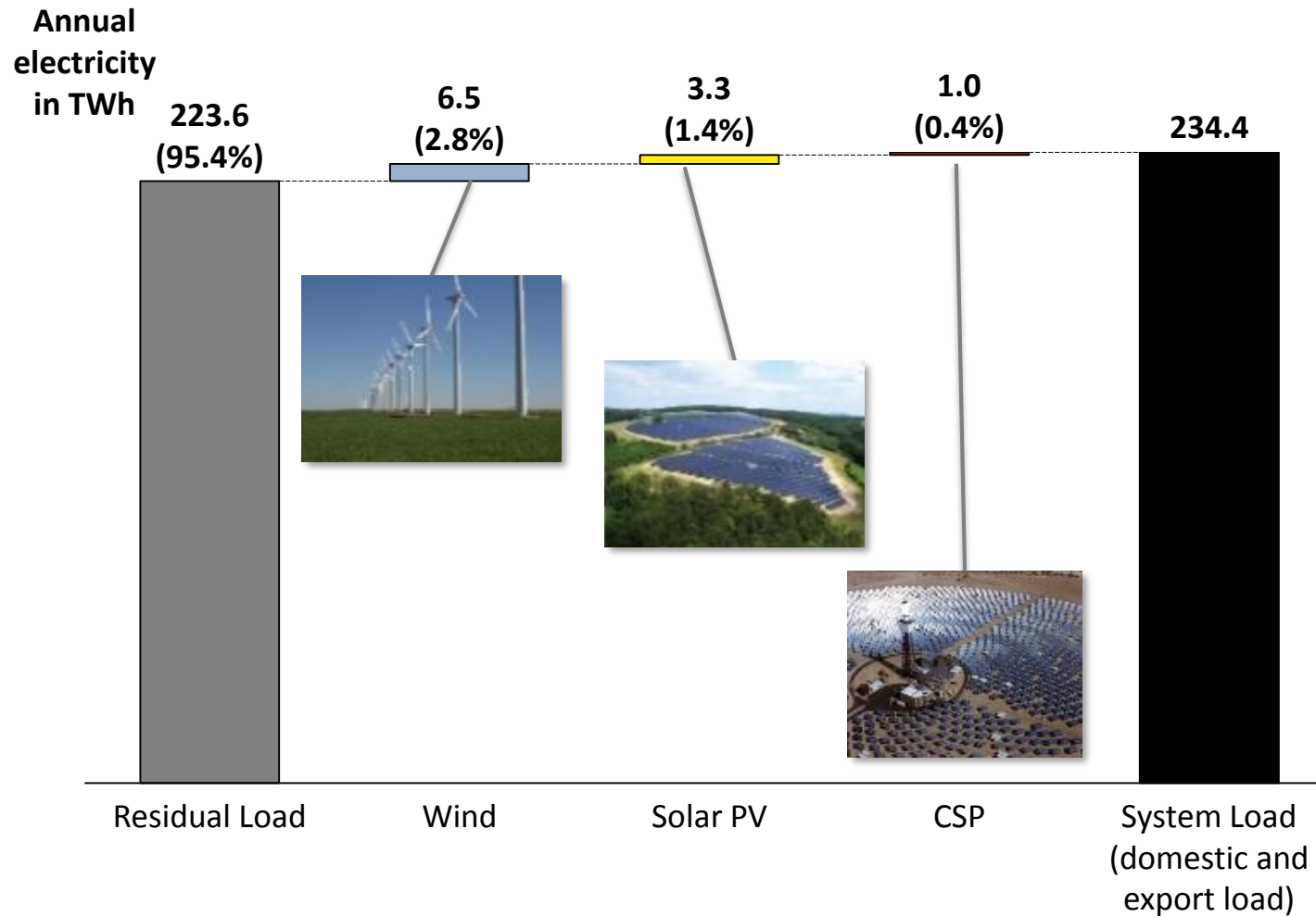
Actuals captured in wholesale market for Jan-Dec 2018 (i.e. without self-consumption of embedded plants)

Annual
electricity
in TWh



In 2018 wind, solar PV & CSP supplied 4.6% of total SA system load

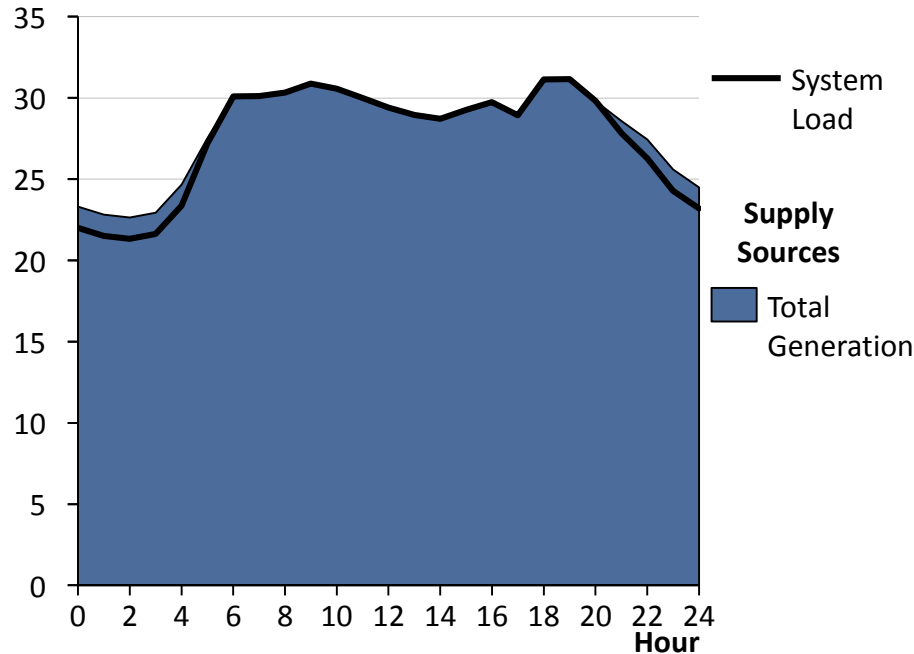
Actuals captured in wholesale market for Jan-Dec 2018 (i.e. without self-consumption of embedded plants)



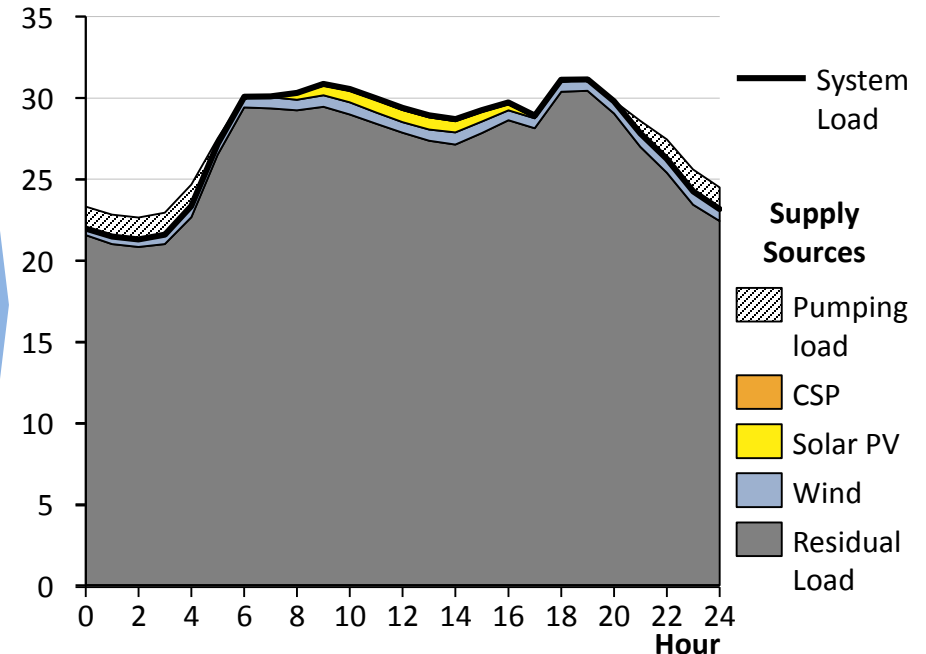
Illustrative day explaining terminologies used in this presentation

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

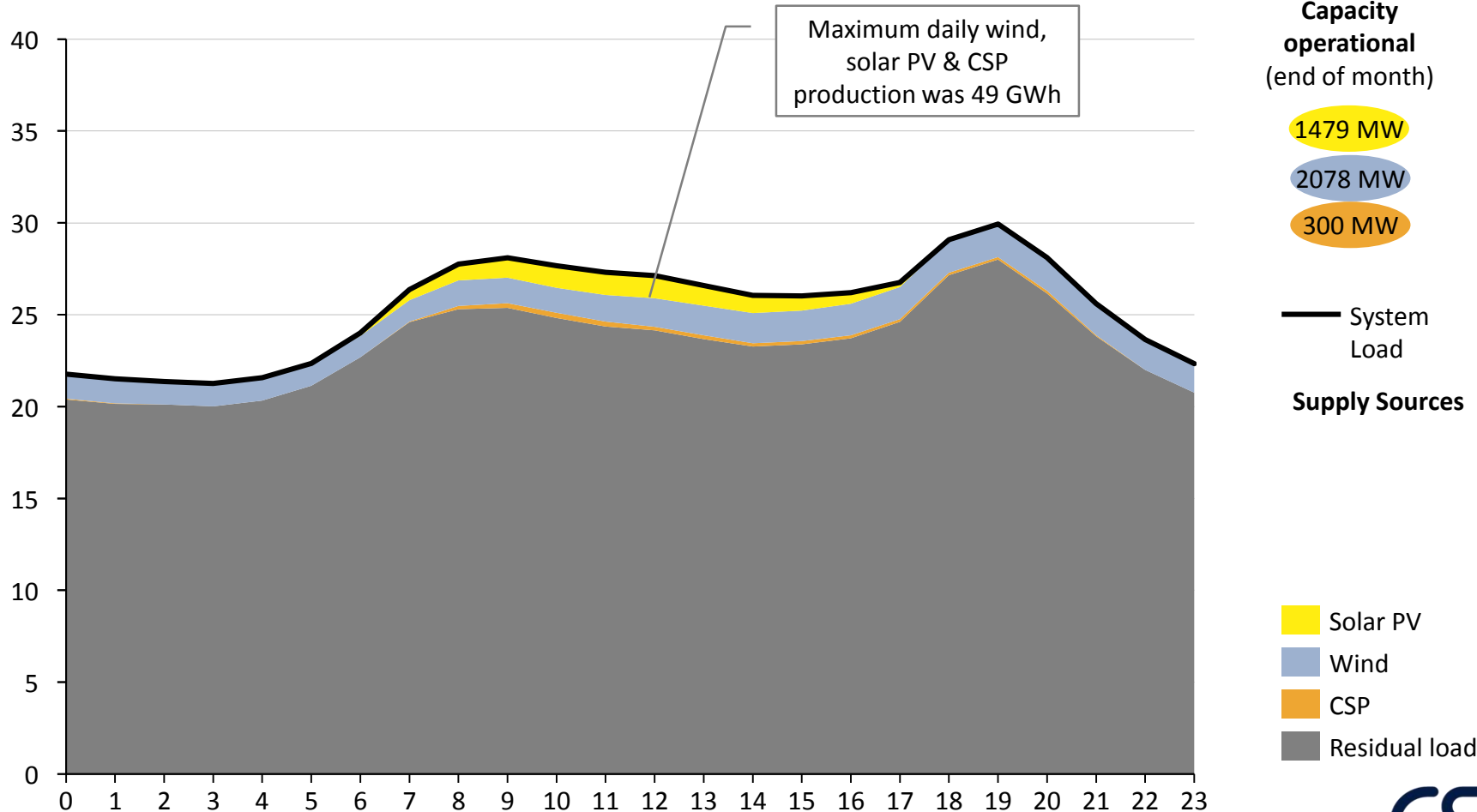
Residual Load

= System Load – wind – solar PV - CSP

Maximum daily wind, solar PV & CSP energy of 49 GWh on 21 Oct '18

Actual hourly energy production in South Africa on 21 October 2018 (Sunday)

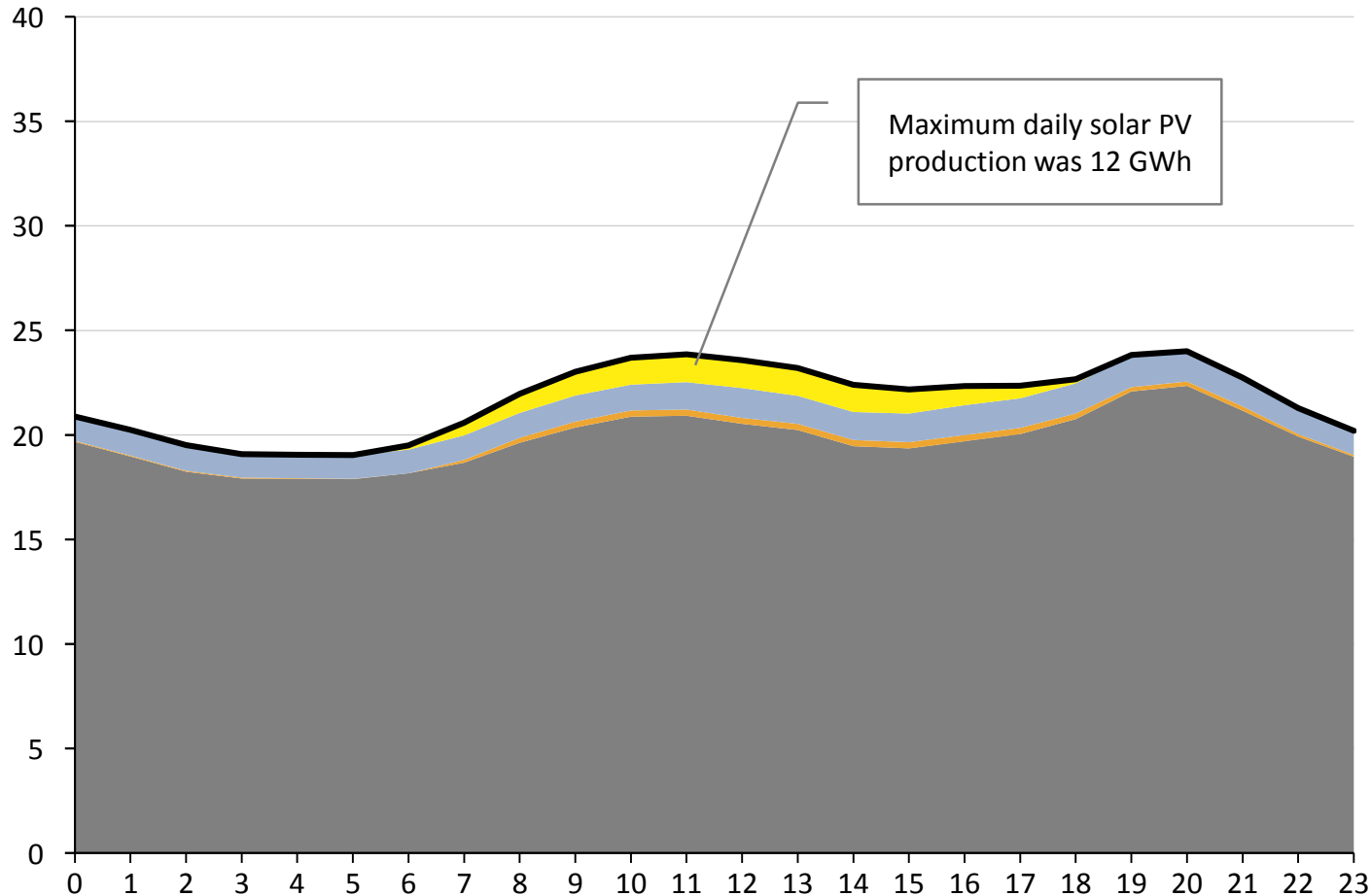
Power in GW



Maximum daily solar PV energy of 12 GWh achieved on 1 Jan 2018

Actual hourly energy production in South Africa on 1 January 2018 (Monday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

300 MW

System Load

Supply Sources

Solar PV

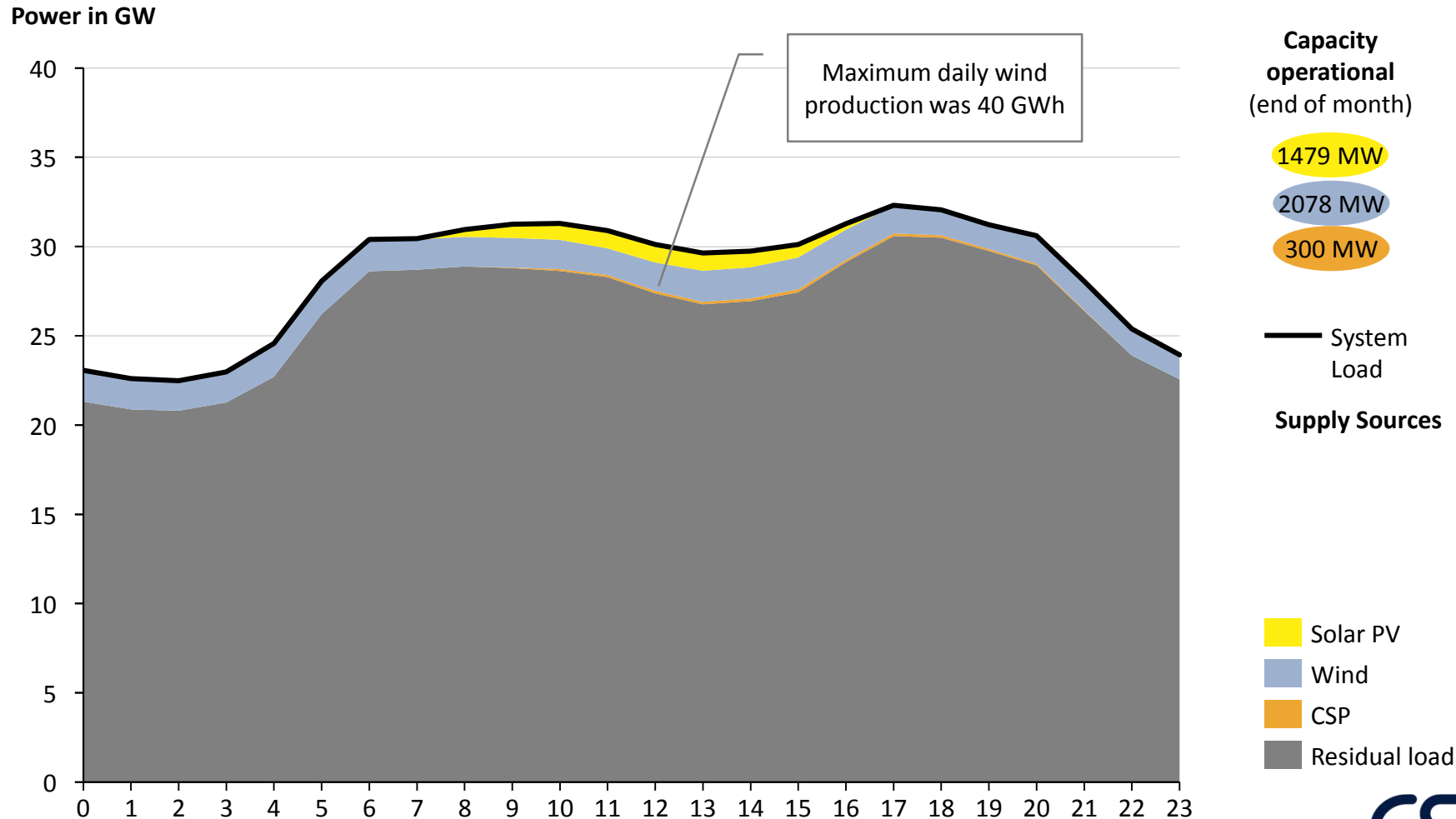
Wind

CSP

Residual load

Maximum daily wind energy of 40 GWh achieved on 14 Jun 2018

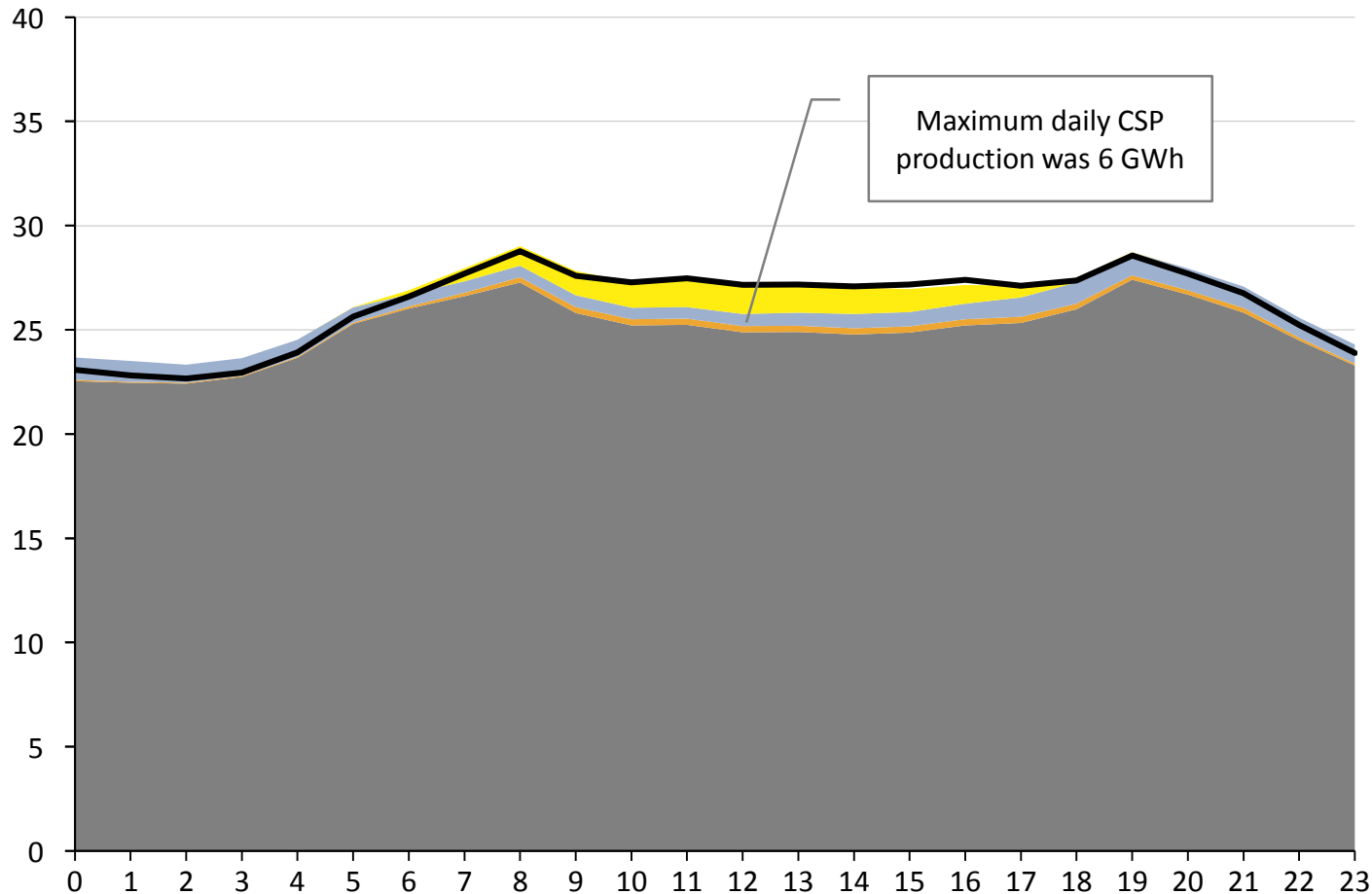
Actual hourly energy production in South Africa on 14 June 2018 (Thursday)



Maximum daily CSP energy of 6 GWh achieved on 4 Dec 2018

Actual hourly energy production in South Africa on 4 Dec 2018 (Tuesday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

400 MW

System Load

Supply Sources

Solar PV

Wind

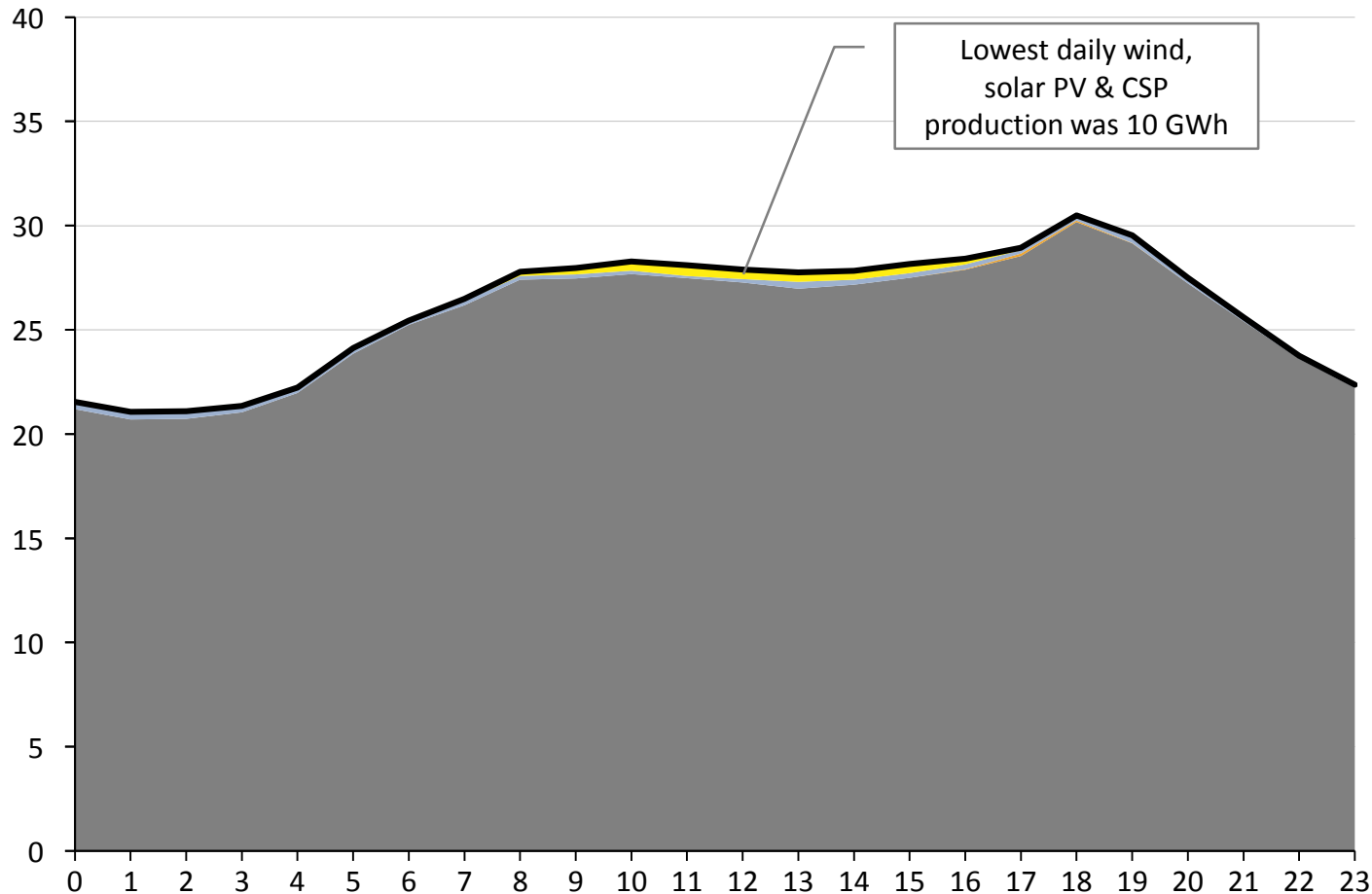
CSP

Residual load

Lowest combined wind, solar PV & CSP energy of 10 GWh on 4 Apr '17

Actual hourly energy production in South Africa on 4 April 2018 (Wednesday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

300 MW

System Load

Supply Sources

Solar PV

Wind

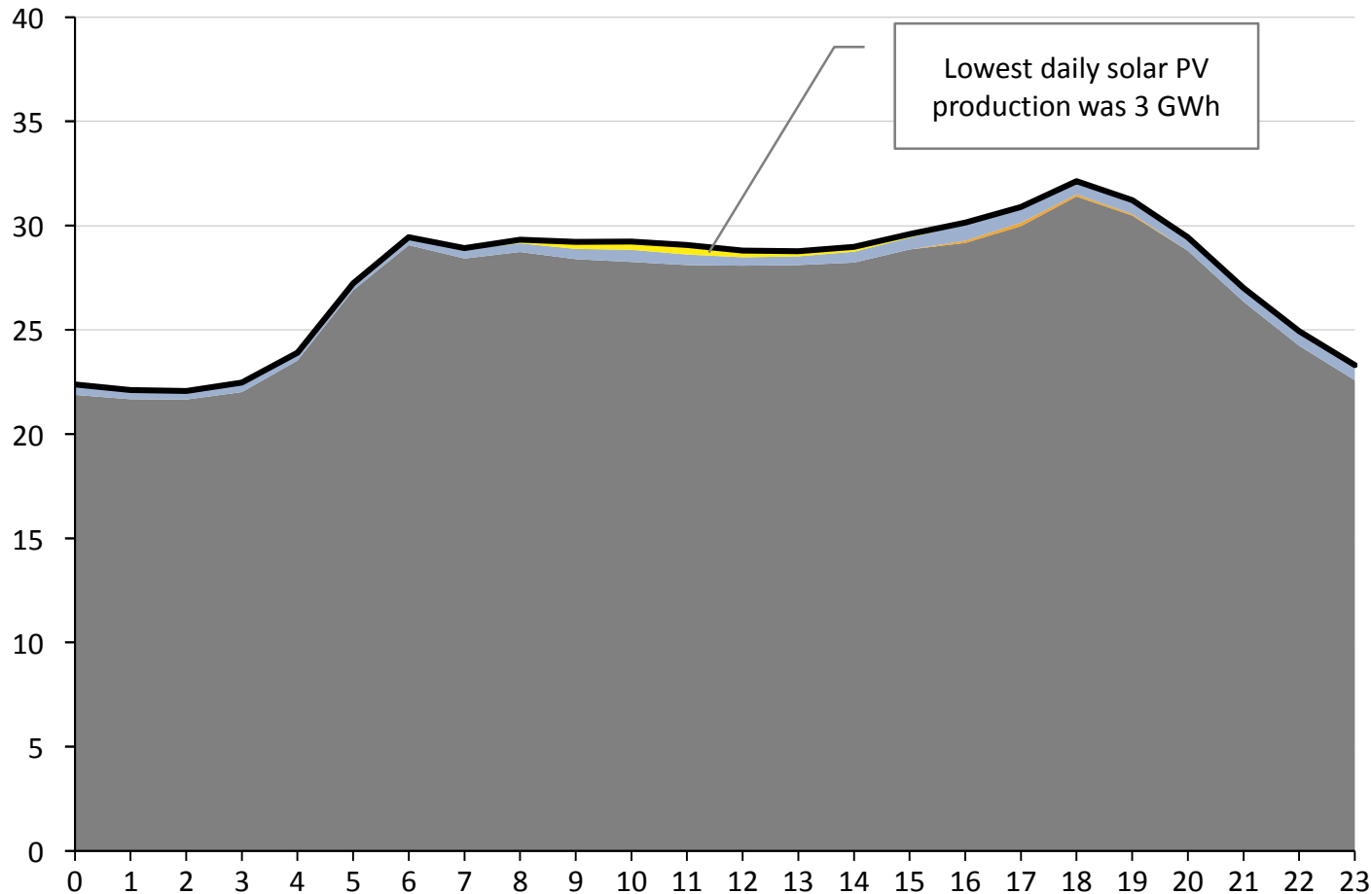
CSP

Residual load

Lowest solar PV energy production of 3 GWh occurred on 6 Sep 2018

Actual hourly energy production in South Africa on 6 Sep 2018 (Thursday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

300 MW

System Load

Supply Sources

Solar PV

Wind

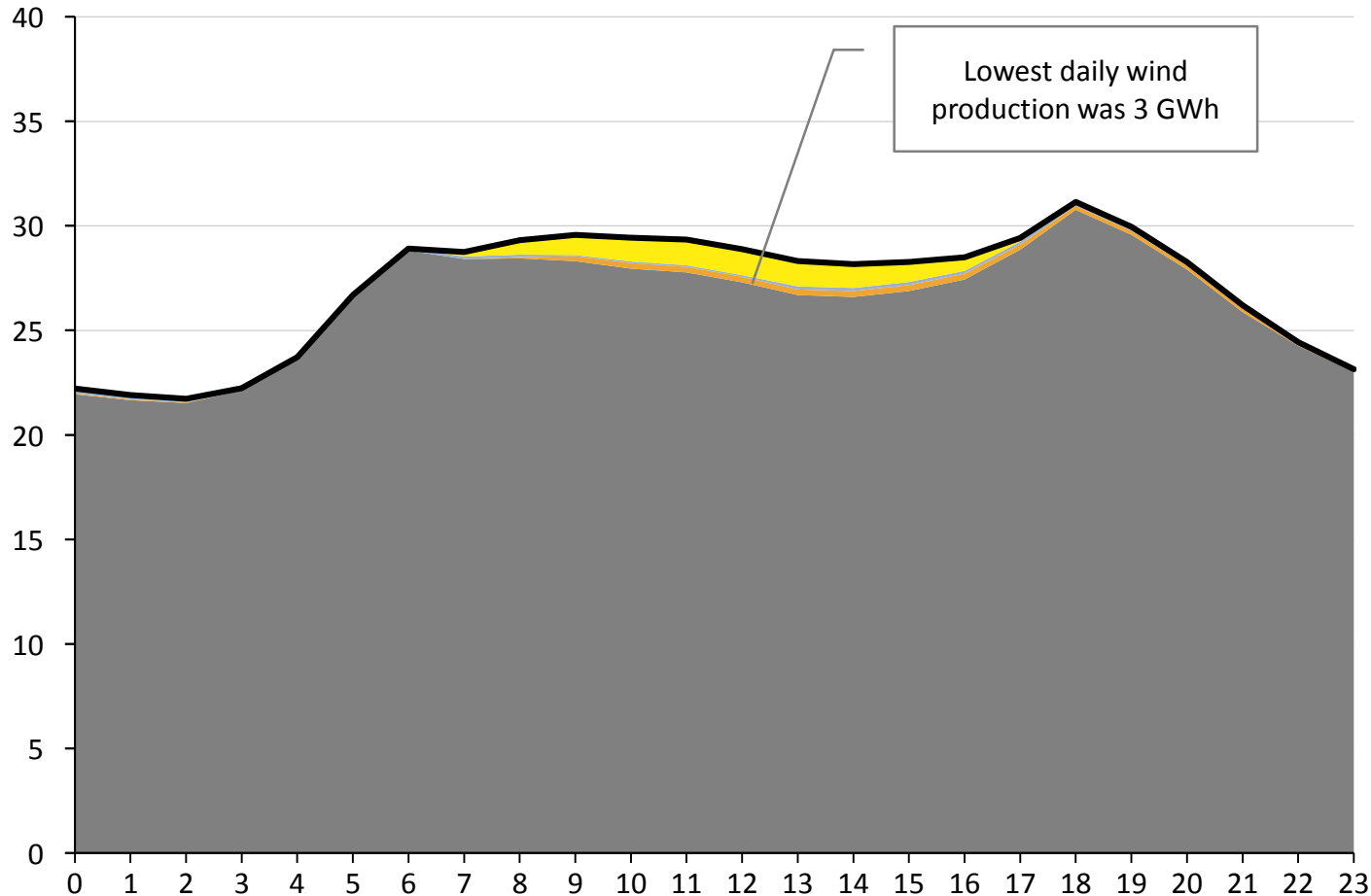
CSP

Residual load

Lowest wind energy production of 3 GWh occurred on 20 Apr 2018

Actual hourly energy production in South Africa on 20 April 2018 (Friday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

300 MW

System Load

Supply Sources

Solar PV

Wind

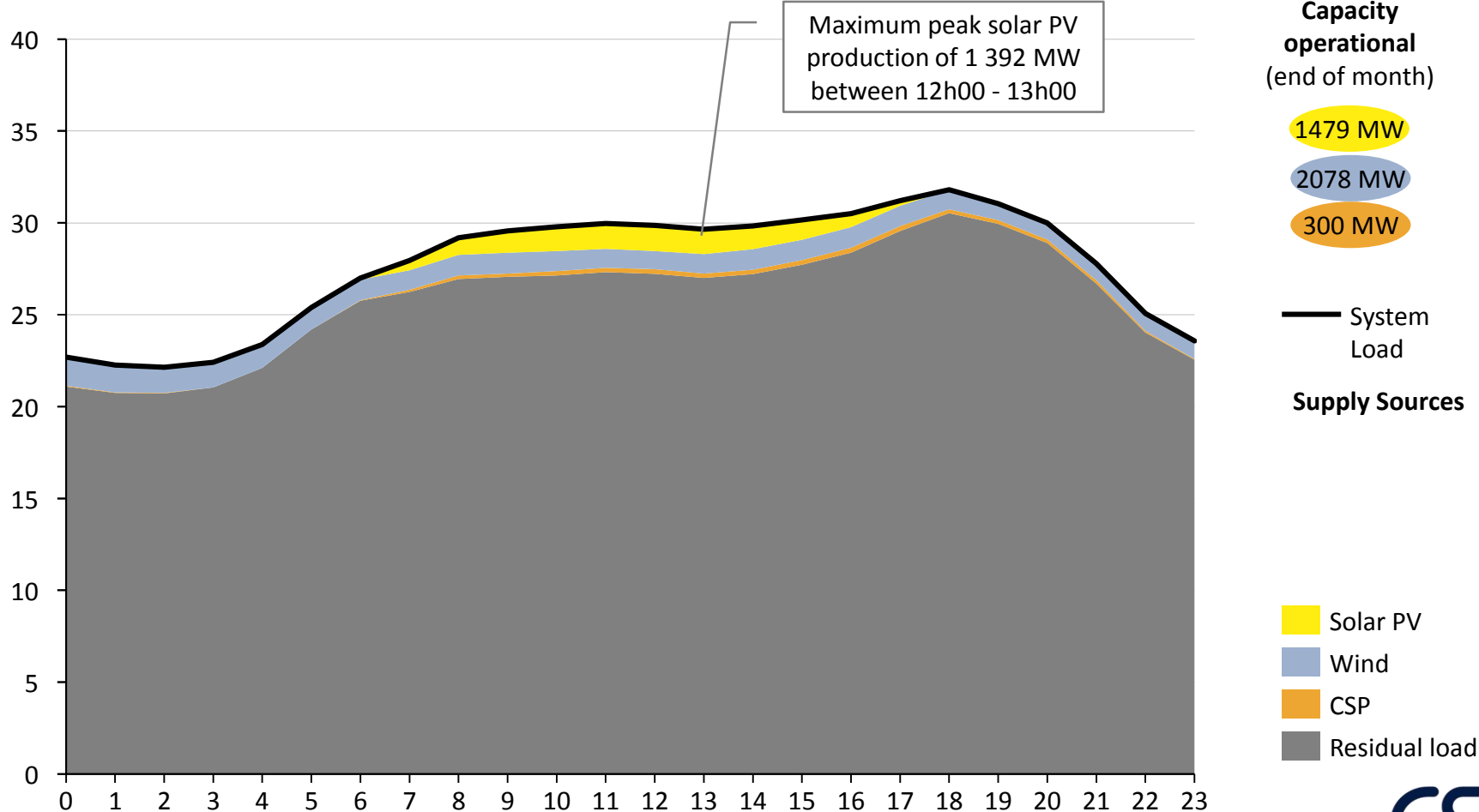
CSP

Residual load

Maximum inst. solar PV power of 1 392 MW occurred on 3 Oct '18

Actual hourly energy production in South Africa on 3 Oct 2018 (Wednesday)

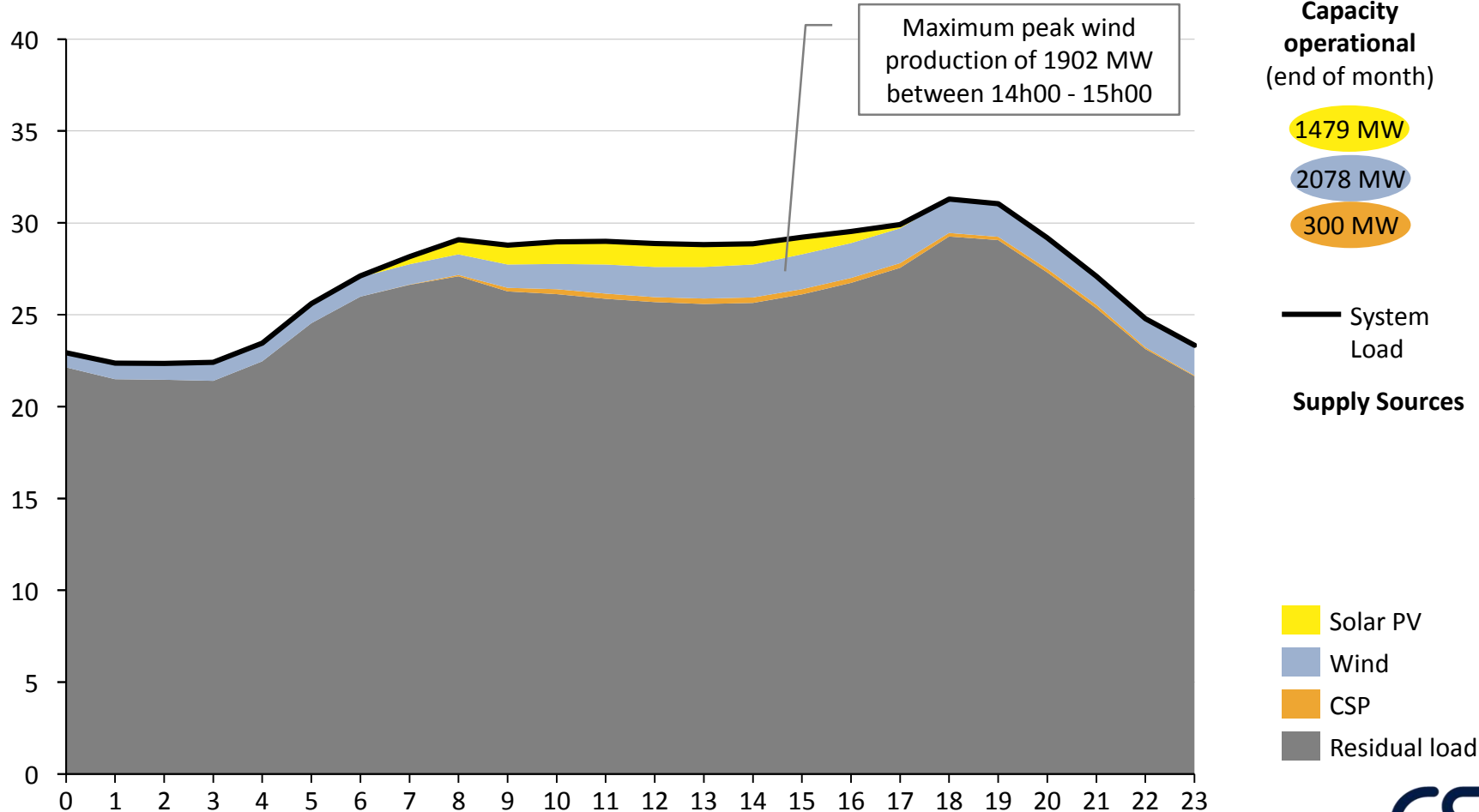
Power in GW



Maximum inst. wind power of 1 902 MW occurred on 2 Oct '18

Actual hourly energy production in South Africa on 2 Oct 2018 (Tuesday)

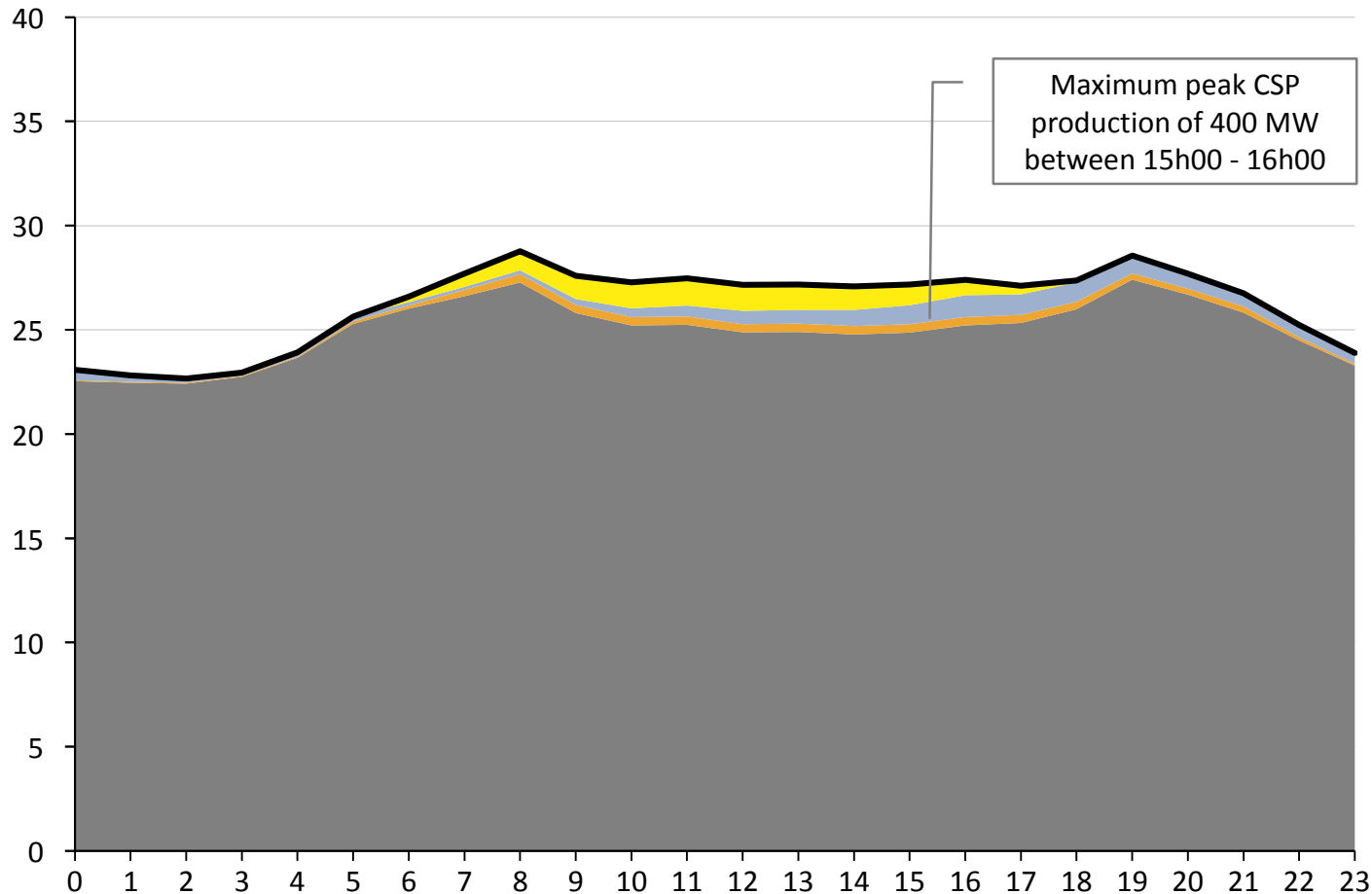
Power in GW



Maximum inst. CSP power of 400 MW occurred on 4 Dec '18

Actual hourly energy production in South Africa on 4 December 2018 (Tuesday)

Power in GW



Capacity operational (end of month)

1479 MW

2078 MW

400 MW

System Load

Supply Sources

Solar PV

Wind

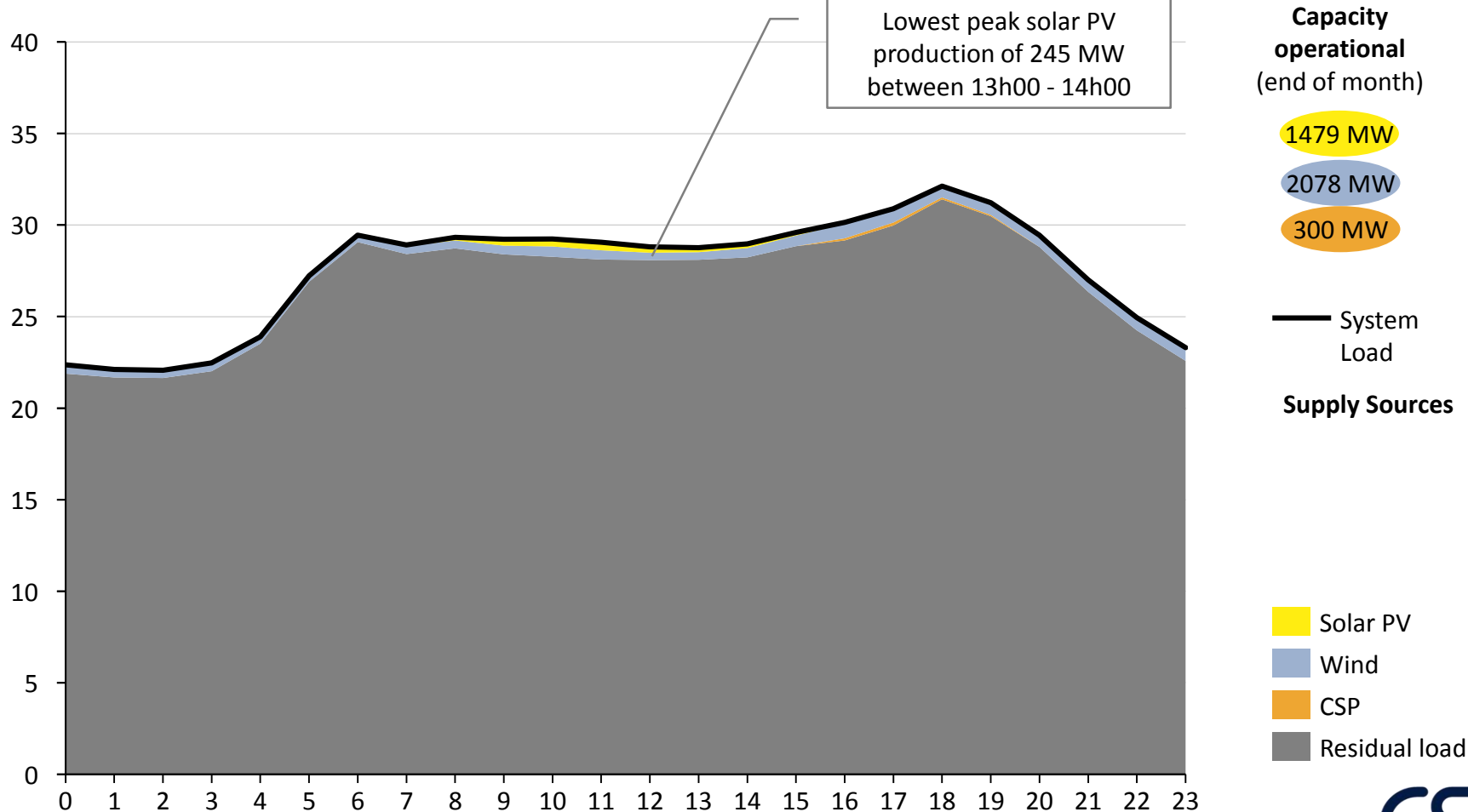
CSP

Residual load

Lowest inst. peak solar PV power of 245 MW on 6 Sep 2018

Actual hourly energy production in South Africa on 6 Sep 2018 (Thursday)

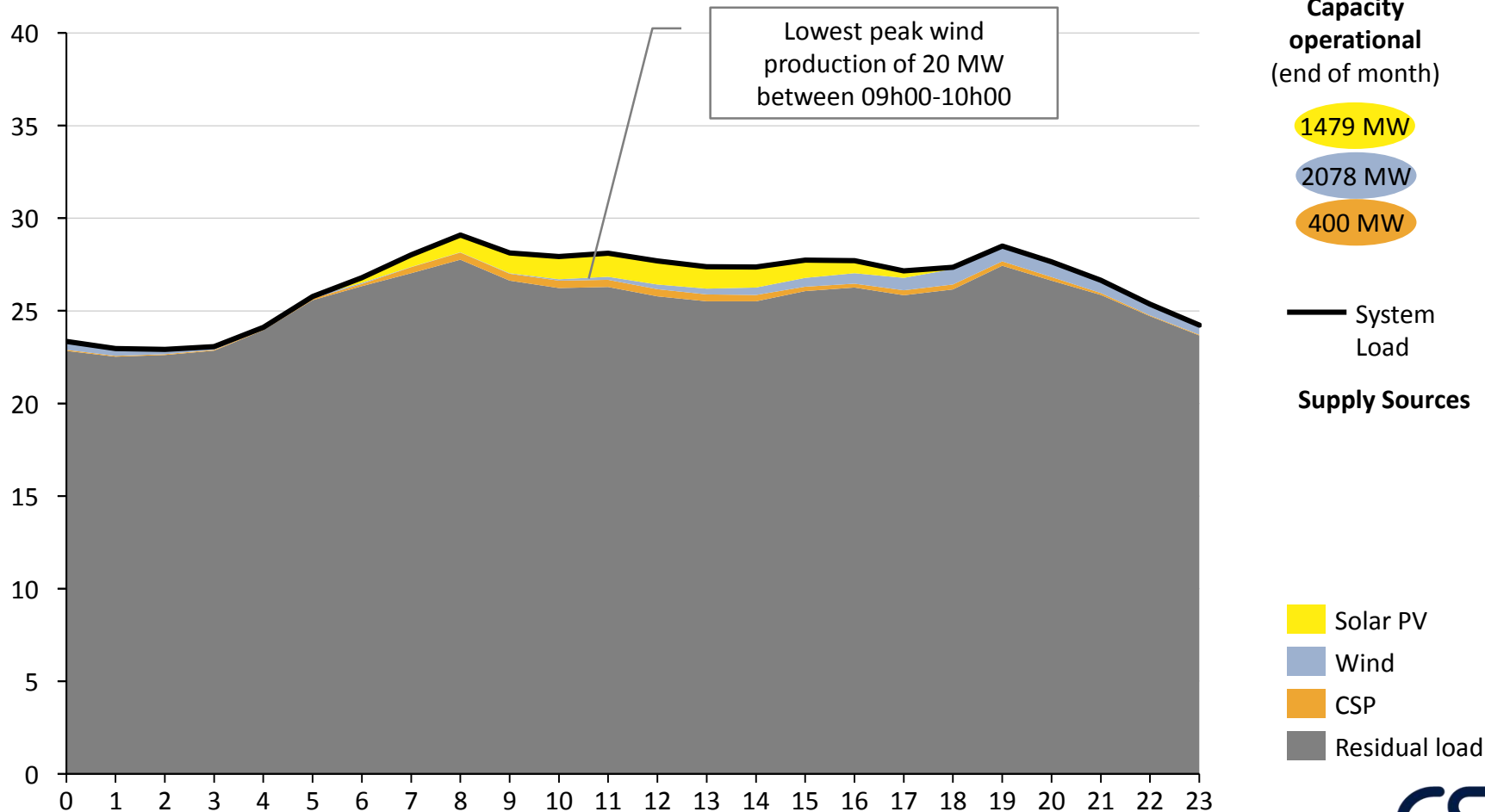
Power in GW



Lowest inst. peak wind power of 20 MW on 4 Dec 2018

Actual hourly energy production in South Africa on 4 December 2018 (Tuesday)

Power in GW



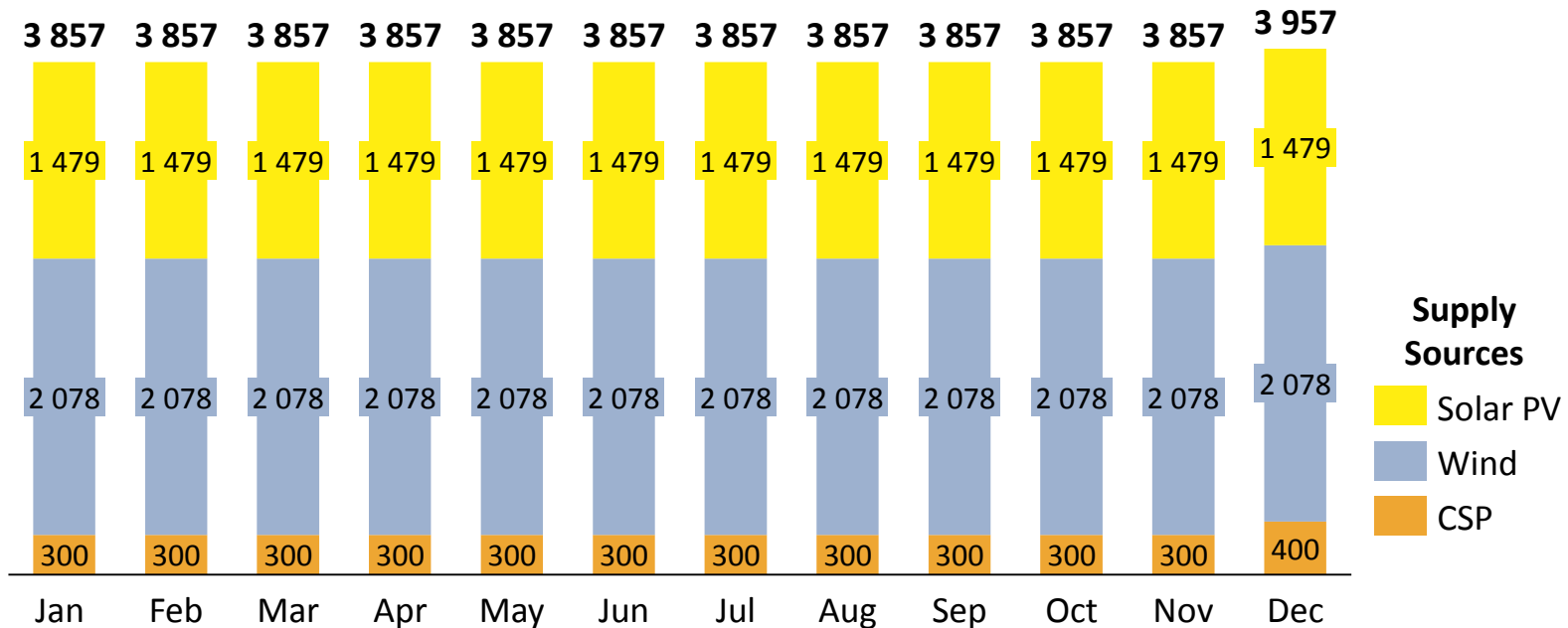
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In 2018, 100 MW CSP was added to the grid, no new wind or solar PV

Total monthly installed capacity of solar PV, wind and CSP in MW in RSA from Jan-Dec 2018

**Capacity
operational in MW**
(end of month)

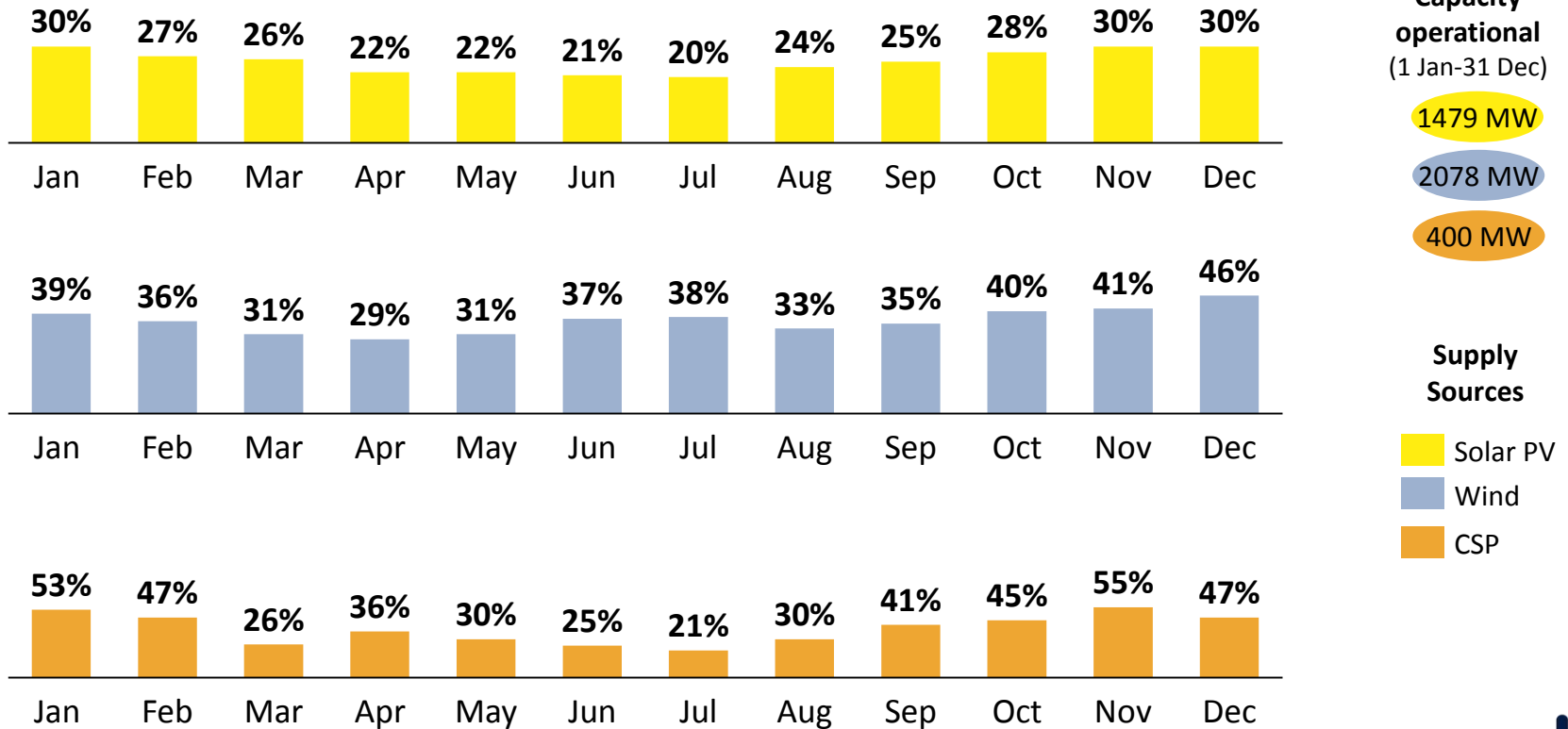


Notes: Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants commissioned. Wind includes Sere wind farm (100 MW).
Sources: Eskom

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 2018

Average Monthly Capacity Factor

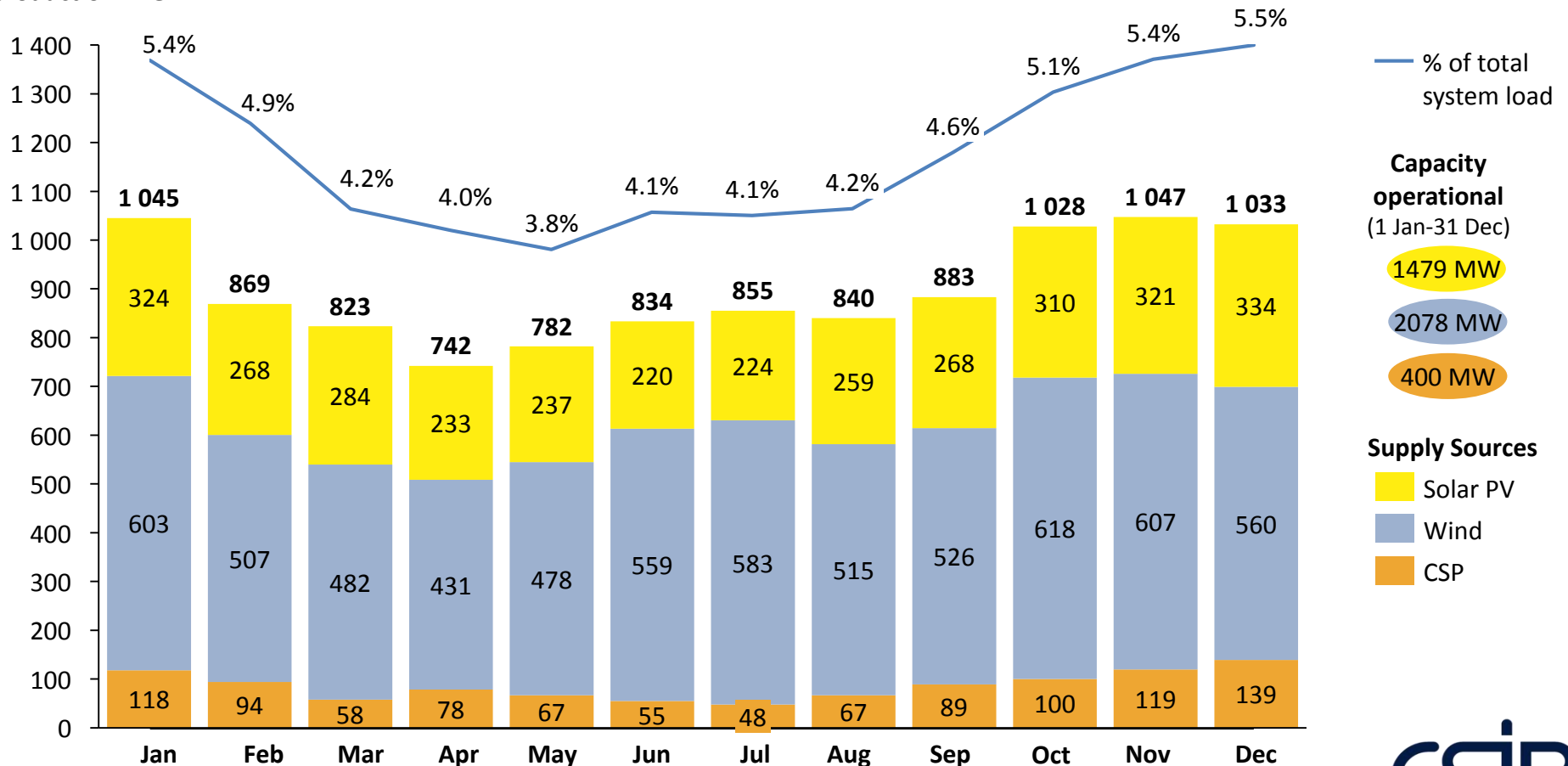


Notes: Capacity operational as per actual start of operation (can differ from REIPPP contracted date), CSP - only measured from date when more than two CSP plants commissioned. Wind includes Sere wind farm (100 MW).
Sources: Eskom

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

Actual monthly production from wind, solar PV and CSP plants in South Africa from Jan-Dec 2018

Monthly electricity production in GWh



Note: Wind generation includes Eskom's 100 MW Sere wind farm. CSP energy only measured from date when more than two CSP plant were commissioned.

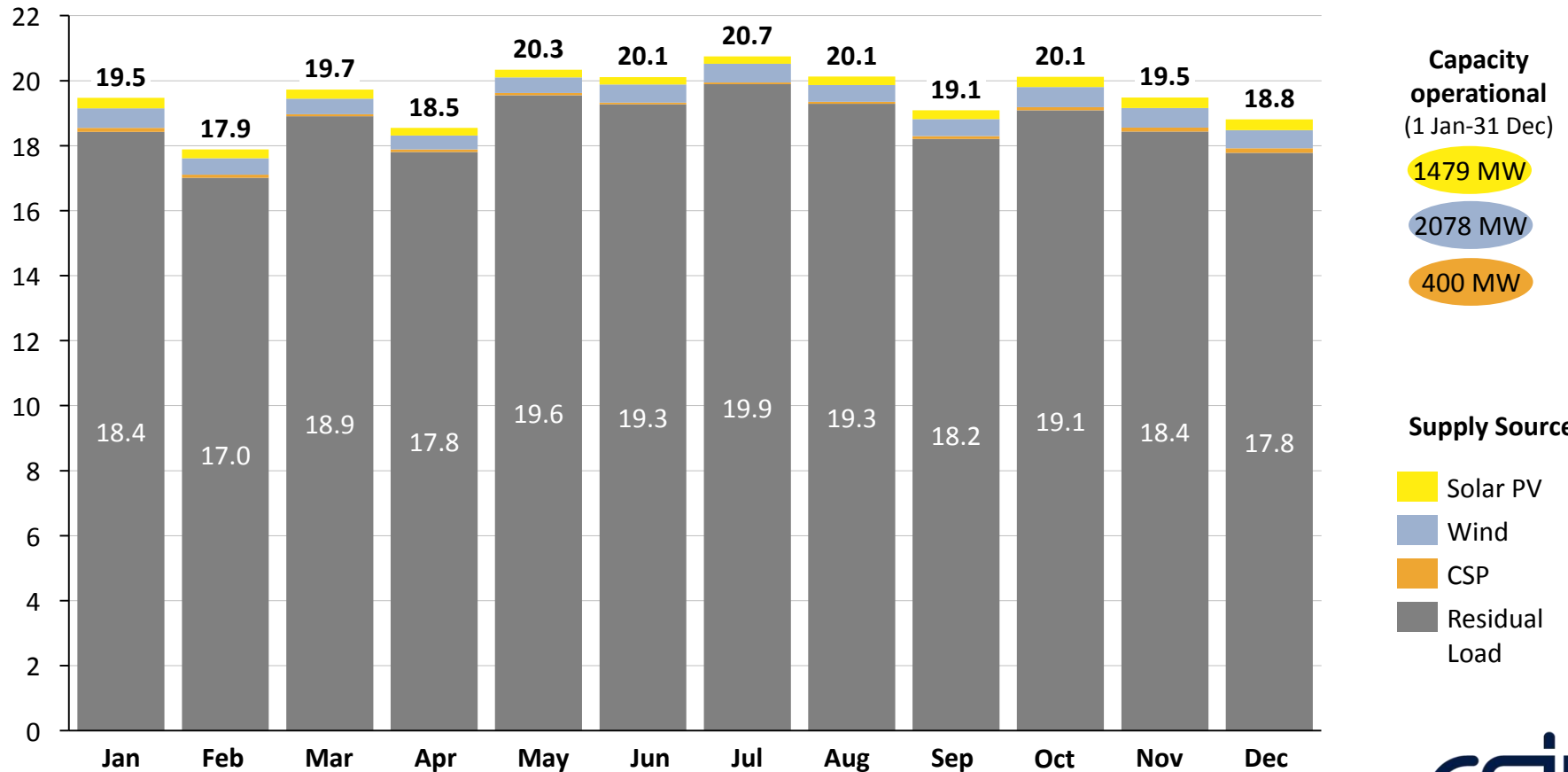
Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation.

Sources: Eskom; CSIR Energy Centre analysis

Monthly electricity production wind, solar PV, CSP and residual load

Actual monthly electricity production for Jan-Dec 2018 from the different supply sources in South Africa

Monthly electricity production in TWh



Notes: Pumping load excluded. Wind generation includes Eskom's 100 MW Sere wind farm.
Sources: Eskom; CSIR Energy Centre analysis

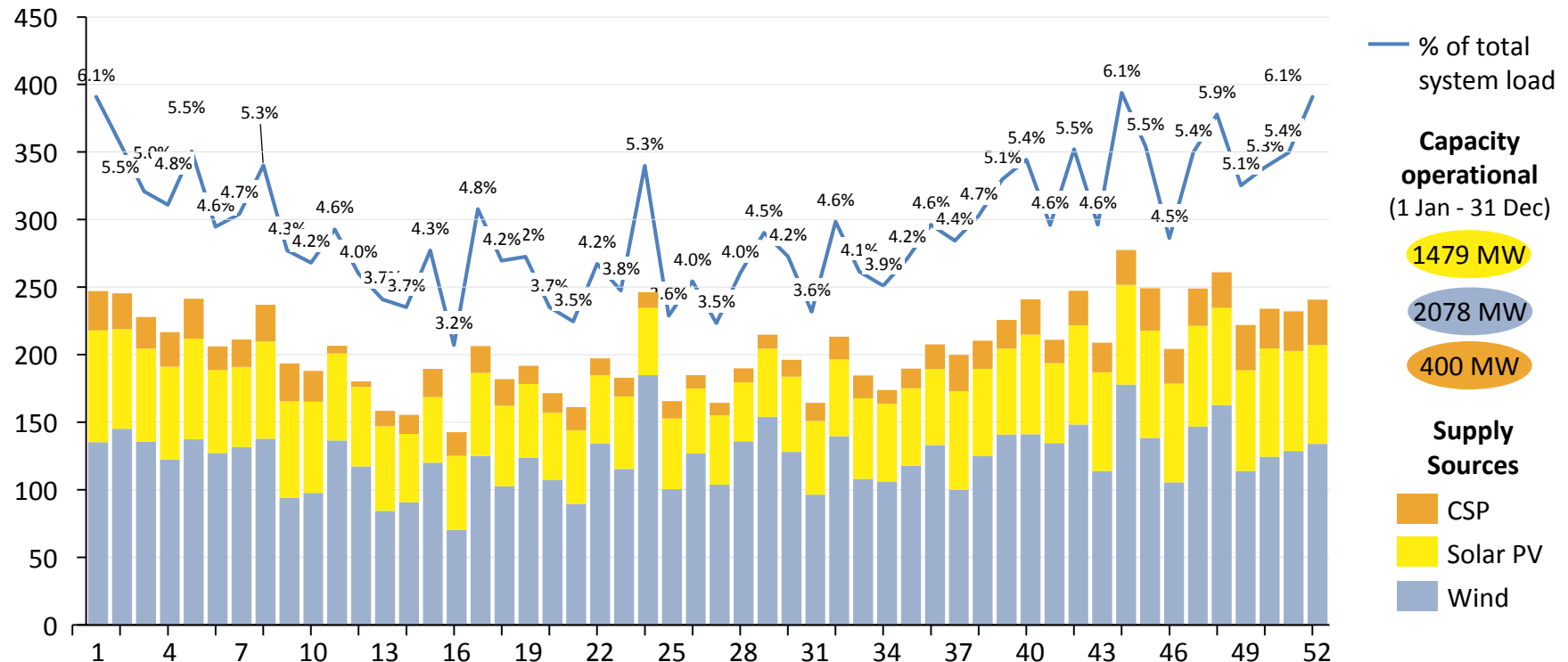
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Weekly electricity production of SA's wind, solar PV and CSP fleet

Actual weekly production from large-scale solar PV, wind & CSP plants under the REIPPPP from Jan-Dec 2018

Electricity production
in GWh/week

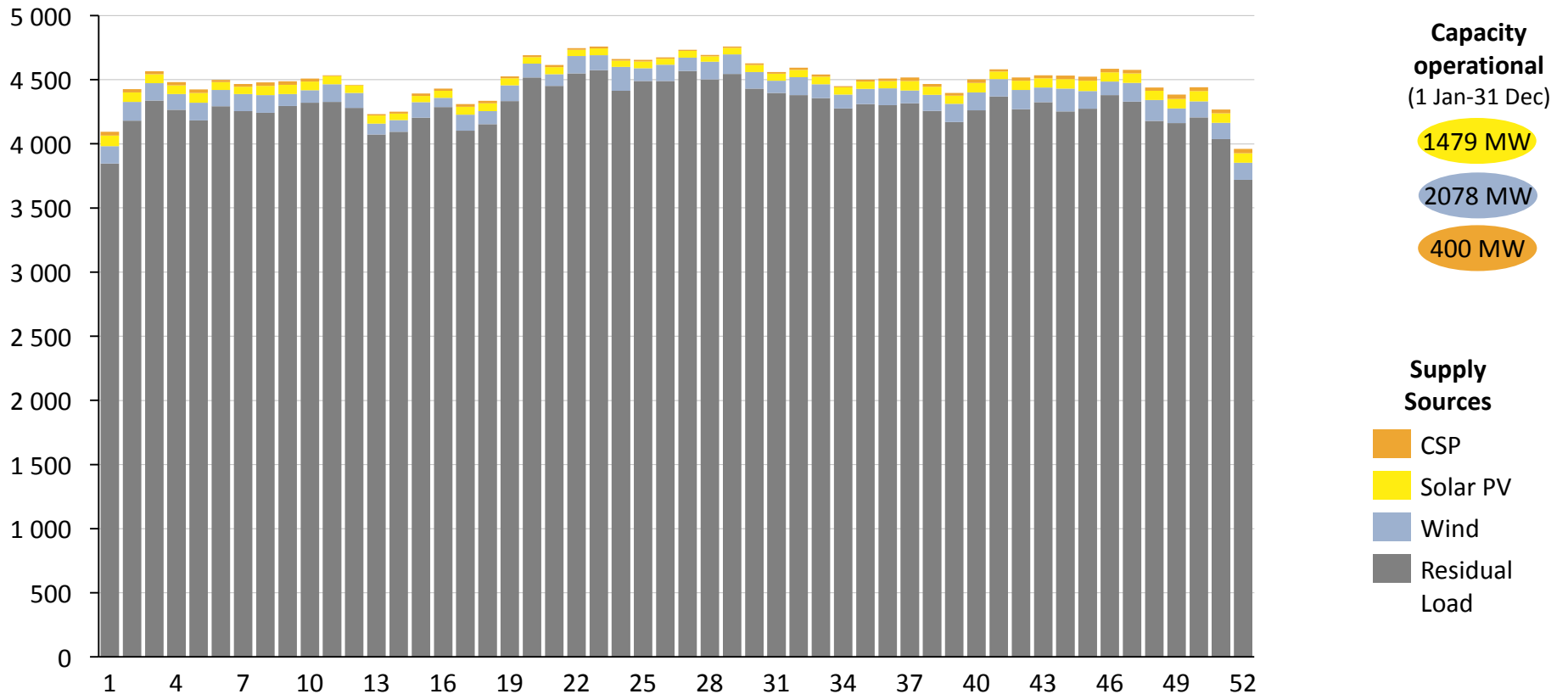


- Maximum wind + solar PV + CSP weekly production of 278 GWh in week 44 (29 Oct - 4 Nov)
- Minimum wind + solar PV + CSP weekly production of 143 GWh in week 16 (16 Apr - 22 Apr)

Weekly electricity production wind, solar PV, CSP and residual load

Actual weekly production: conventional fleet, wind, solar PV & CSP plants under REIPPPP from Jan-Dec 2018

Electricity production
in GWh/week



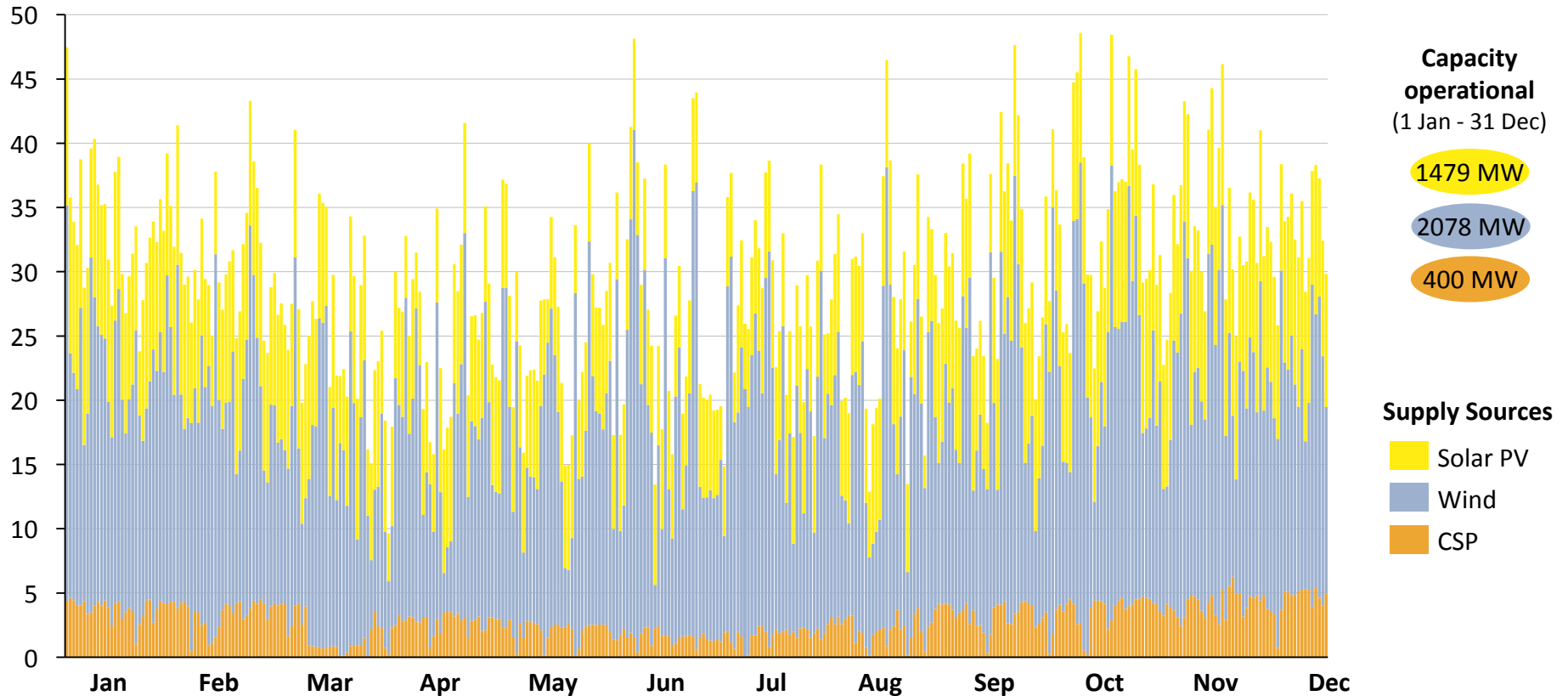
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Daily electricity production wind, solar PV & CSP fleet Jan to Dec 2018

Actual daily production from large-scale solar PV, wind and CSP plants under the REIPPPP from Jan-Dec 2018

Electricity production in GWh/day

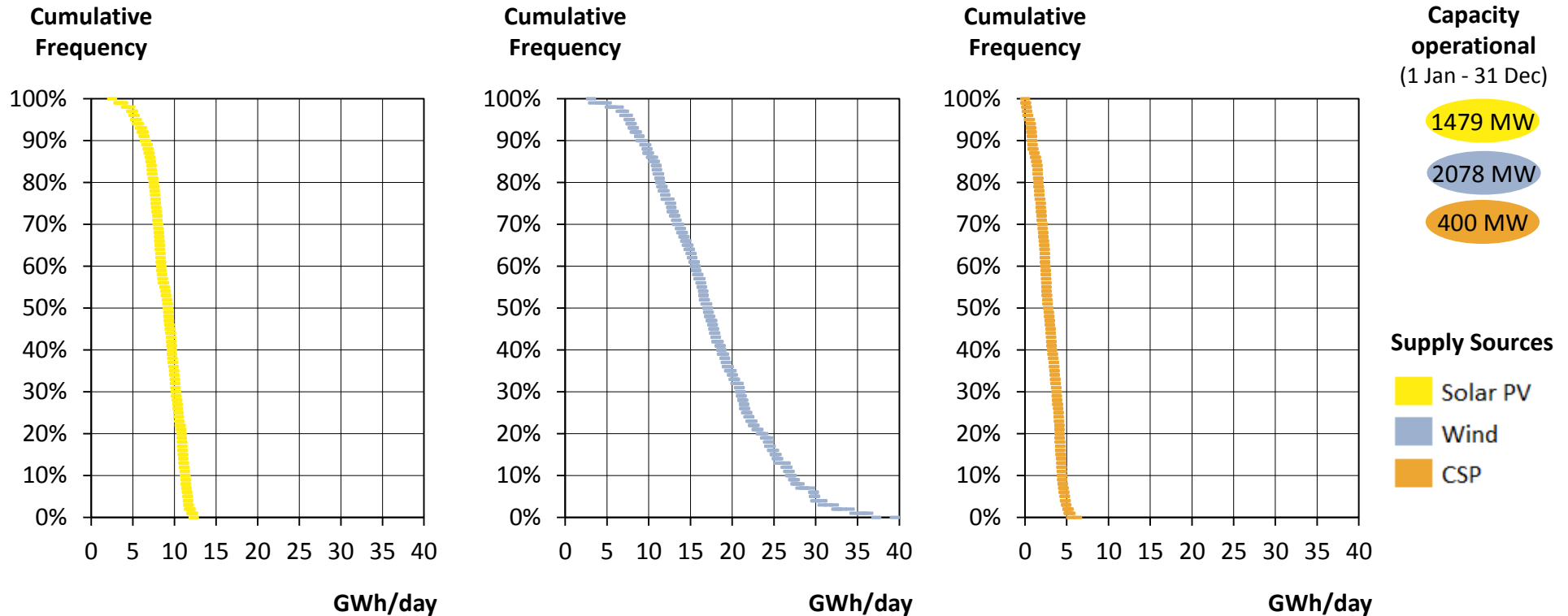


- Maximum daily production of 48.6 GWh on 21 Oct 2018 (Sunday)
- Minimum daily production of 9.6 GWh on 4 Apr 2018 (Wednesday)

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

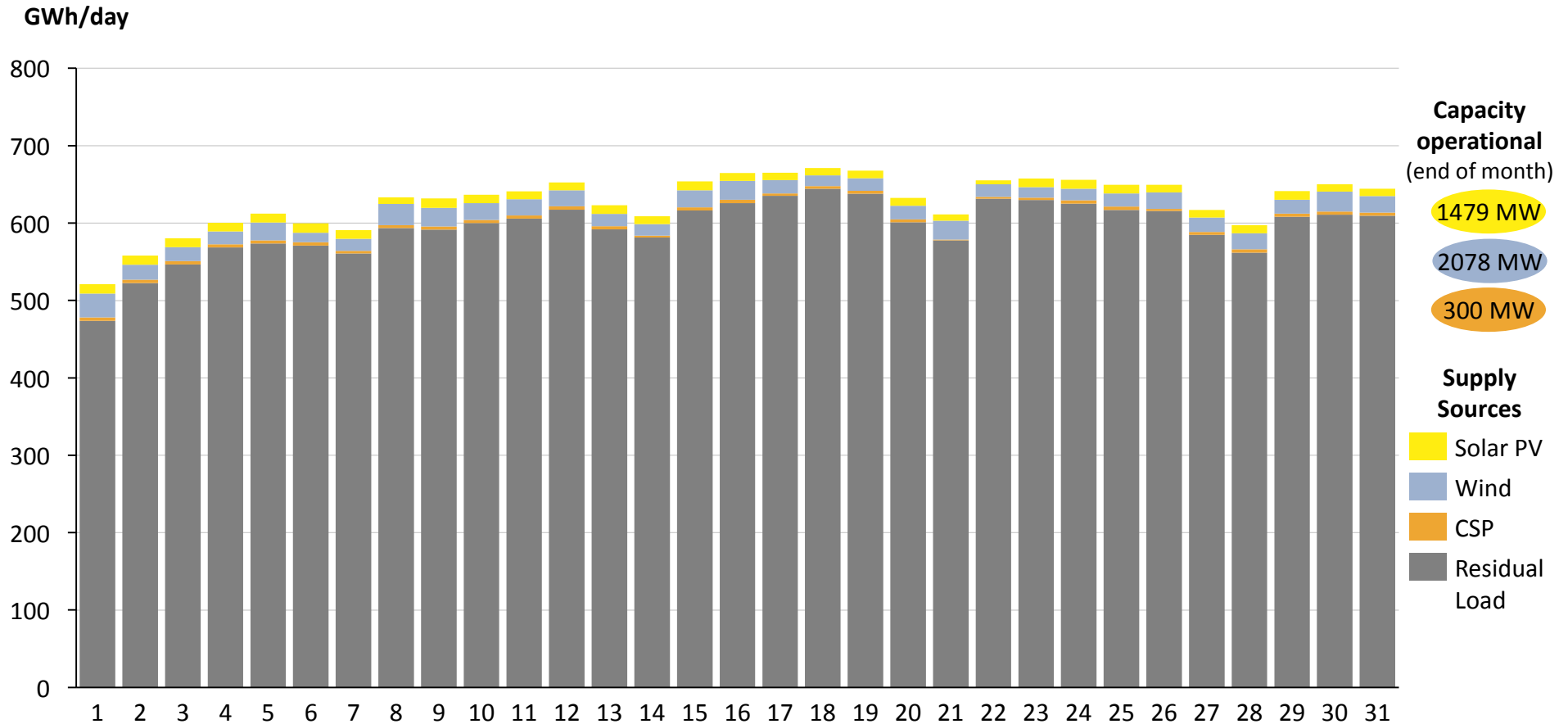
On 90% of the days from Jan - Dec 2018, solar PV and wind had a daily energy production of 6 GWh or more

Frequency distribution of daily solar PV, wind and CSP electricity production for January - December 2018



Daily electricity production of between 521-671 GWh in Jan 2018

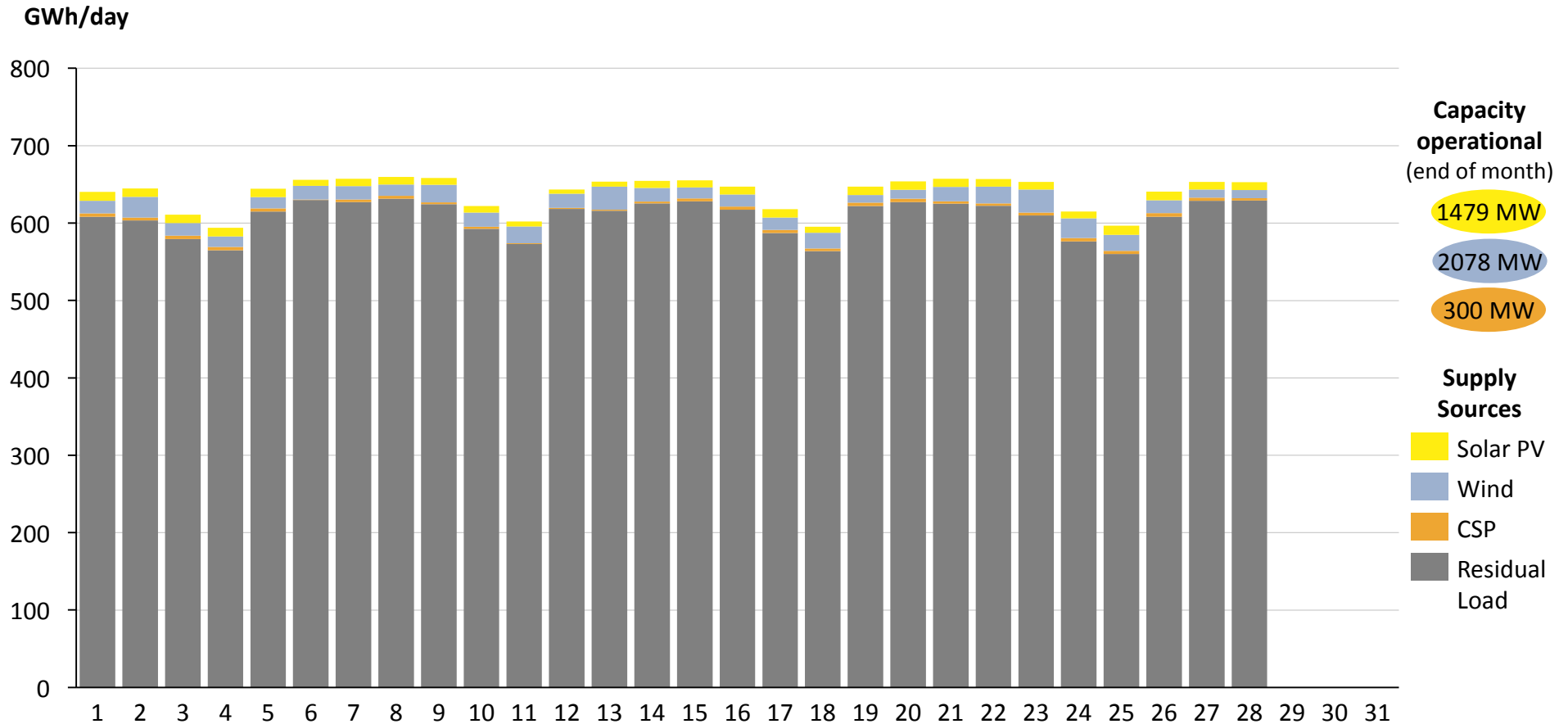
Actual daily production from all power supply sources in South Africa for January 2018



- Maximum daily production of 671 GWh on 18 Jan 2018 (Thursday)
- Minimum daily production of 521 GWh on 1 Jan 2018 (Monday - National Holiday)

Daily electricity production of between 594-659 GWh in Feb 2018

Actual daily production from all power supply sources in South Africa for February 2018

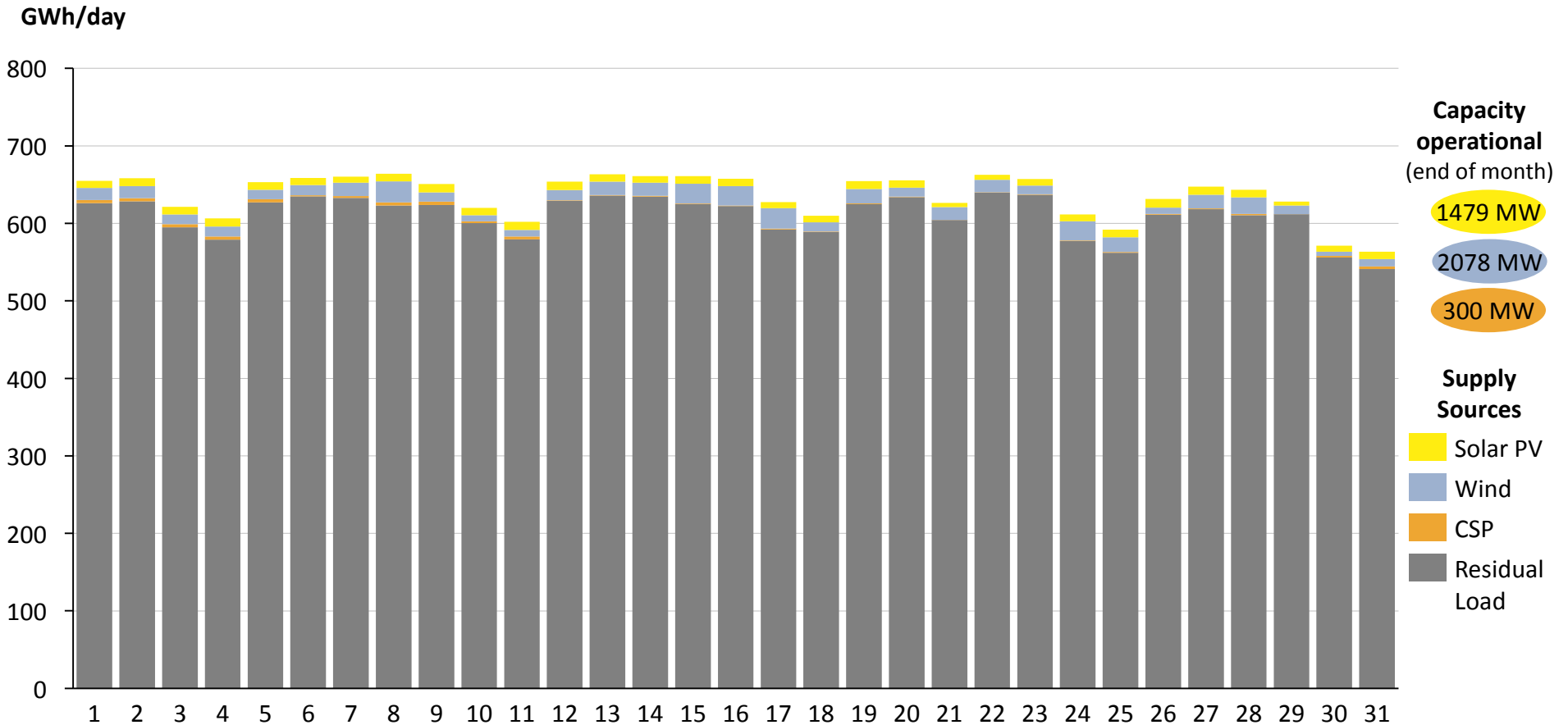


- Maximum daily production of 659 GWh on 8 Feb 2018 (Thursday)
- Minimum daily production of 594 GWh on 4 Feb 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 563-664 GWh in Mar 2018

Actual daily production from all power supply sources in South Africa for March 2018

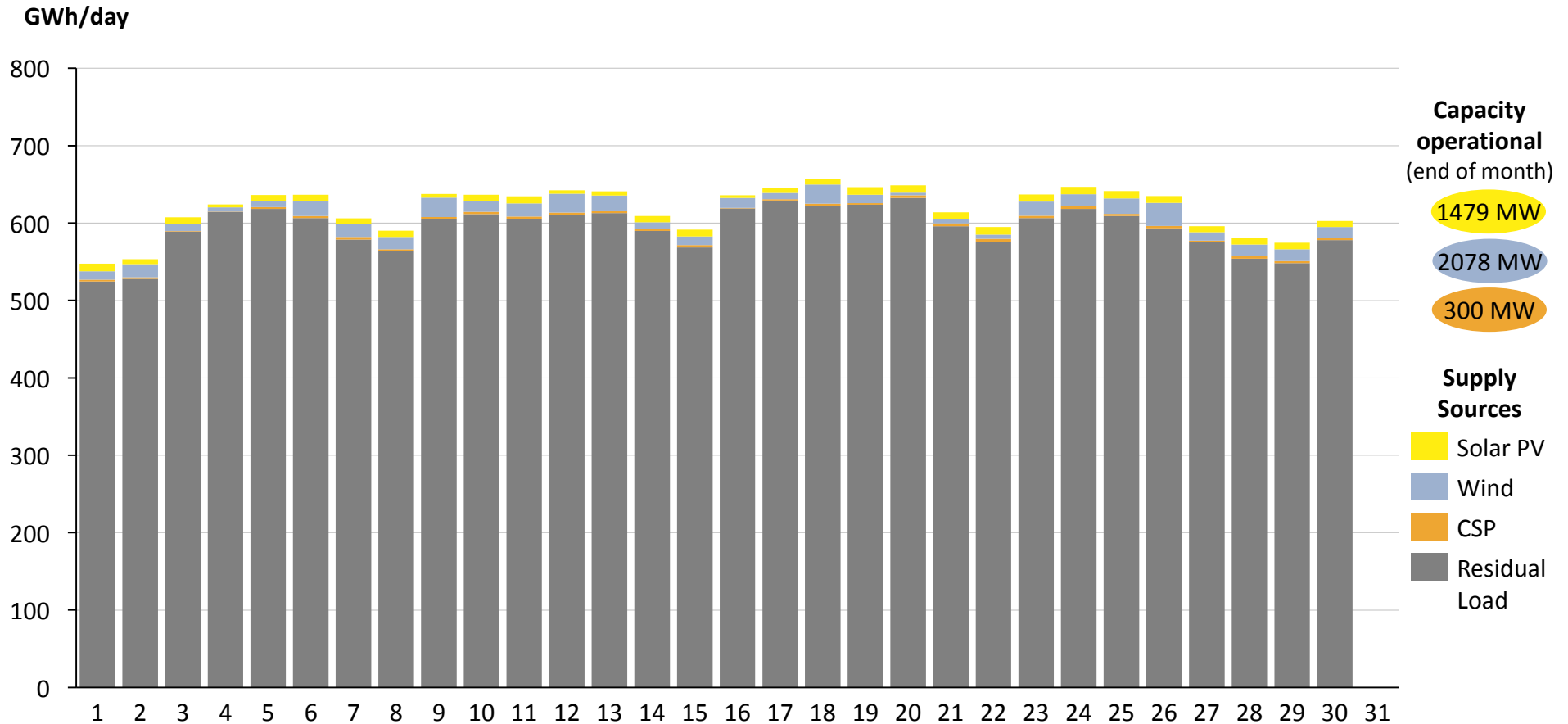


- Maximum daily production of 664 GWh on 8 Mar 2018 (Thursday)
- Minimum daily production of 563 GWh on 31 Mar 2018 (Saturday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 547-657 GWh in Apr 2018

Actual daily production from all power supply sources in South Africa for April 2018

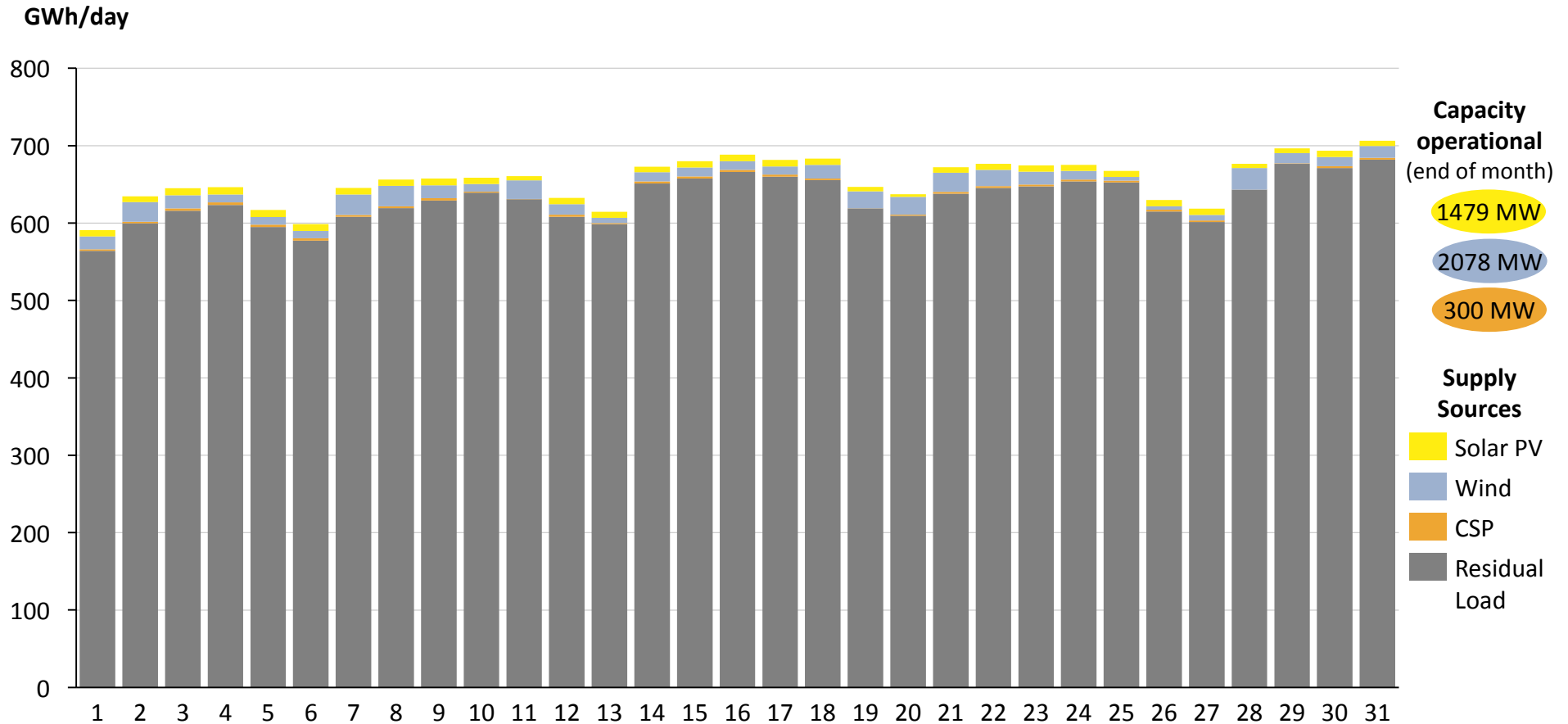


- Maximum daily production of 657 GWh on 18 Apr 2018 (Wednesday)
- Minimum daily production of 547 GWh on 1 Apr 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 591-706 GWh in May 2018

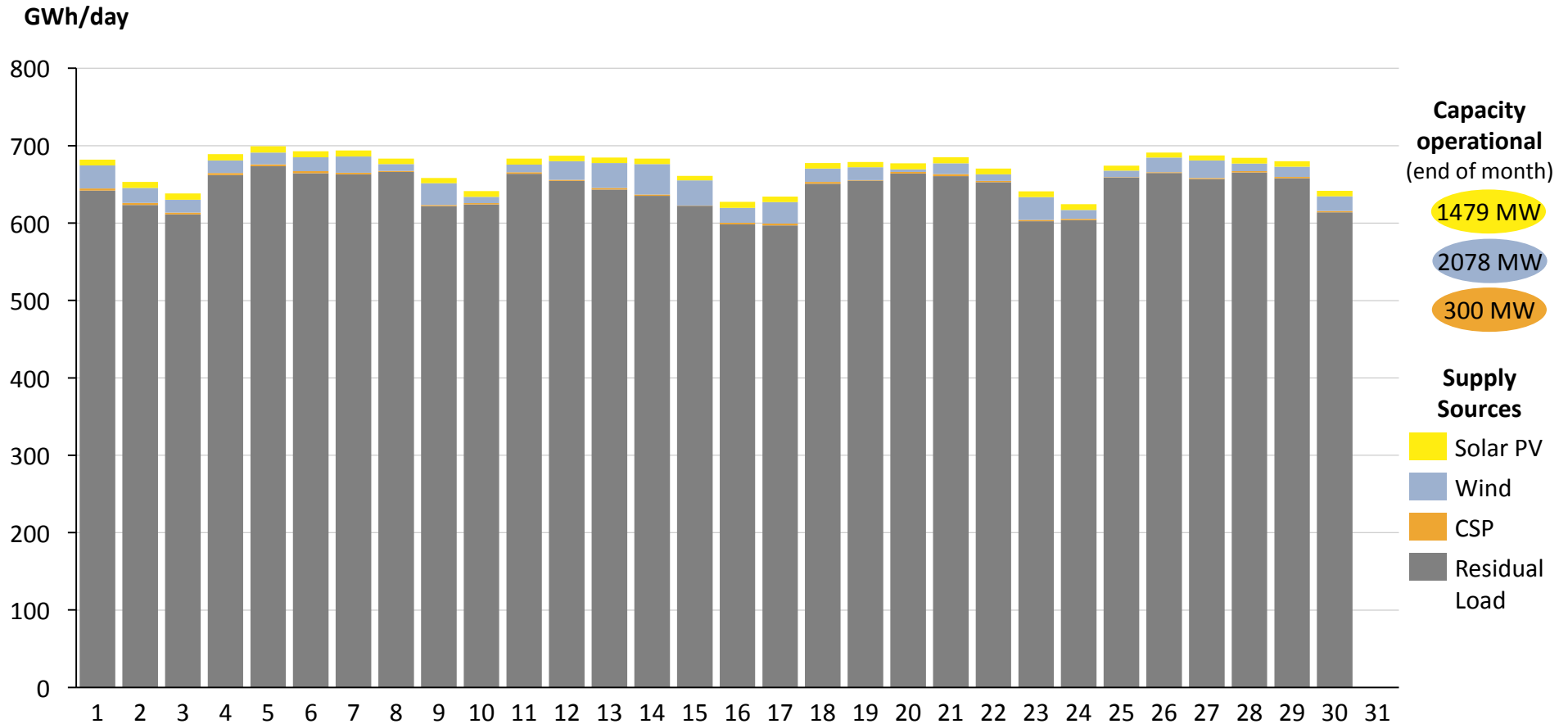
Actual daily production from all power supply sources in South Africa for May 2018



- Maximum daily production of 706 GWh on 31 May 2018 (Thursday)
- Minimum daily production of 591 GWh on 1 May 2018 (Tuesday - National Holiday)

Daily electricity production of between 625-699 GWh in Jun 2018

Actual daily production from all power supply sources in South Africa for June 2018

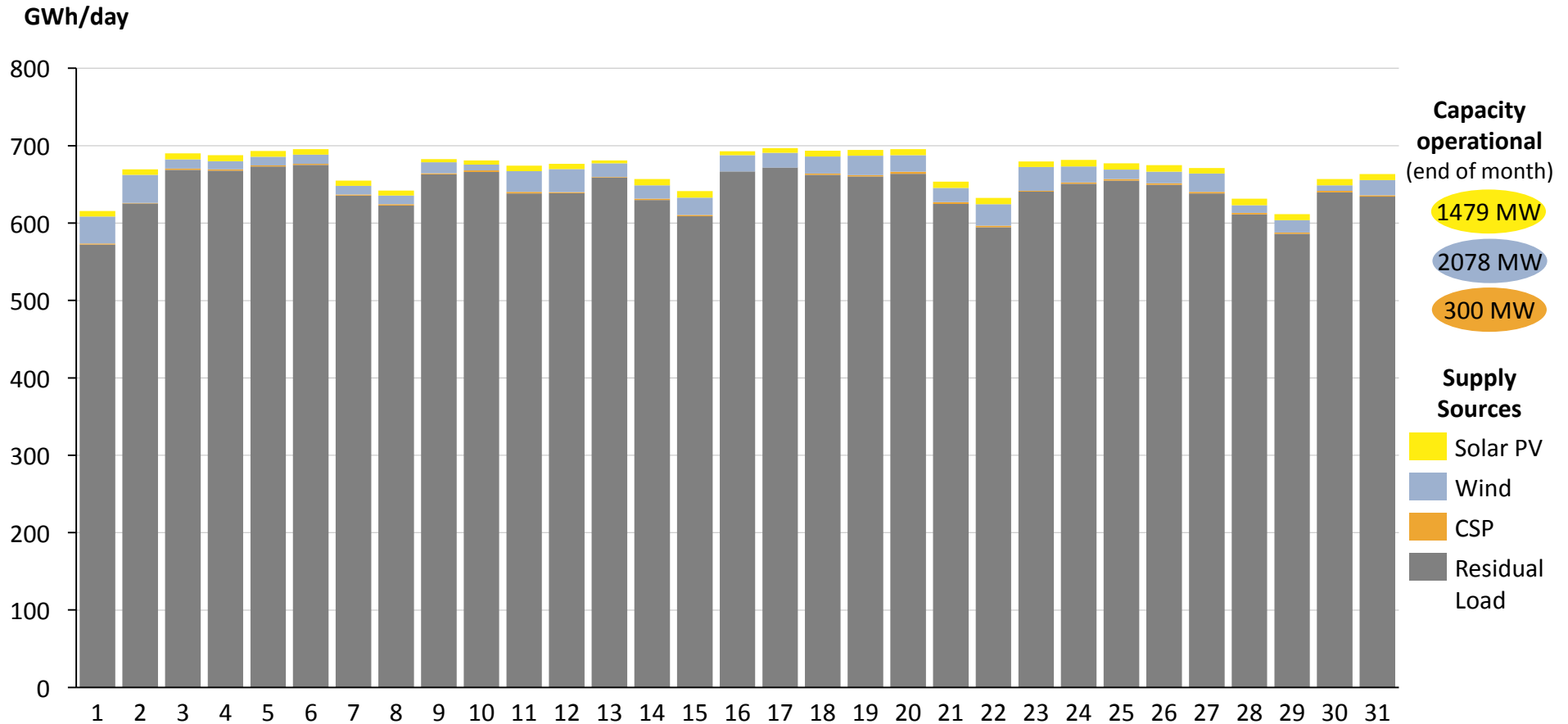


- Maximum daily production of 699 GWh on 5 Jun 2018 (Tuesday)
- Minimum daily production of 625 GWh on 24 Jun 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 612-697 GWh in Jul 2018

Actual daily production from all power supply sources in South Africa for July 2018

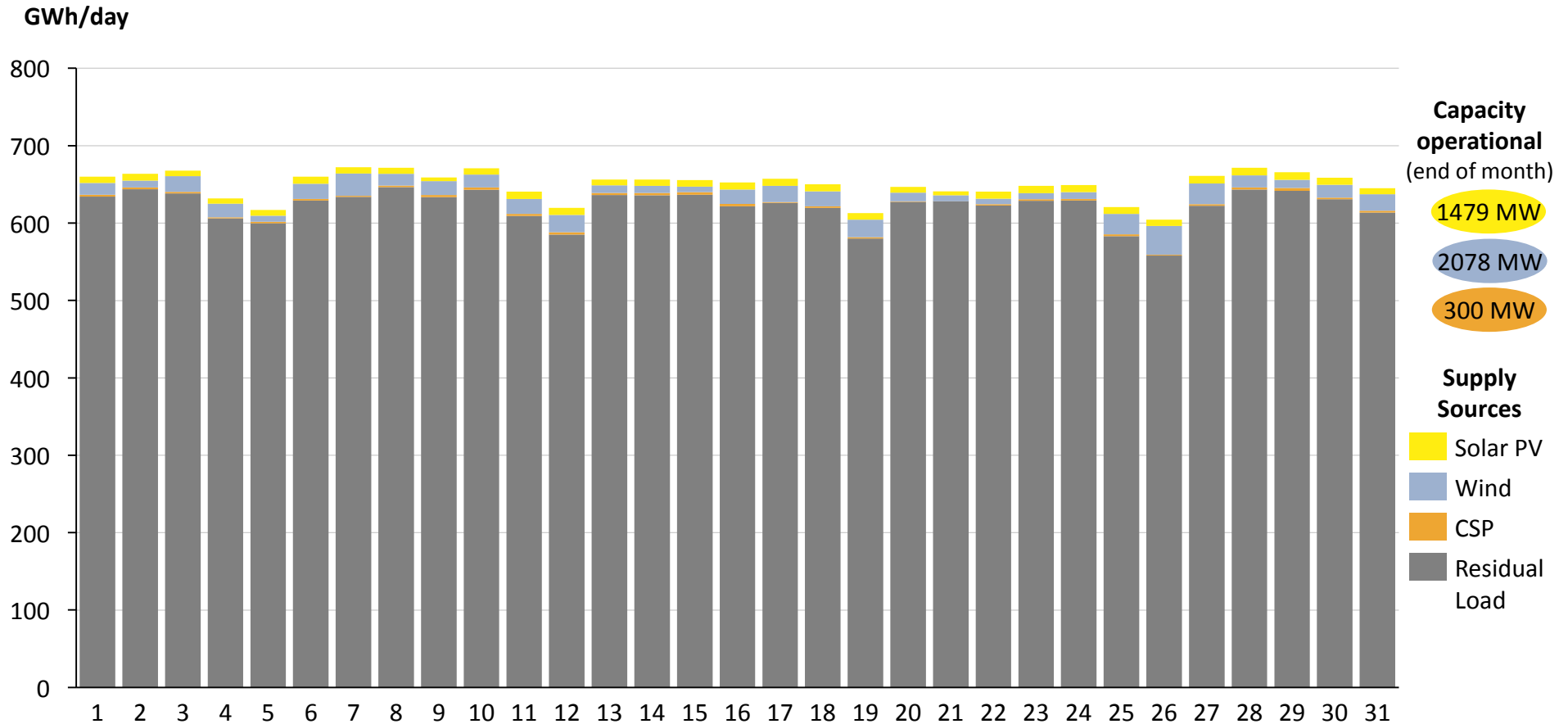


- Maximum daily production of 697 GWh on 17 Jul 2018 (Tuesday)
- Minimum daily production of 612 GWh on 29 Jul 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 604-672 GWh in Aug 2018

Actual daily production from all power supply sources in South Africa for August 2018

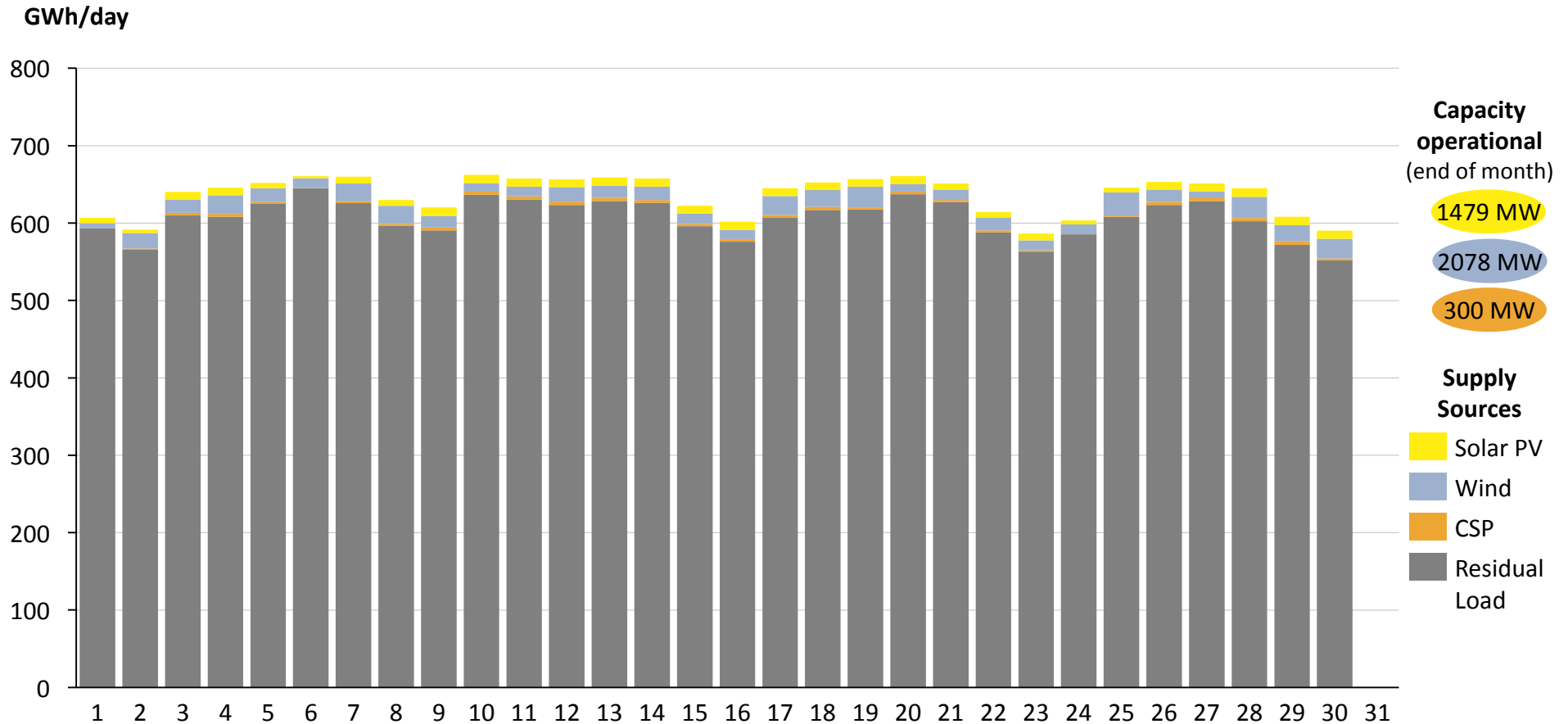


- Maximum daily production of 672 GWh on 7 Aug 2018 (Tuesday)
- Minimum daily production of 604 GWh on 26 Aug 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 586-662 GWh in Sep 2018

Actual daily production from all power supply sources in South Africa for September 2018

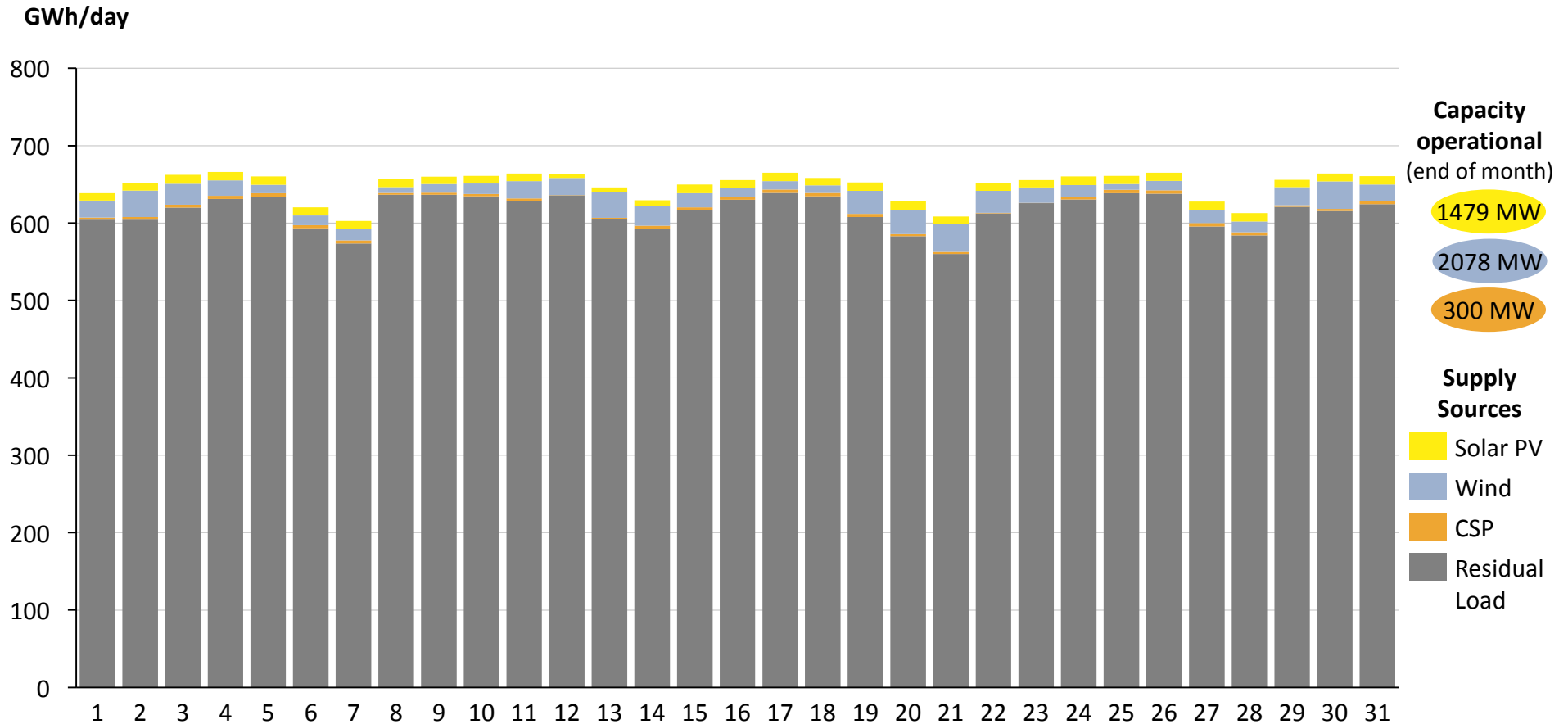


- Maximum daily production of 662 GWh on 10 Sep 2018 (Monday)
- Minimum daily production of 586 GWh on 23 Sep 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 603-666 GWh in Oct 2018

Actual daily production from all power supply sources in South Africa for October 2018

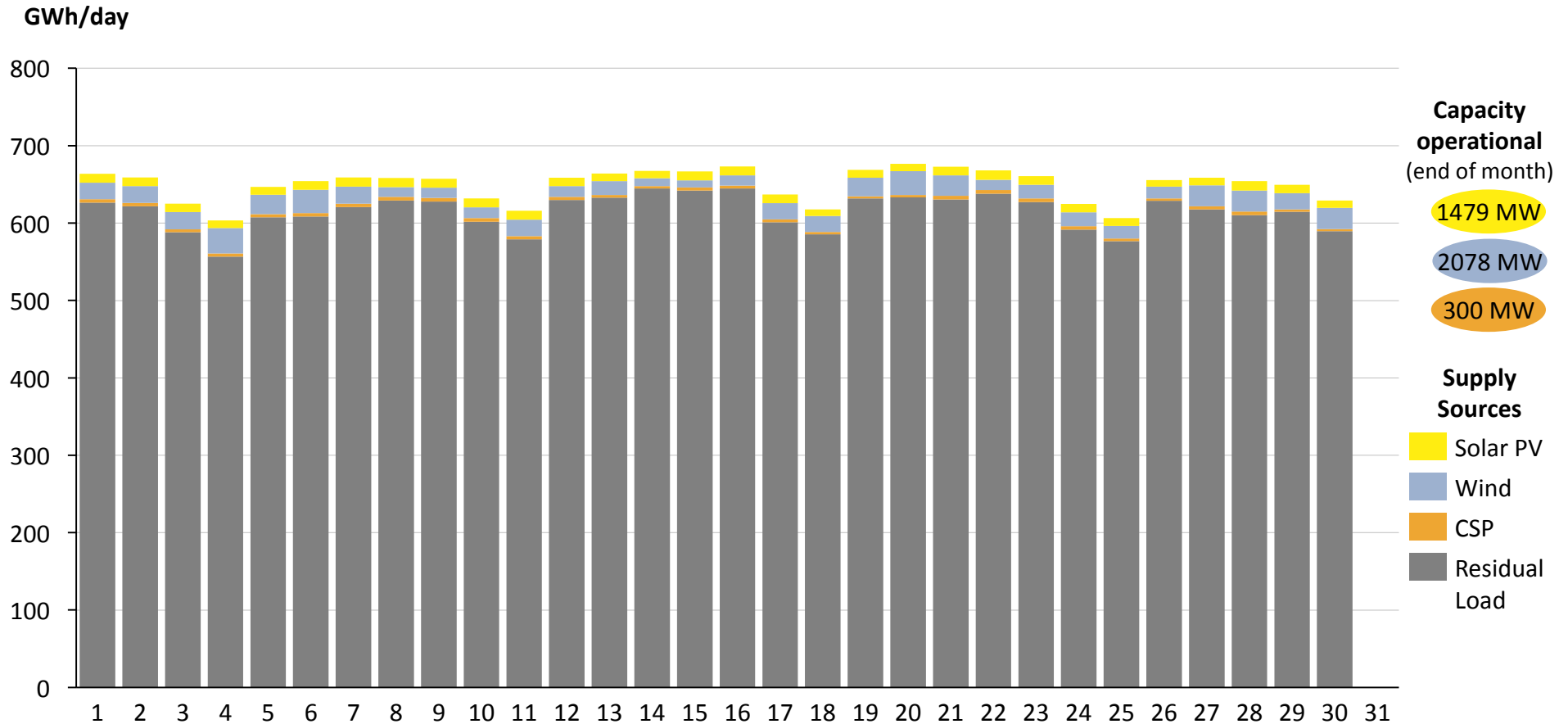


- Maximum daily production of 666 GWh on 4 Oct 2018 (Thursday)
- Minimum daily production of 603 GWh on 7 Oct 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 603-677 GWh in Nov 2018

Actual daily production from all power supply sources in South Africa for November 2018

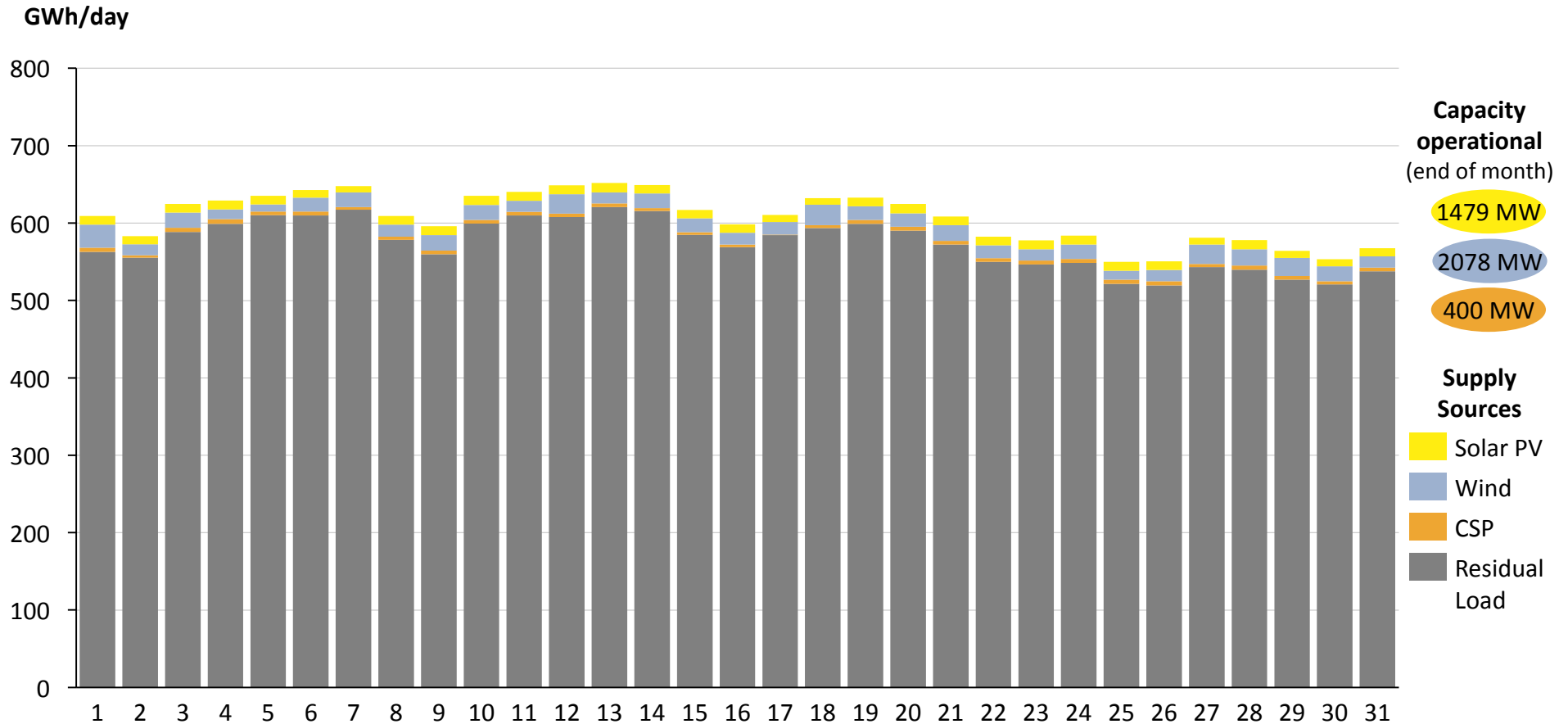


- Maximum daily production of 677 GWh on 20 Nov 2018 (Tuesday)
- Minimum daily production of 603 GWh on 4 Nov 2018 (Sunday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily electricity production of between 550-652 GWh in Dec 2018

Actual daily production from all power supply sources in South Africa for December 2018



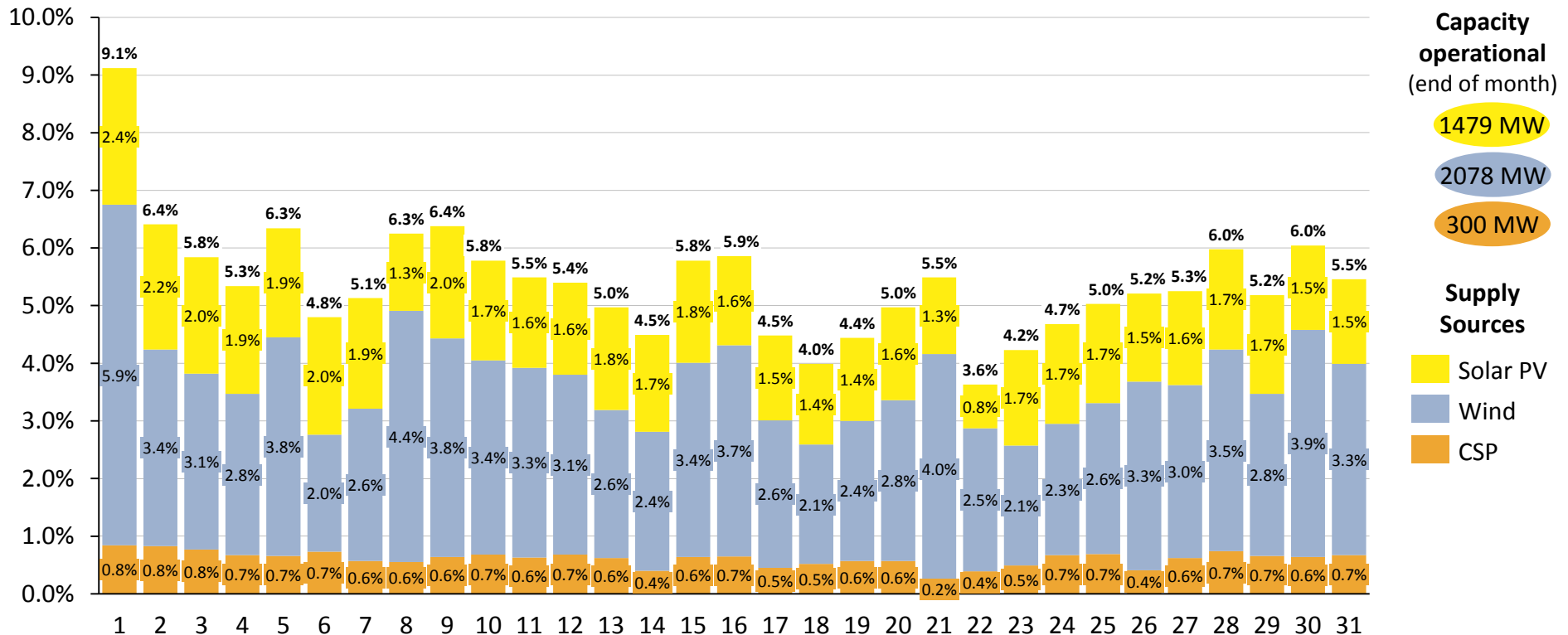
- Maximum daily production of 652 GWh on 13 Dec 2018 (Thursday)
- Minimum daily production of 550 GWh on 25 Dec 2018 (Tuesday - National Holiday)

Note: Design as per Fraunhofer ISE. Daily production excludes pumping load. Wind includes Sere.
Sources: Eskom; CSIR Energy Centre analysis

Daily solar PV, wind & CSP contribution of 3.6-9.1% in Jan 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for January 2018

Relative daily contribution

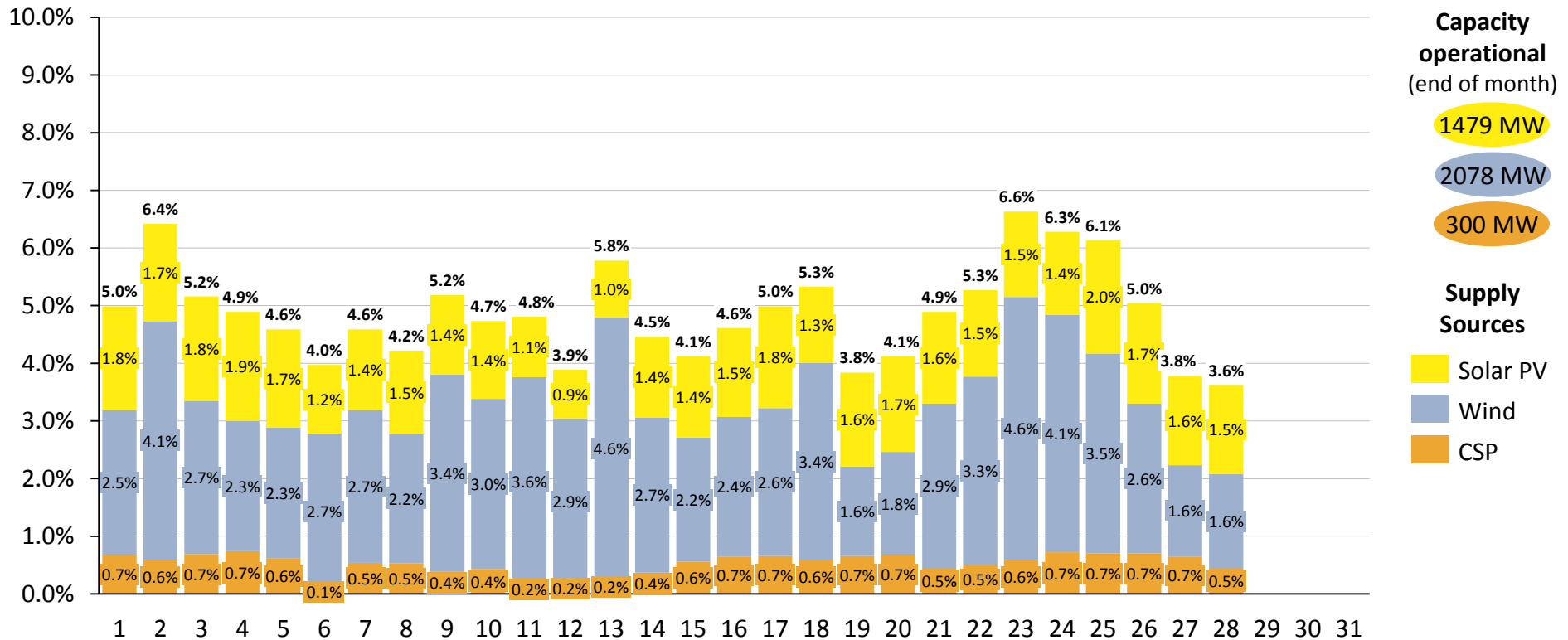


- Maximum daily relative solar PV contribution of 2.4% on 1 Jan 2018 (Monday - National Holiday)
- Maximum daily relative wind contribution of 5.9% on 1 Jan 2018 (Monday)
- Maximum daily relative CSP contribution of 2.4% on 1 Jan 2018 (Monday)

Daily solar PV, wind & CSP contribution of 3.6-6.6% in Feb 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for February 2018

Relative daily contribution

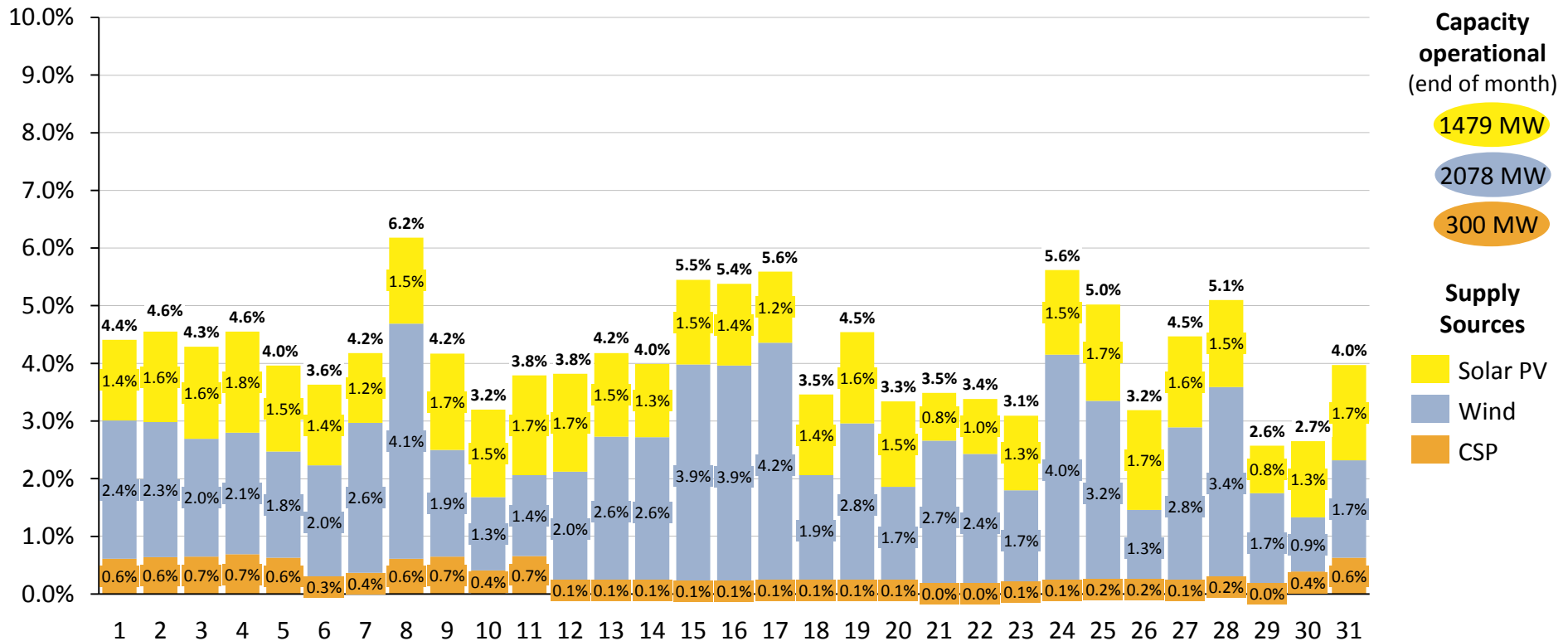


- Maximum daily relative solar PV contribution of 2.0% on 25 Feb 2018 (Sunday)
- Maximum daily relative wind contribution of 4.6% on 23 Feb 2018 (Friday)
- Maximum daily relative CSP contribution of 0.7% on 4 Feb 2018 (Sunday)

Daily solar PV, wind & CSP contribution of 2.6-6.2% in Mar 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for March 2018

Relative daily contribution

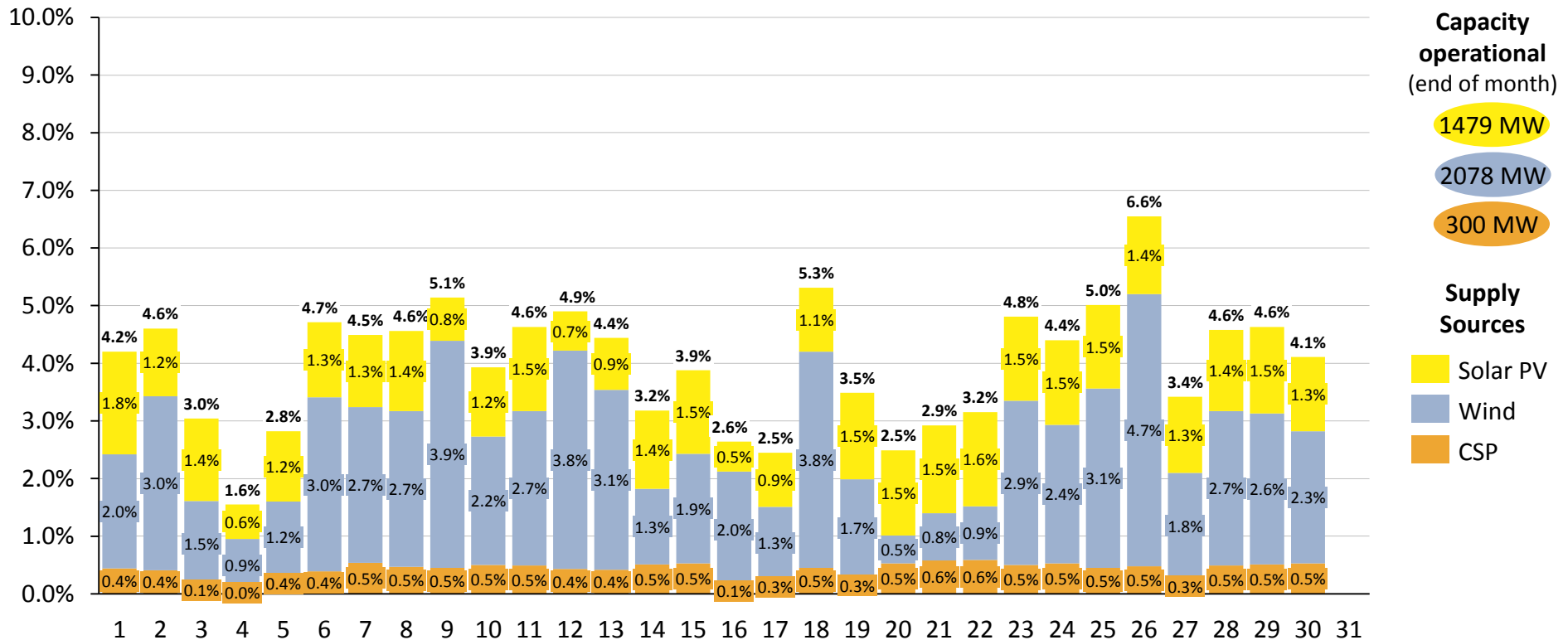


- Maximum daily relative solar PV contribution of 1.7% on 4 Mar 2018 (Sunday)
- Maximum daily relative wind contribution of 4.2% on 17 Mar 2018 (Saturday)
- Maximum daily relative CSP contribution of 0.7% on 4 Mar 2018 (Sunday)

Daily solar PV, wind & CSP contribution of 1.6-6.6% in Apr 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for April 2018

Relative daily contribution

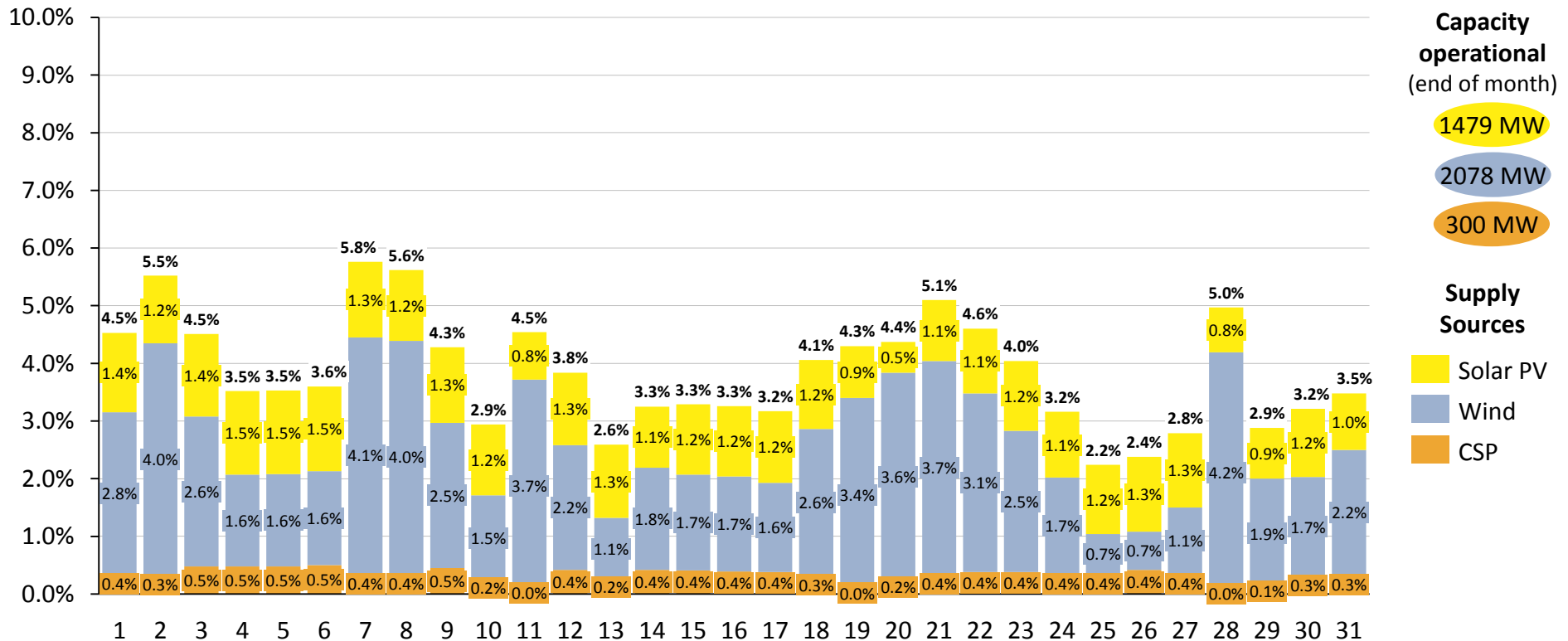


- Maximum daily relative solar PV contribution of 1.8% on 1 Apr 2018 (Sunday)
- Maximum daily relative wind contribution of 4.7% on 26 Apr 2018 (Thursday)
- Maximum daily relative CSP contribution of 0.6% on 22 Apr 2018 (Sunday)

Daily solar PV, wind & CSP contribution of 2.2-5.8% in May 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for May 2018

Relative daily contribution

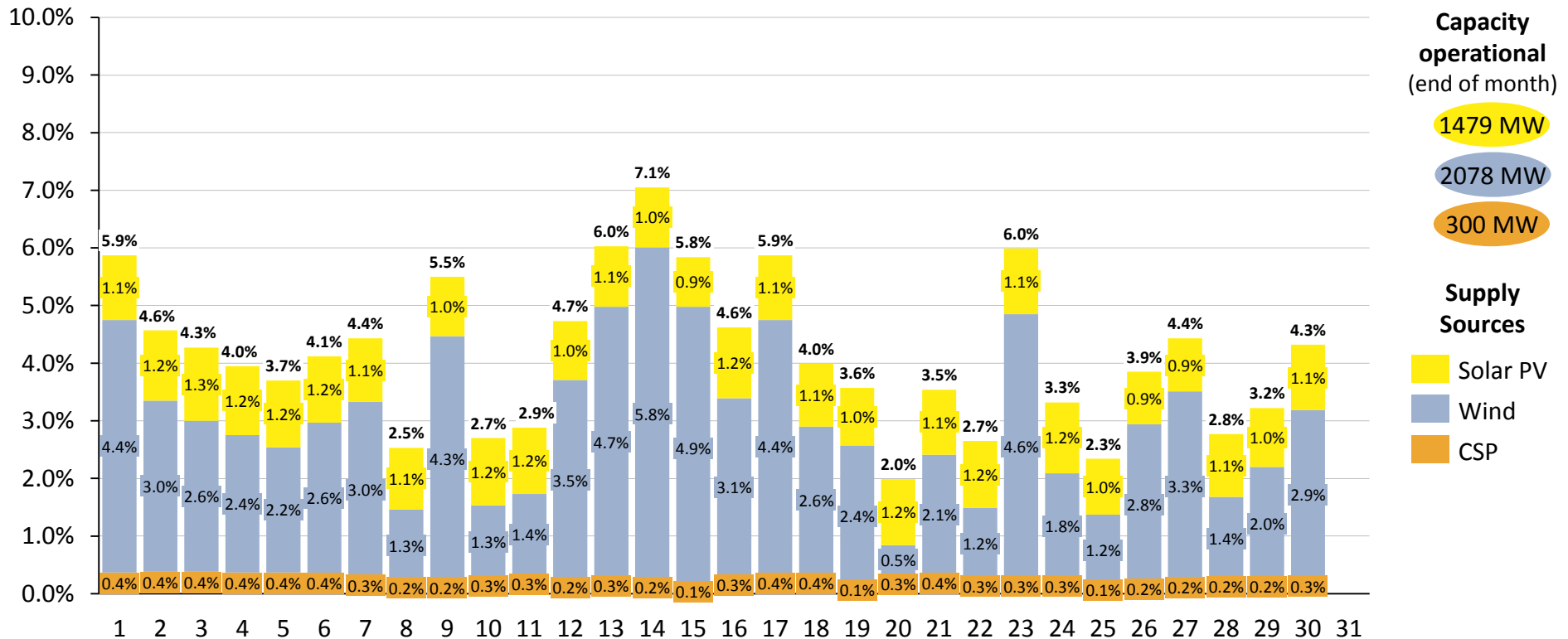


- Maximum daily relative solar PV contribution of 1.5% on 6 May 2018 (Sunday)
- Maximum daily relative wind contribution of 4.2% on 28 May 2018 (Monday)
- Maximum daily relative CSP contribution of 0.5% on 6 May 2018 (Sunday)

Daily solar PV, wind & CSP contribution of 2.0-7.1% in Jun 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for June 2018

Relative daily contribution

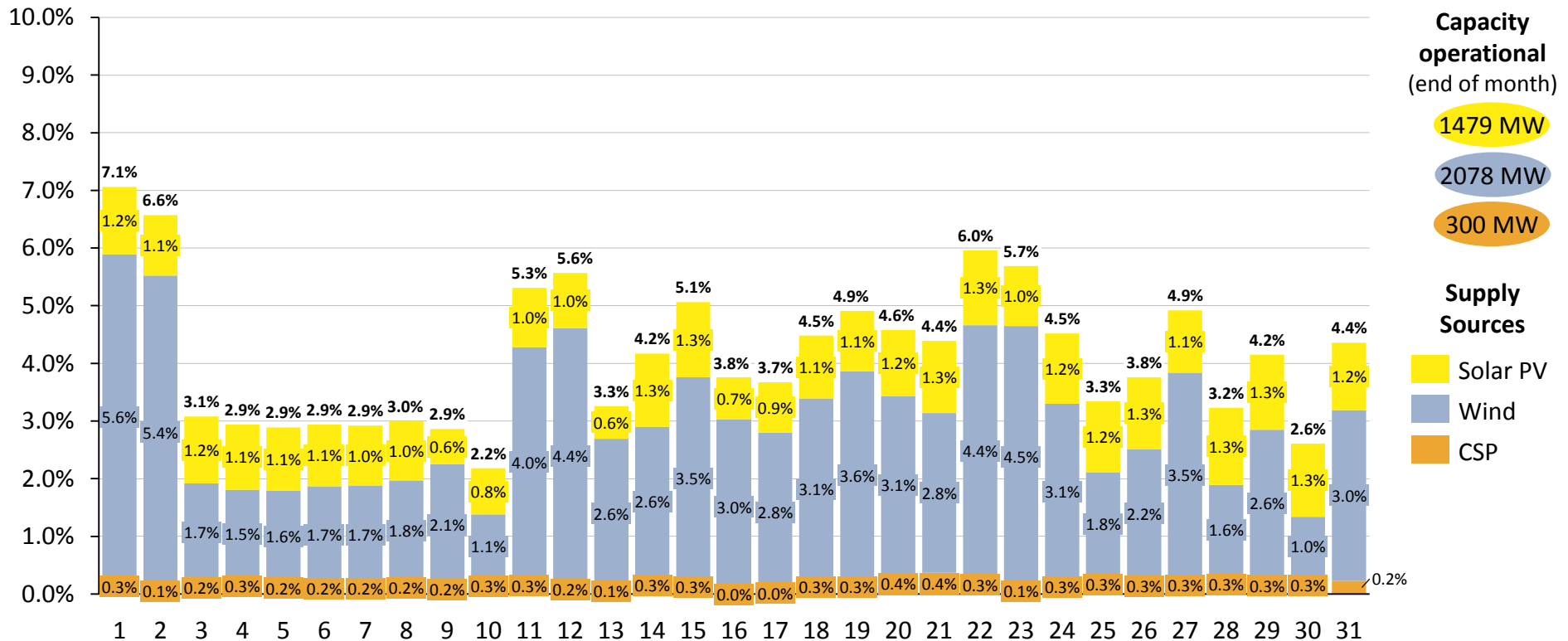


- Maximum daily relative solar PV contribution of 1.3% on 3 Jun 2018 (Sunday)
- Maximum daily relative wind contribution of 5.8% on 14 Jun 2018 (Thursday)
- Maximum daily relative CSP contribution of 0.4% on 2 Jun 2018 (Saturday)

Daily solar PV, wind & CSP contribution of 2.2-7.1% in Jul 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for July 2018

Relative daily contribution

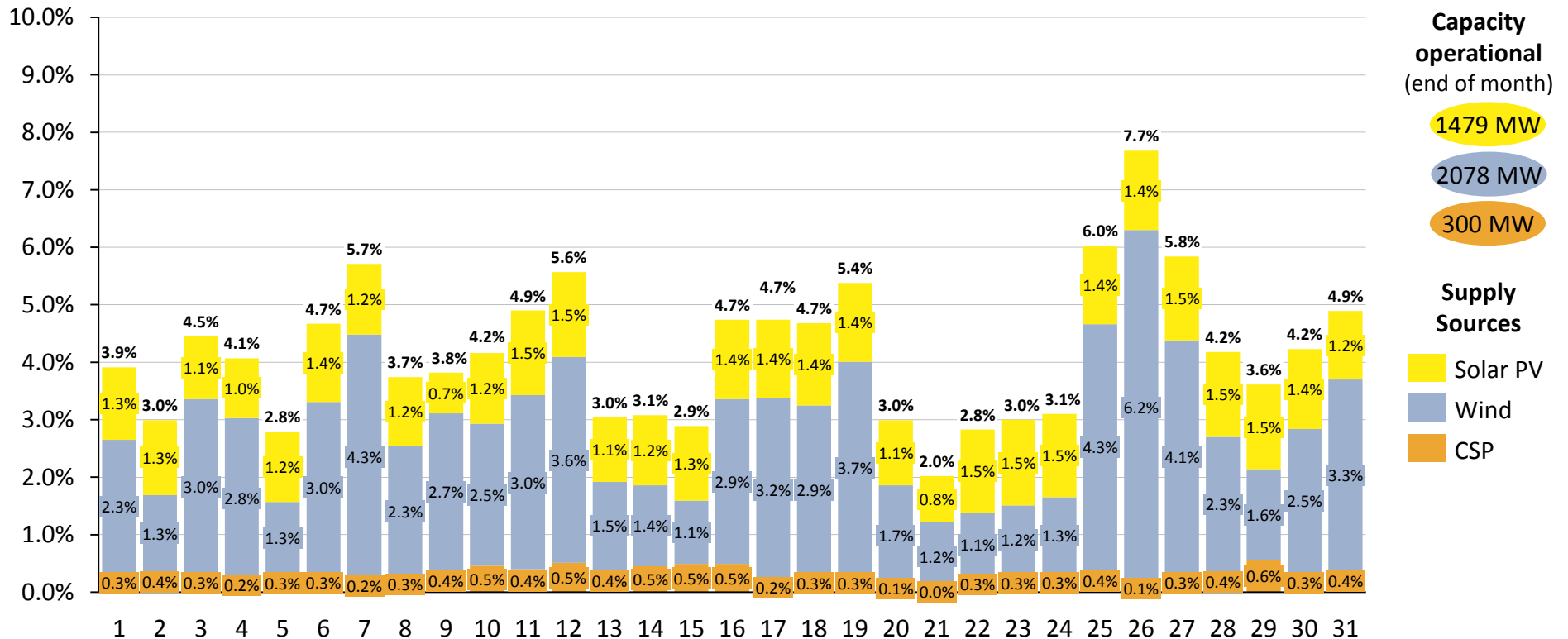


- Maximum daily relative solar PV contribution of 1.3% on 28 Jul 2018 (Saturday)
- Maximum daily relative wind contribution of 5.6% on 1 Jul 2018 (Sunday)
- Maximum daily relative CSP contribution of 0.4% on 21 Jul 2018 (Saturday)

Daily solar PV, wind & CSP contribution of 2.0-7.7% in Aug 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for August 2018

Relative daily contribution

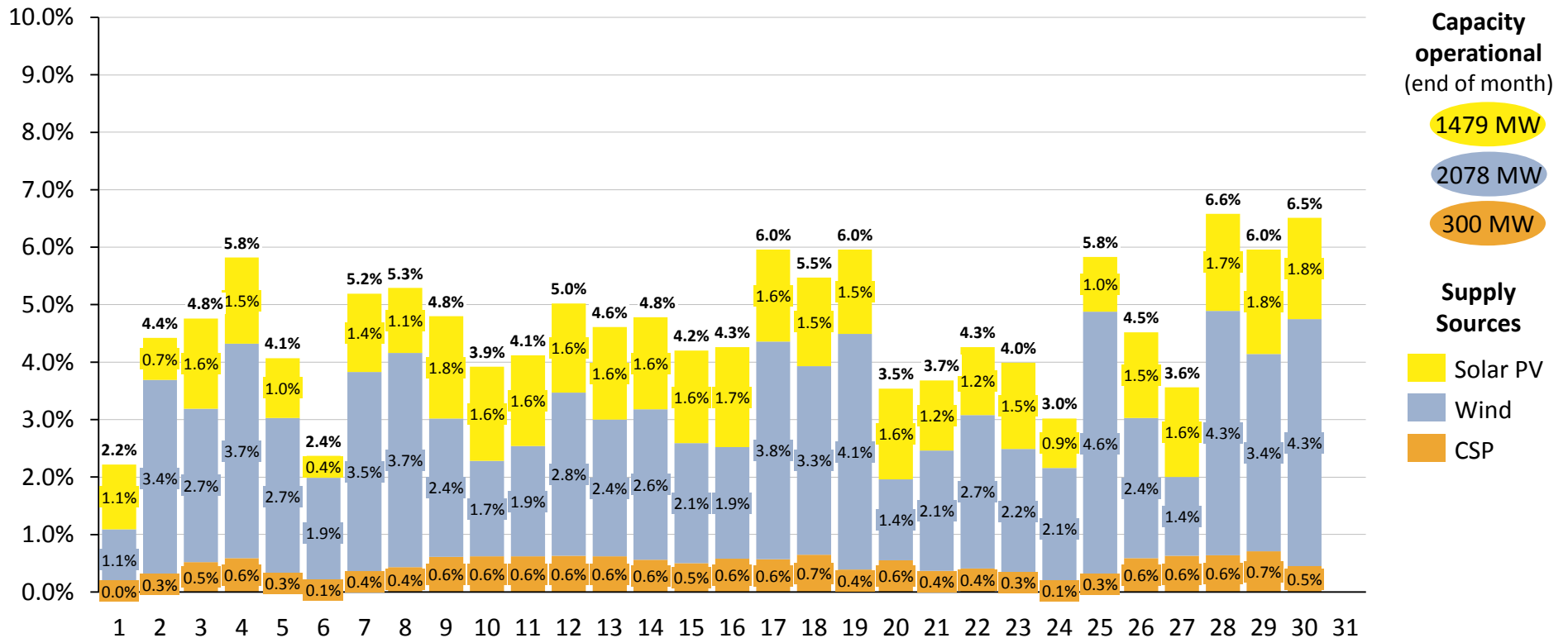


- Maximum daily relative solar PV contribution of 1.5% on 23 Aug 2018 (Thursday)
- Maximum daily relative wind contribution of 6.2% on 26 Aug 2018 (Sunday)
- Maximum daily relative CSP contribution of 0.6% on 29 Aug 2018 (Wednesday)

Daily solar PV, wind & CSP contribution of 2.2-6.6% in Sep 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for September 2018

Relative daily contribution

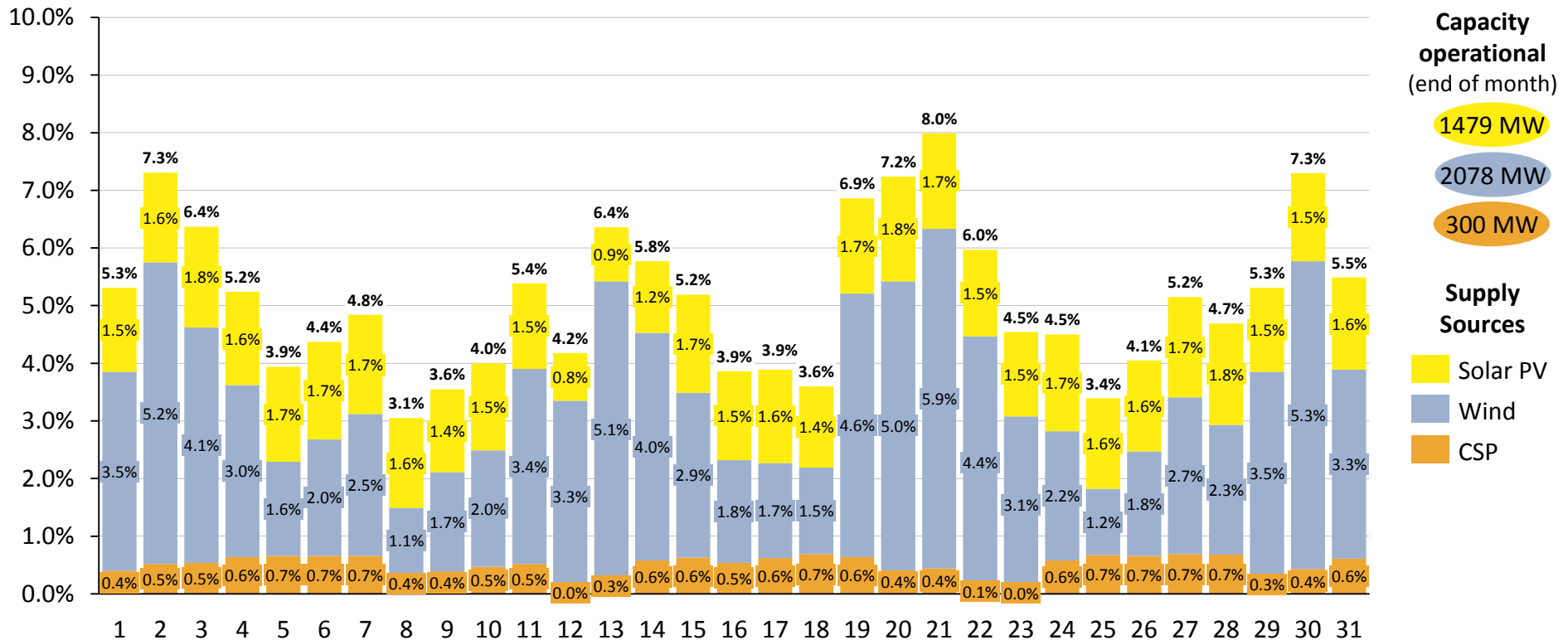


- Maximum daily relative solar PV contribution of 1.8% on 29 Sep 2018 (Saturday)
- Maximum daily relative wind contribution of 4.6% on 25 Sep 2018 (Tuesday)
- Maximum daily relative CSP contribution of 0.7% on 29 Sep 2018 (Saturday)

Daily solar PV, wind & CSP contribution of 3.1-8.0% in Oct 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for October 2018

Relative daily contribution

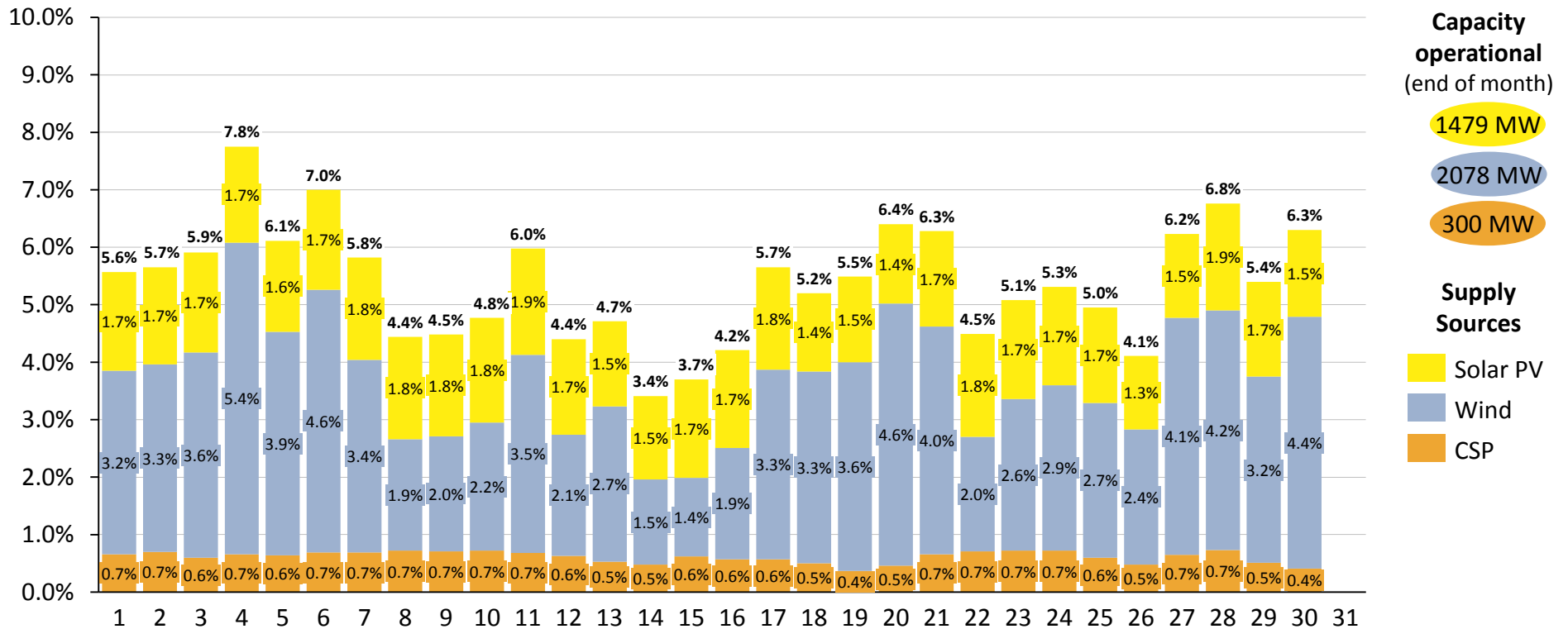


- Maximum daily relative solar PV contribution of 1.8% on 20 Oct 2018 (Saturday)
- Maximum daily relative wind contribution of 5.9% on 21 Oct 2018 (Sunday)
- Maximum daily relative CSP contribution of 0.7% on 27 Oct 2018 (Sunday)

Daily solar PV, wind & CSP contribution of 3.4-7.8% in Nov 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for November 2018

Relative daily contribution

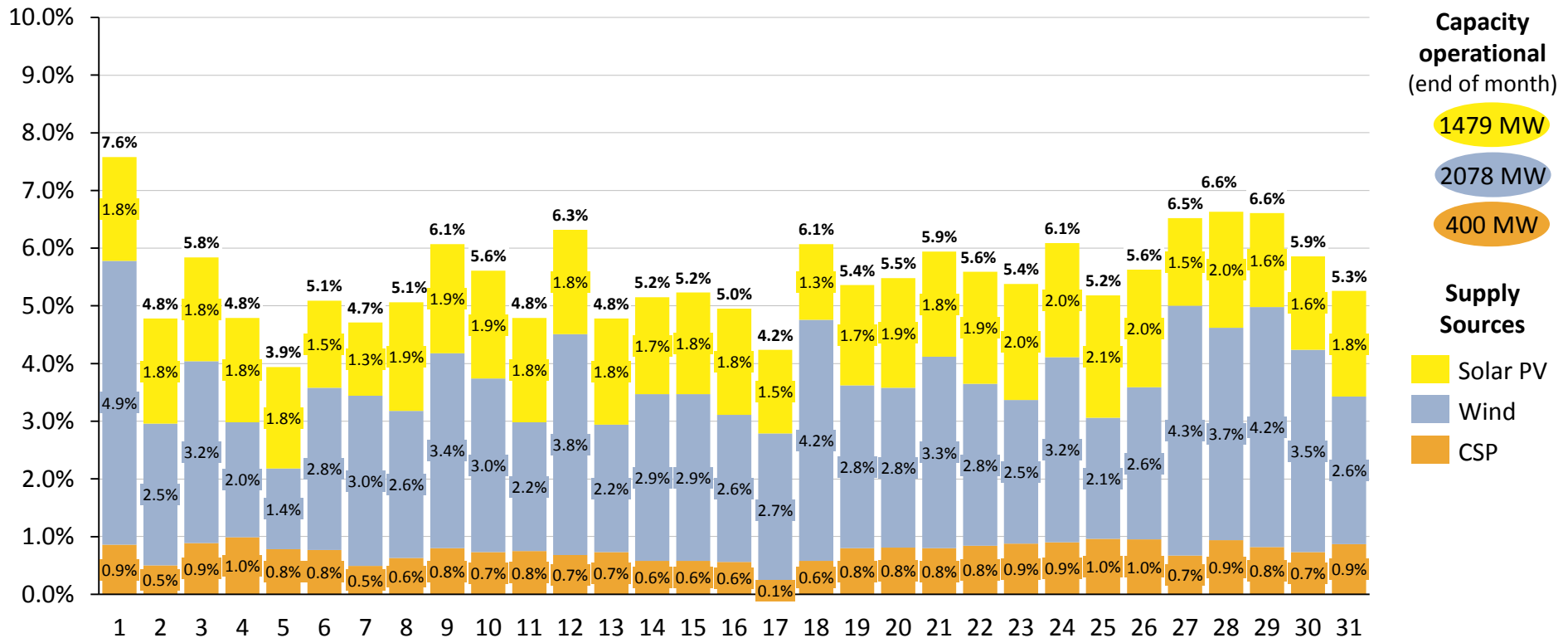


- Maximum daily relative solar PV contribution of 1.9% on 28 Nov 2018 (Wednesday)
- Maximum daily relative wind contribution of 5.4% on 4 Nov 2018 (Sunday)
- Maximum daily relative CSP contribution of 0.7% on 28 Nov 2018 (Wednesday)

Daily solar PV, wind & CSP contribution of 3.9-7.6% in Dec 2018

Actual daily relative solar PV/wind/CSP contribution as % of total supply in RSA for December 2018

Relative daily contribution



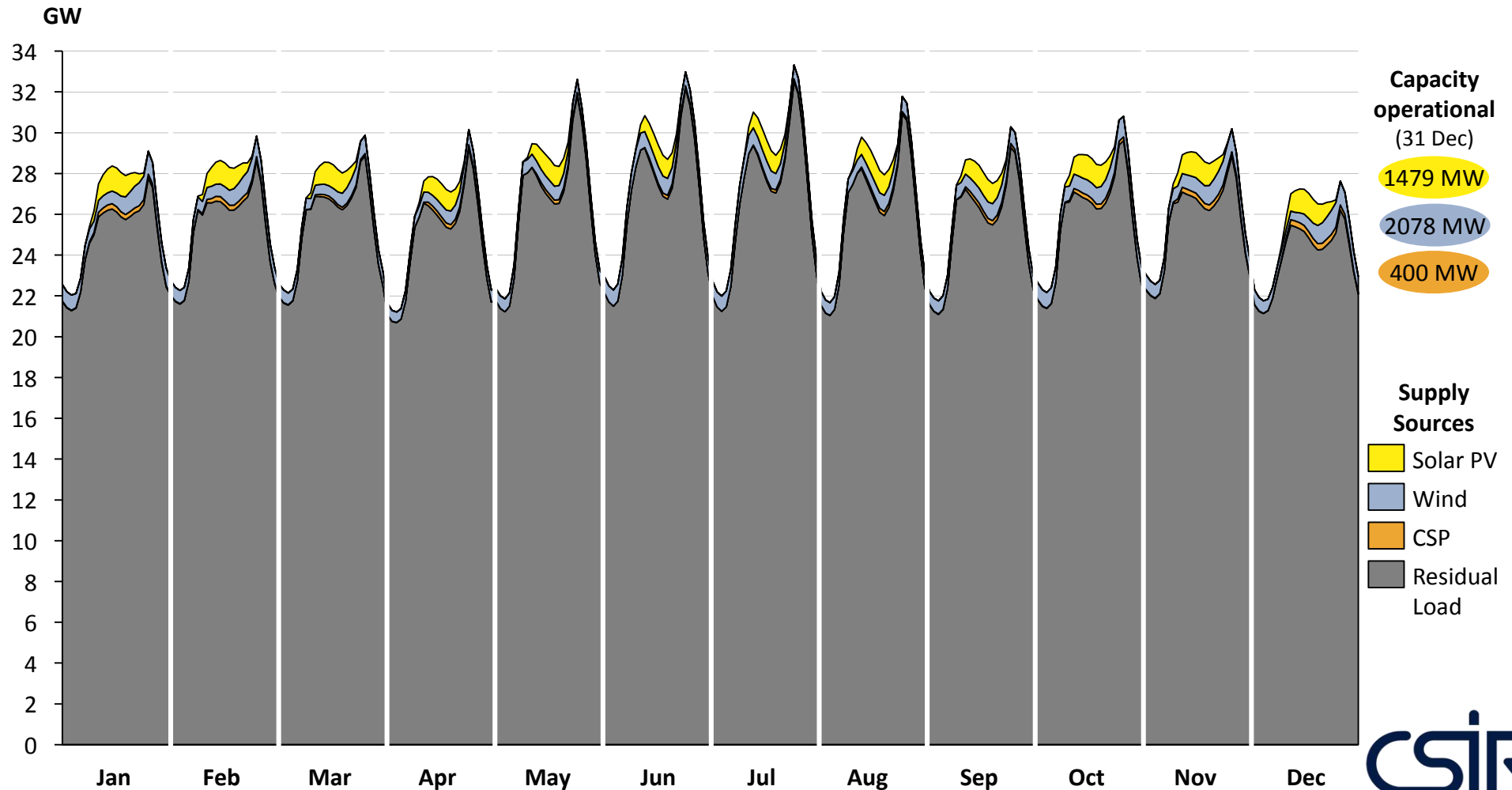
- Maximum daily relative solar PV contribution of 2.1% on 25 Dec 2018 (Tuesday - National Holiday)
- Maximum daily relative wind contribution of 4.9% on 1 Dec 2018 (Saturday)
- Maximum daily relative CSP contribution of 1.0% on 4 Dec 2018 (Tuesday)

Agenda

- 1 Overview and status of REIPPPP
- 2 Overview actual electricity production data for 2018
- 3 Monthly electricity production
- 4 Weekly electricity production
- 5 Daily electricity production
- 6 Hourly electricity production
- 7 Actual load shedding in 2018

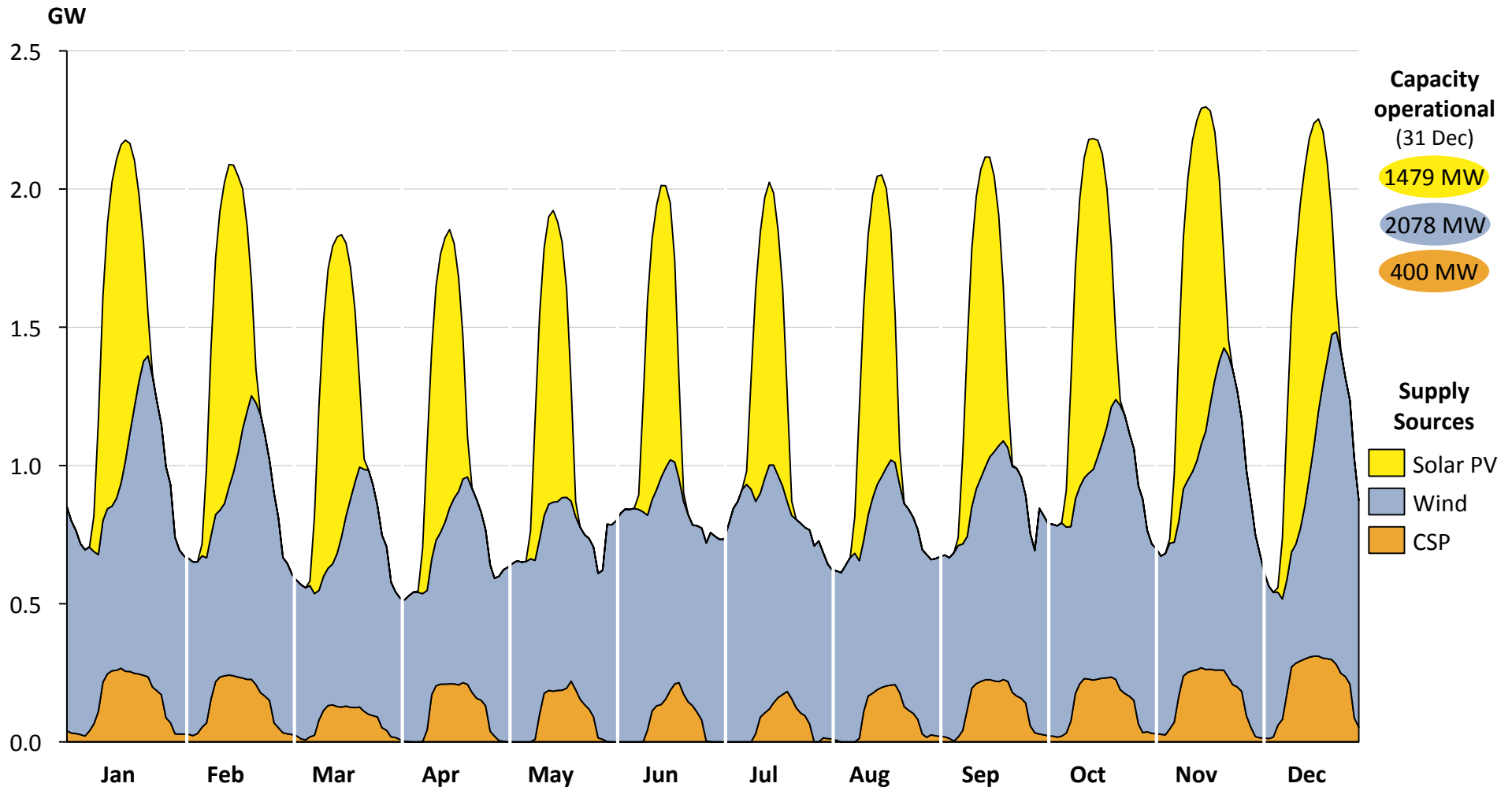
Diurnal Courses

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



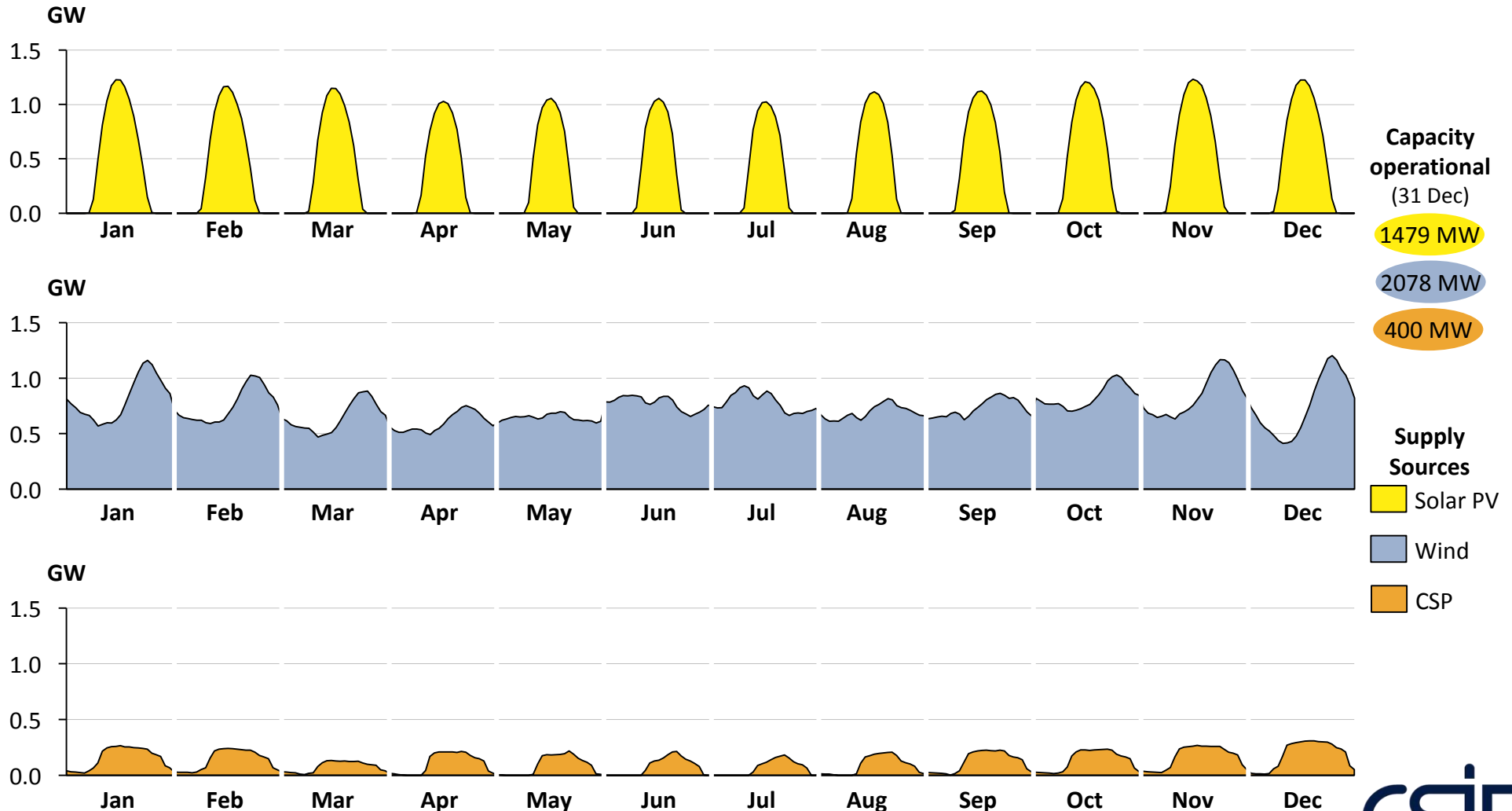
Diurnal Courses

Actual monthly average diurnal courses of solar PV, wind and CSP in RSA for the months from Jan-Dec 2018



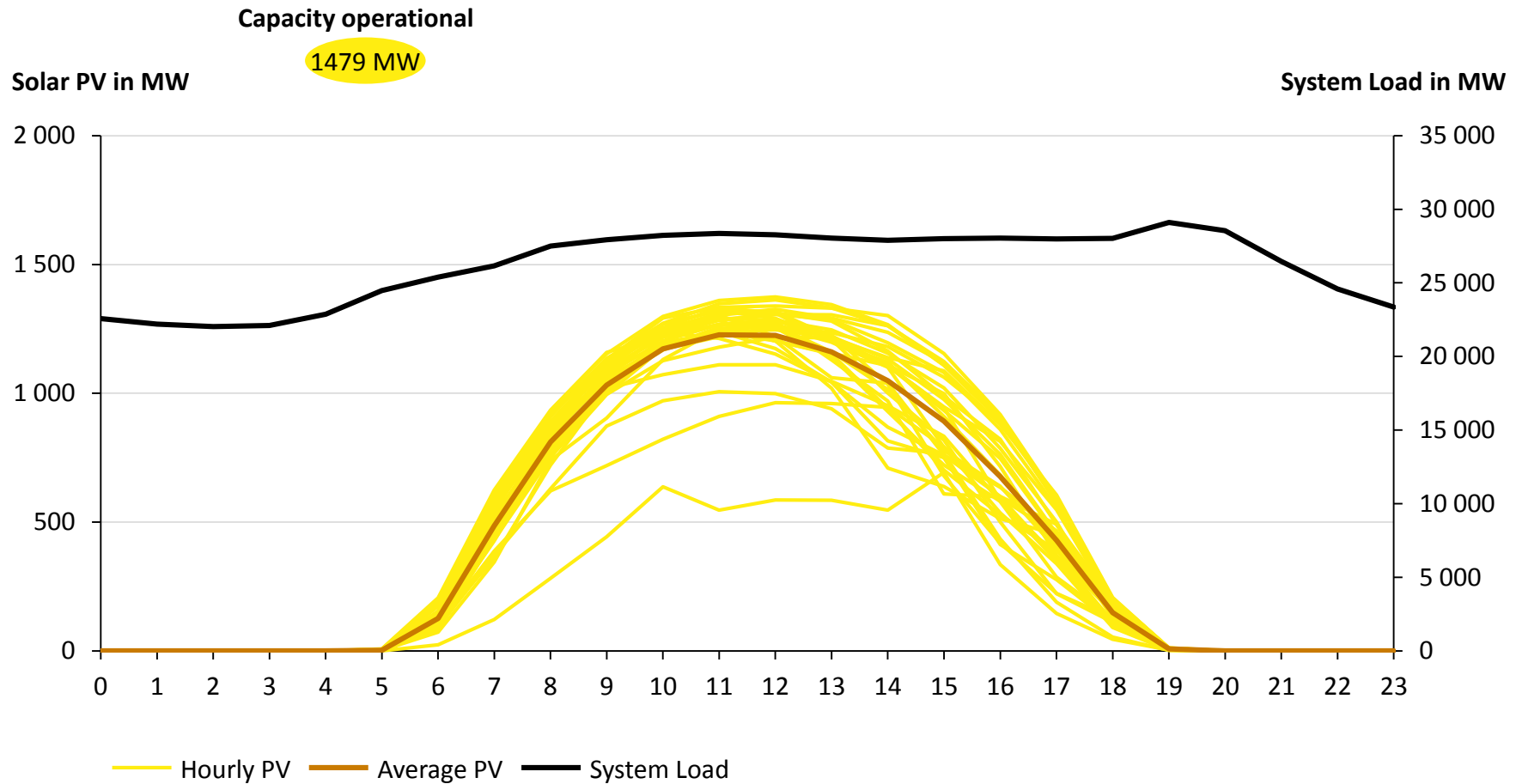
Diurnal Courses

Actual monthly average diurnal courses of solar PV, wind and CSP in RSA for the months from Jan-Dec 2018



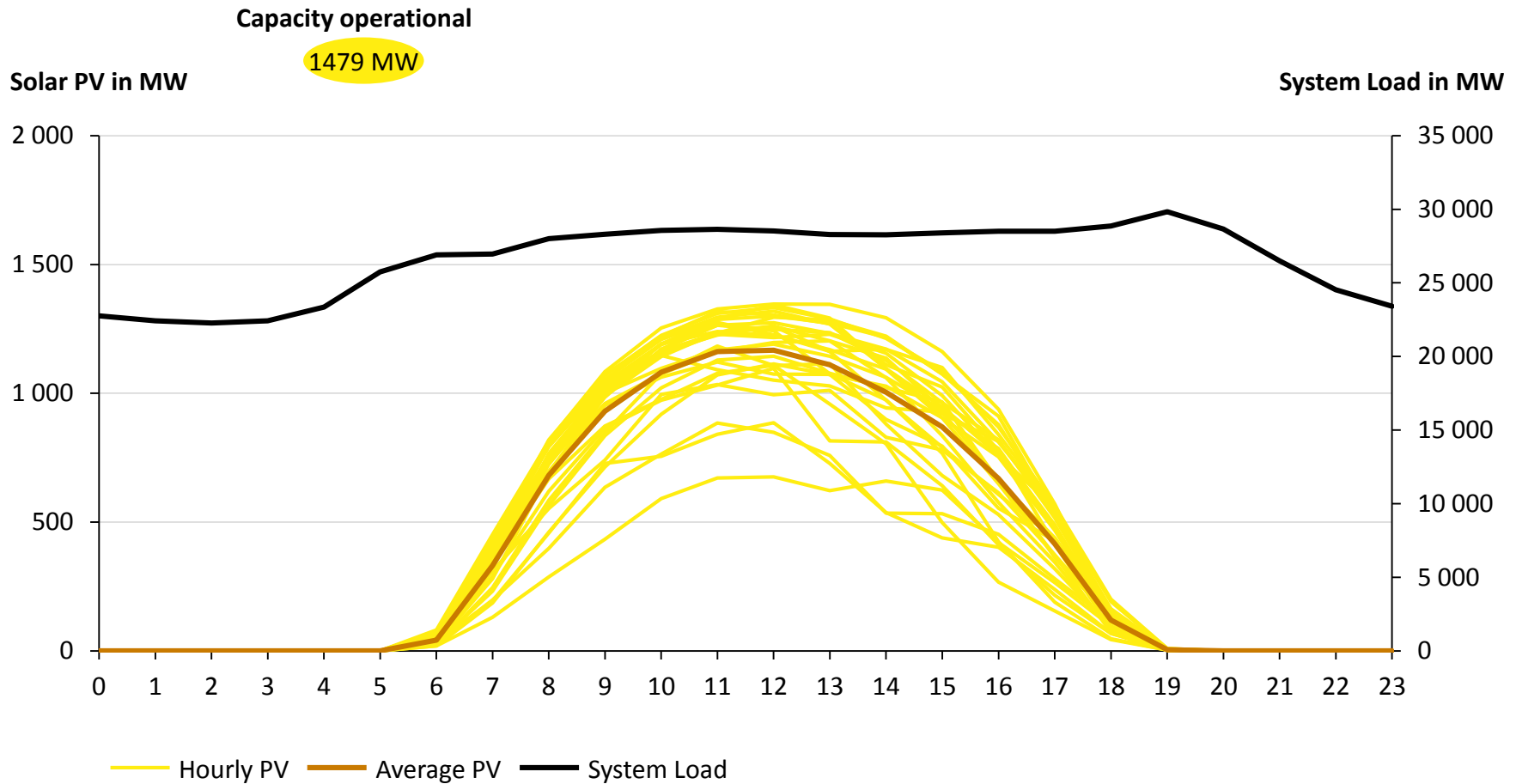
Solar PV supply in Jan 2018 was very stable

Hourly solar PV production for all 31 days of January 2018 and average system load diurnal course



Solar PV supply in Feb 2018 was very stable

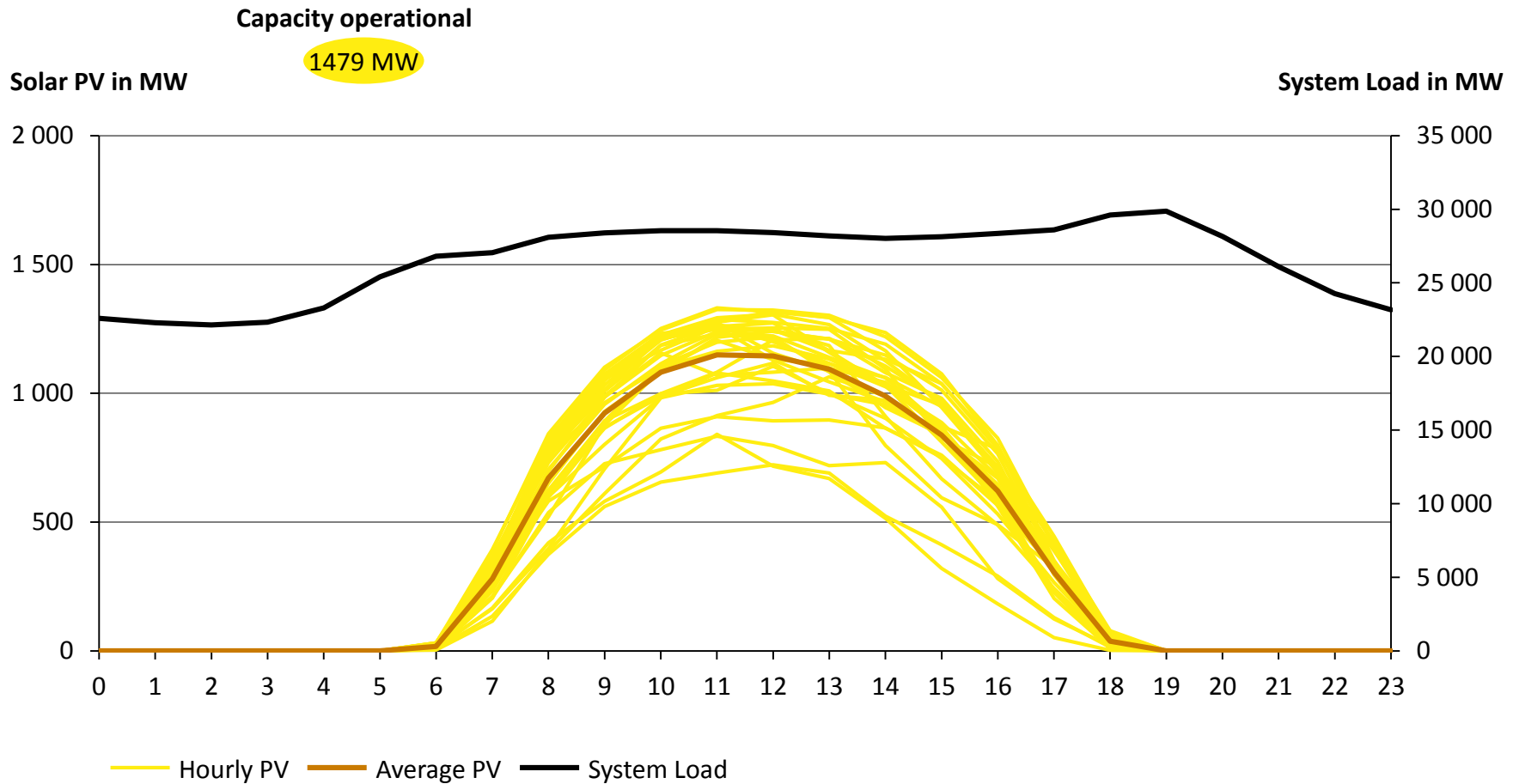
Hourly solar PV production for all 28 days of February 2018 and average system load diurnal course



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

Solar PV supply in Mar 2018 was very stable

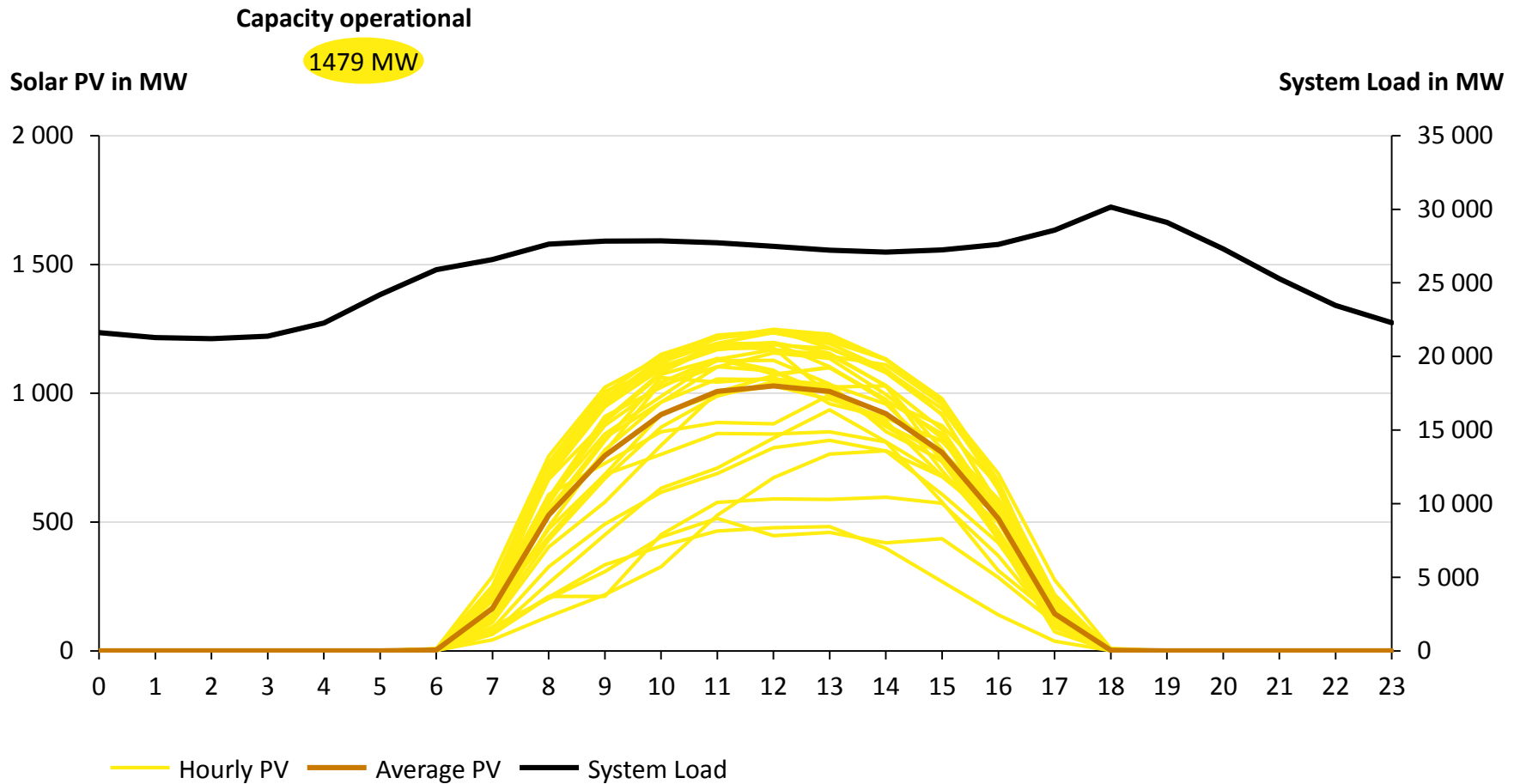
Hourly solar PV production for all 31 days of March 2018 and average system load diurnal course



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

Solar PV supply in Apr 2018 very stable

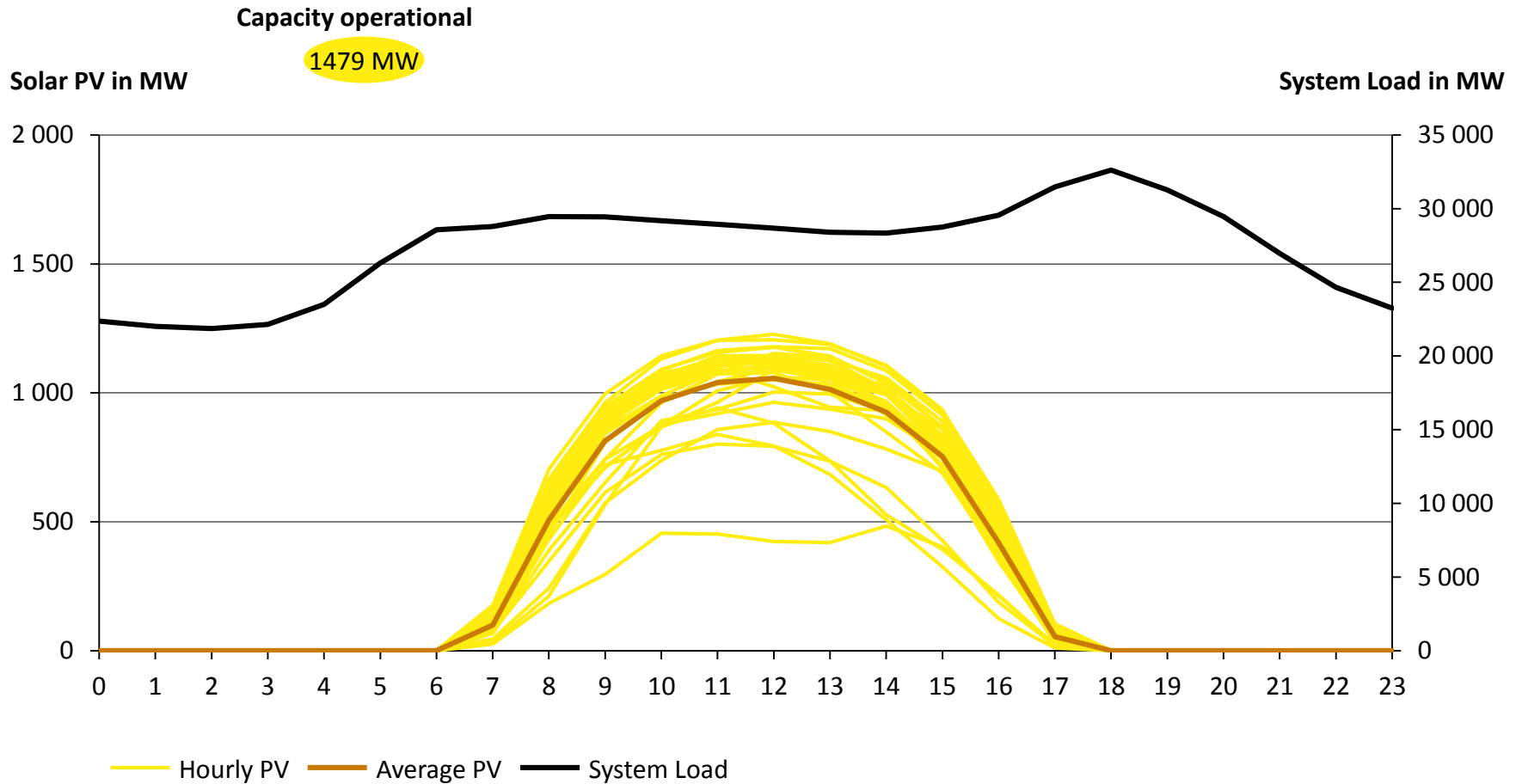
Hourly solar PV production for all 30 days of April 2018 and average system load diurnal course



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

Solar PV supply in May 2018 very stable

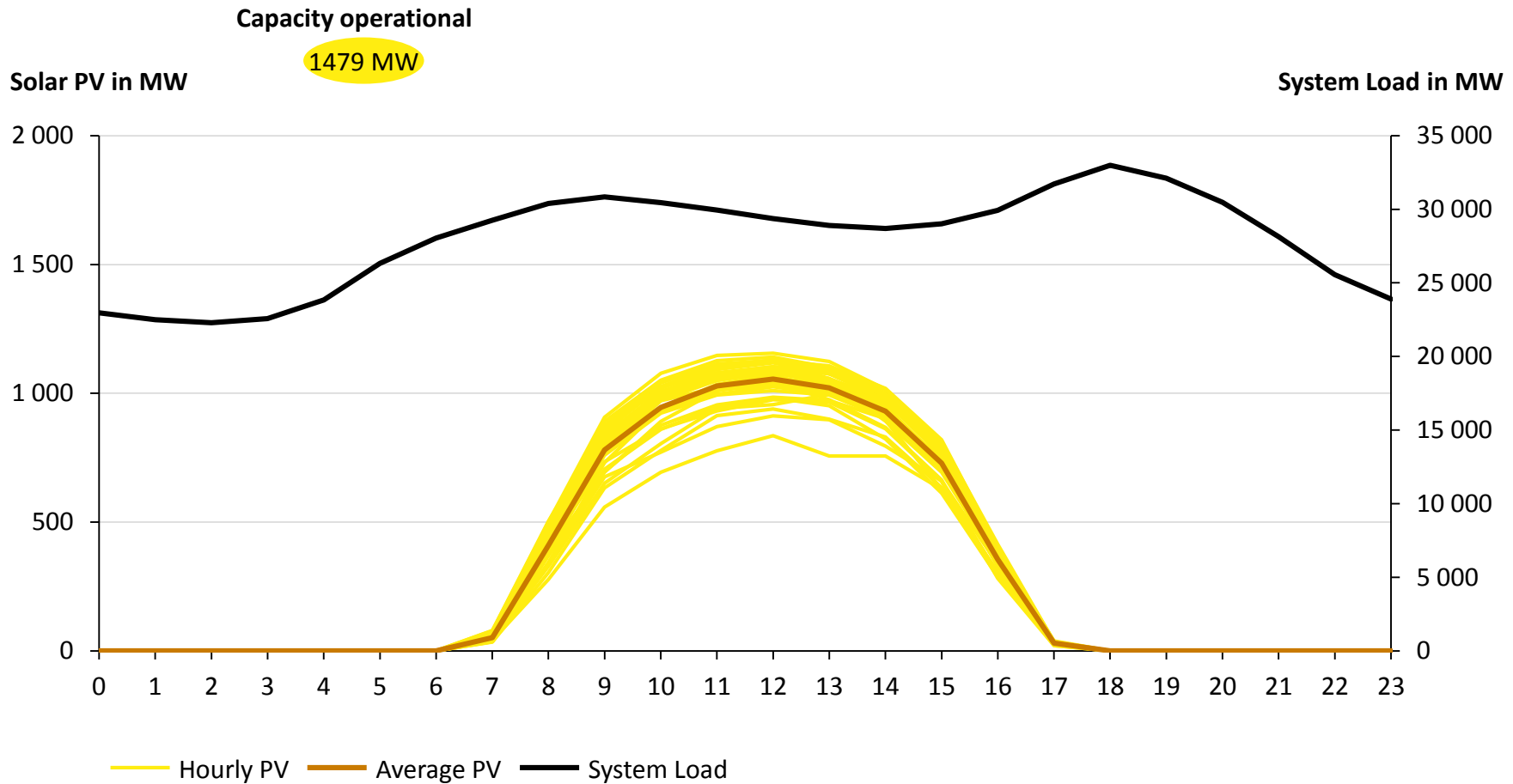
Hourly solar PV production for all 31 days of May 2018 and average system load diurnal course



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

Solar PV supply in Jun 2018 very stable

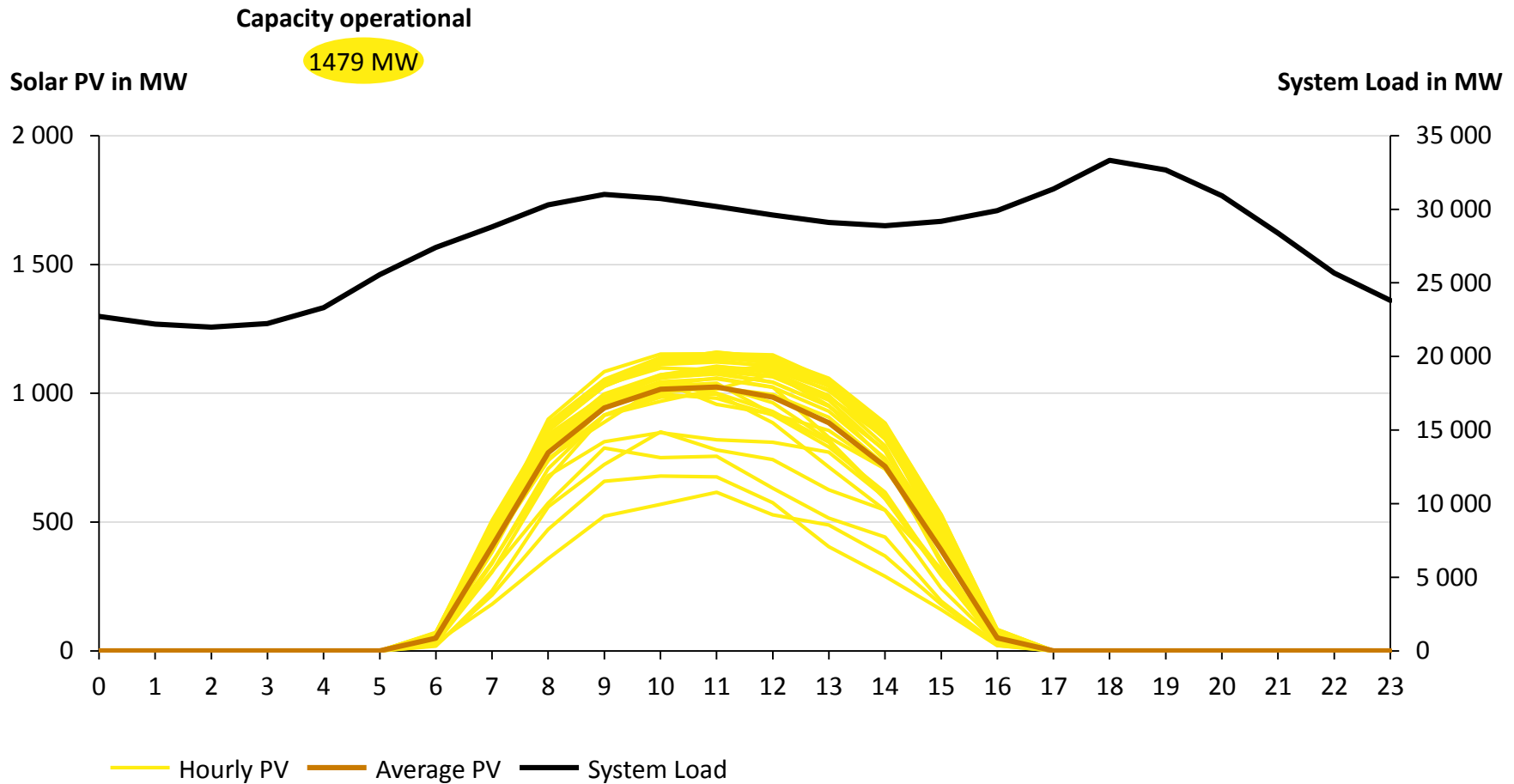
Hourly solar PV production for all 30 days of June 2018 and average system load diurnal course



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

Solar PV supply in Jul 2018 very stable

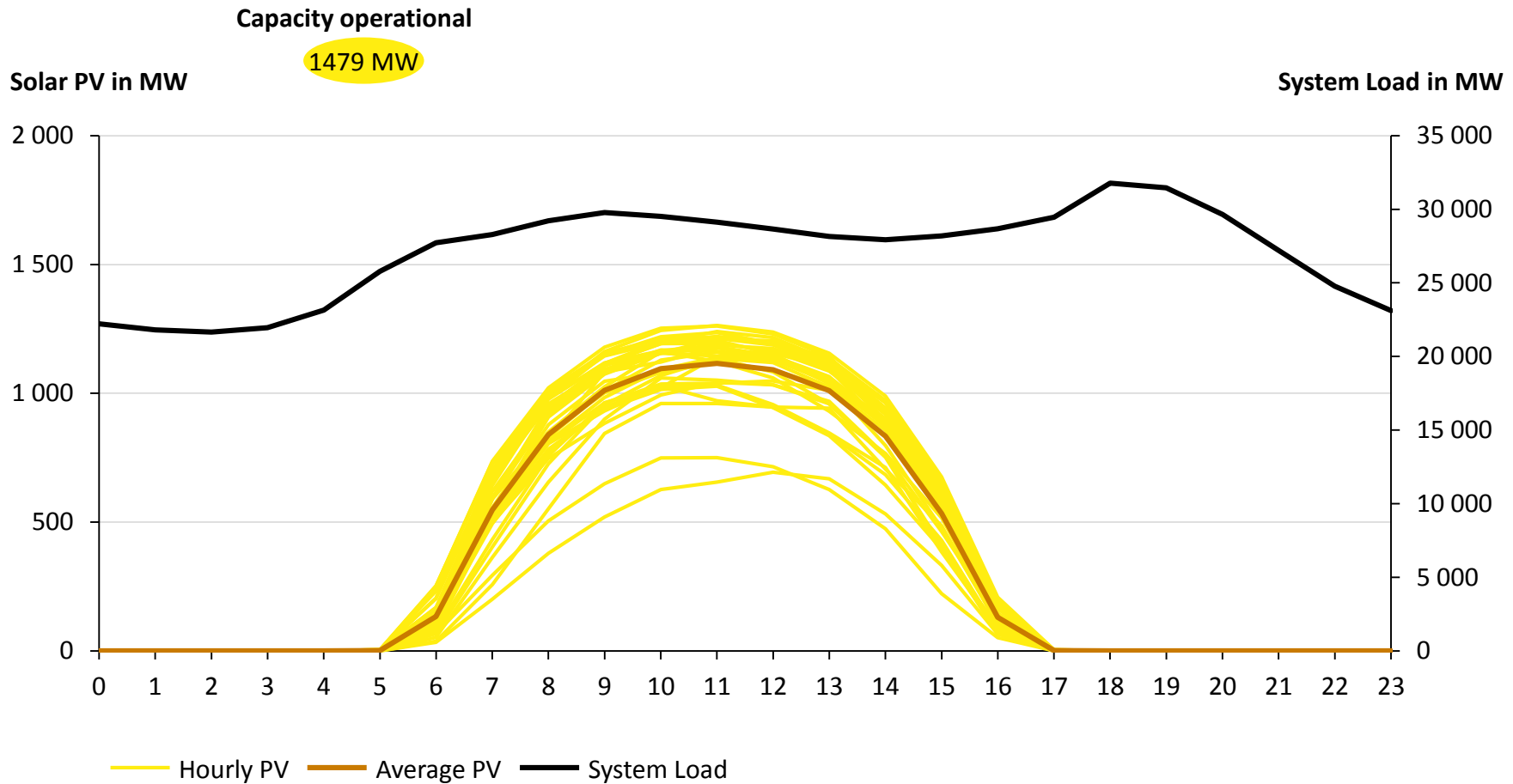
Hourly solar PV production for all 31 days of July 2018 and average system load diurnal course



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

Solar PV supply in Aug 2018 very stable

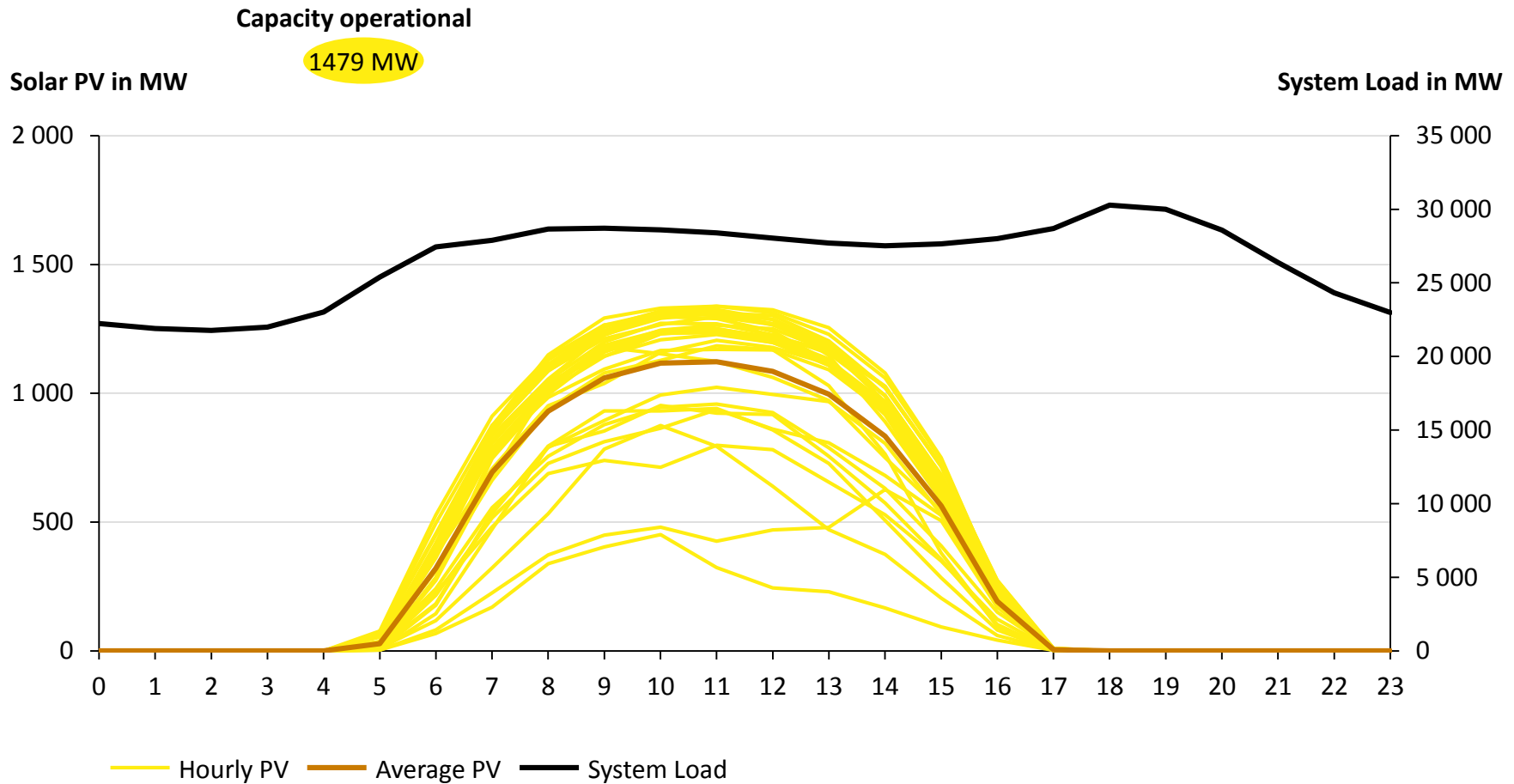
Hourly solar PV production for all 31 days of August 2018 and average system load diurnal course



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

Solar PV supply in Sep 2018 very stable

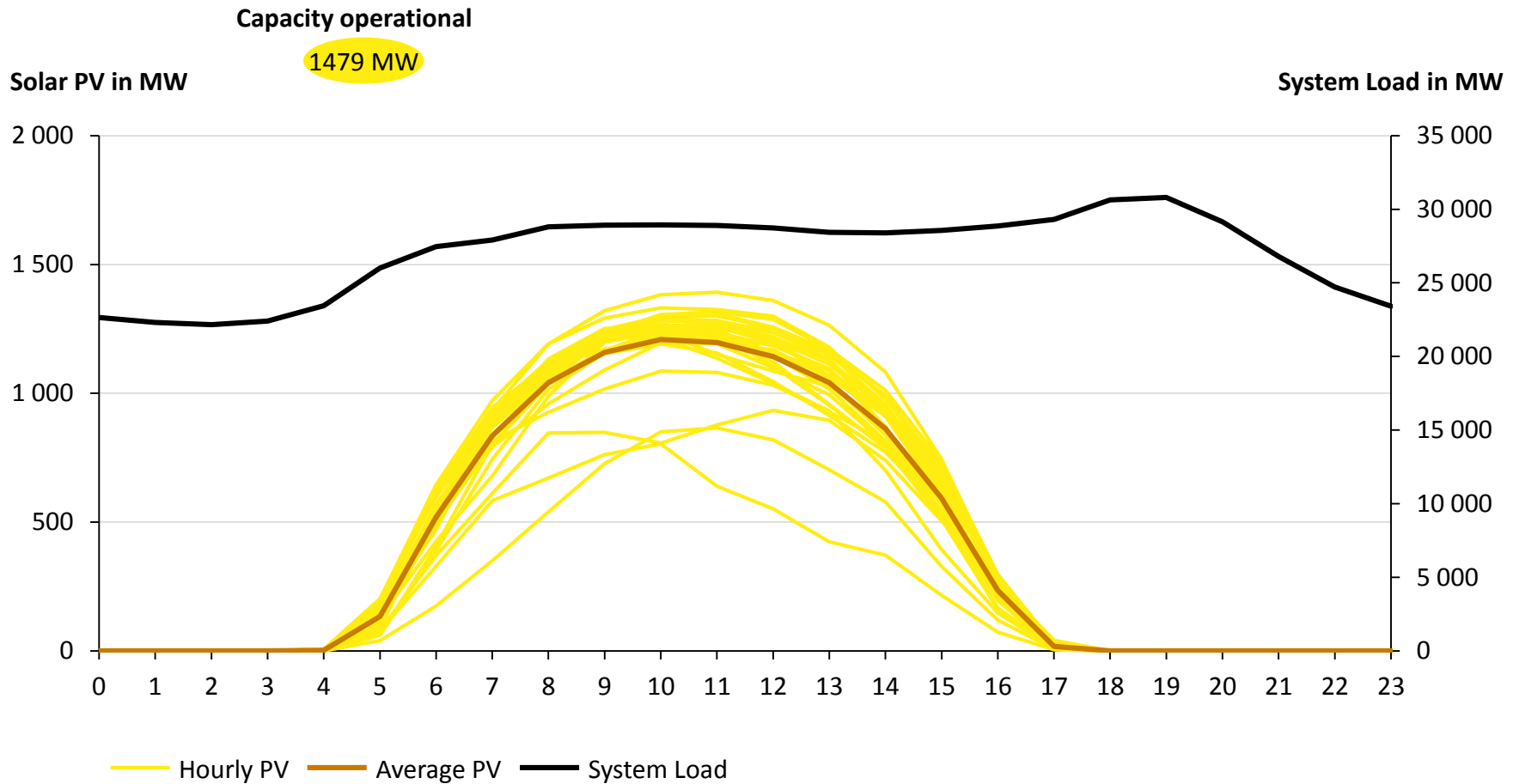
Hourly solar PV production for all 30 days of September 2018 and average system load diurnal course



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

Solar PV supply in Oct 2018 very stable

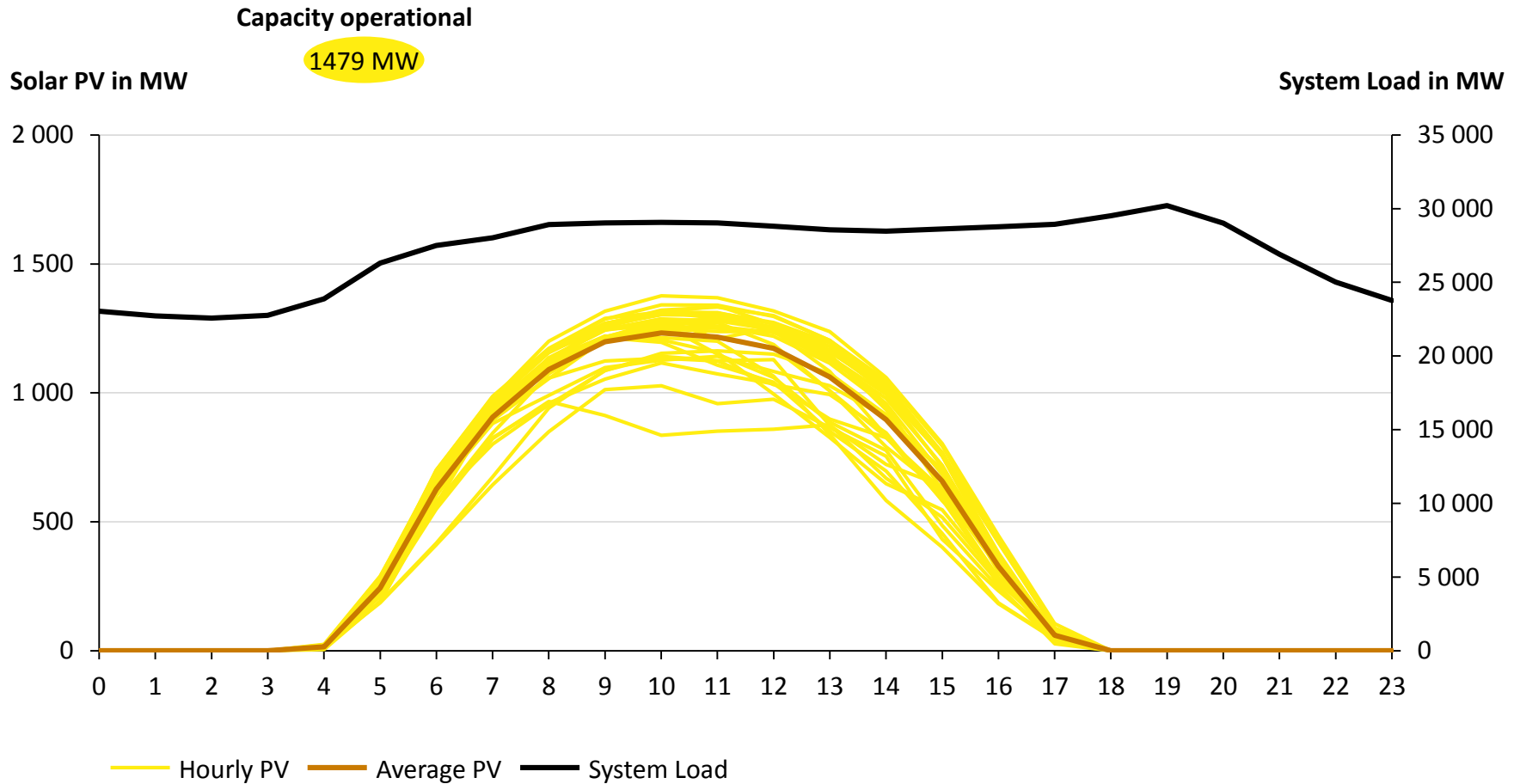
Hourly solar PV production for all 31 days of October 2018 and average system load diurnal course



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

Solar PV supply in Nov 2018 very stable

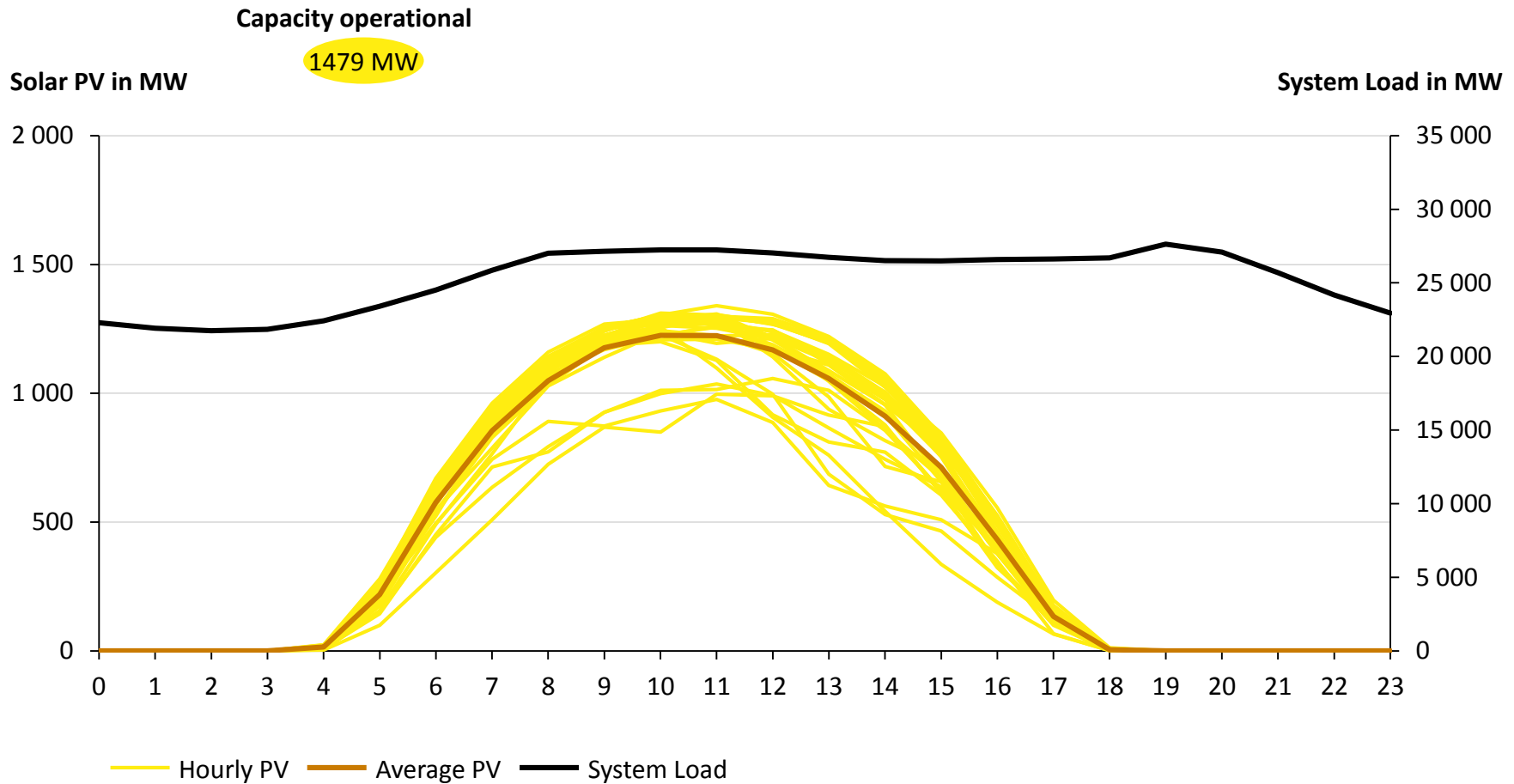
Hourly solar PV production for all 30 days of November 2018 and average system load diurnal course



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

Solar PV supply in Dec 2018 very stable

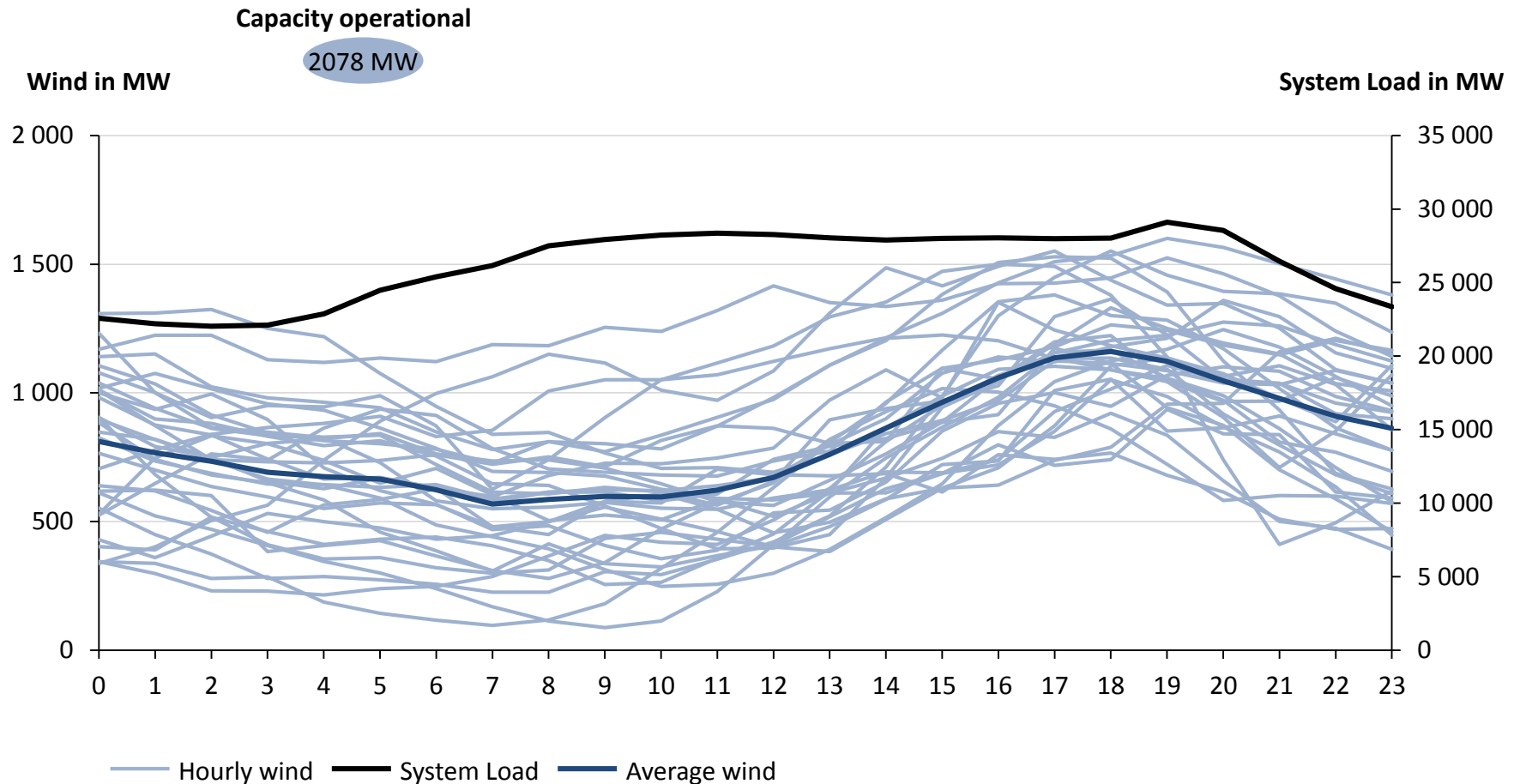
Hourly solar PV production for all 31 days of December 2018 and average system load diurnal course



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

In Jan 2018, wind supplied in the evenings

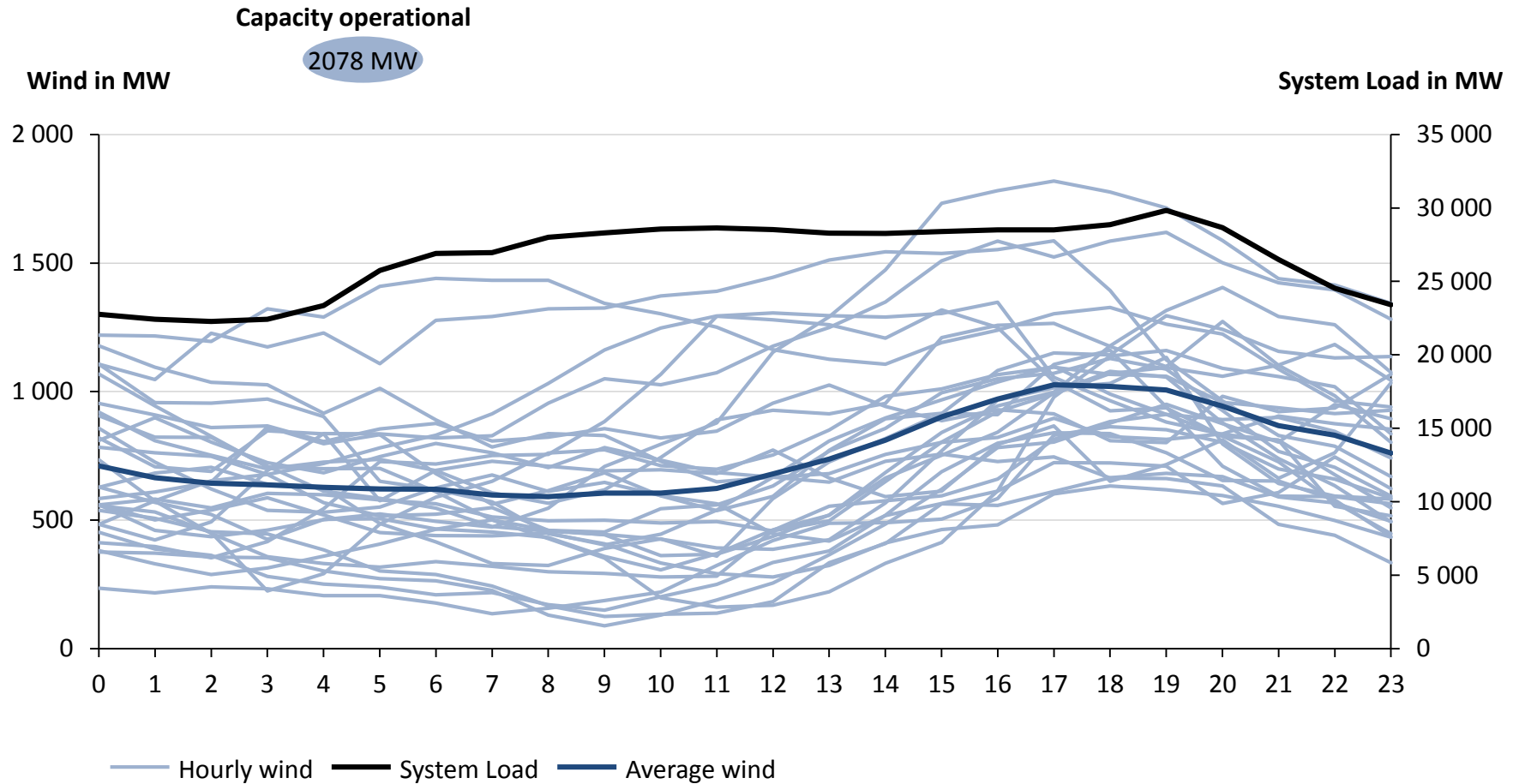
Hourly wind production for all 31 days of January 2018 and average system load diurnal course



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

In Feb 2018, wind supplied in the evenings

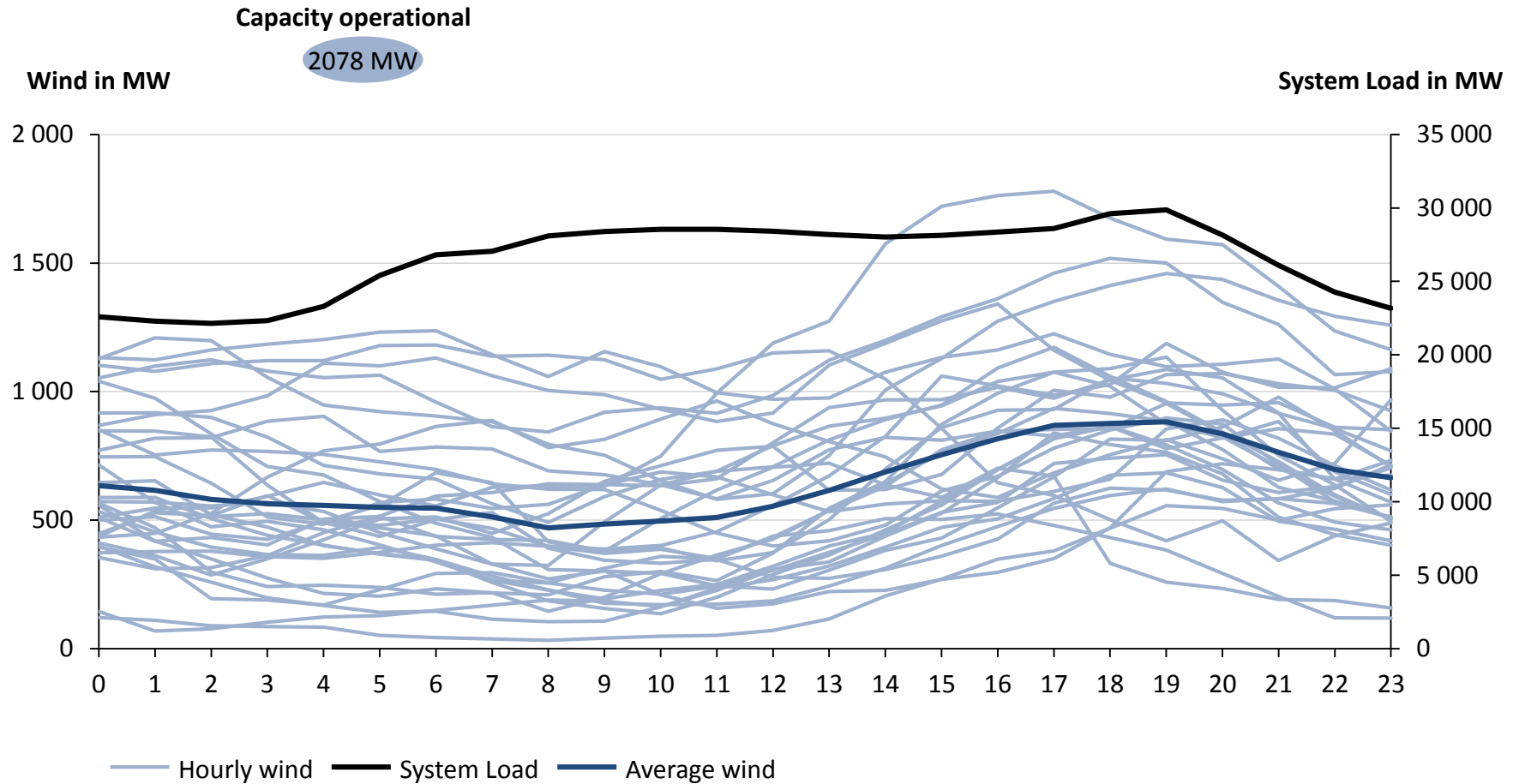
Hourly wind production for all 28 days of February 2018 and average system load diurnal course



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

In Mar 2018, wind supplied in the evenings

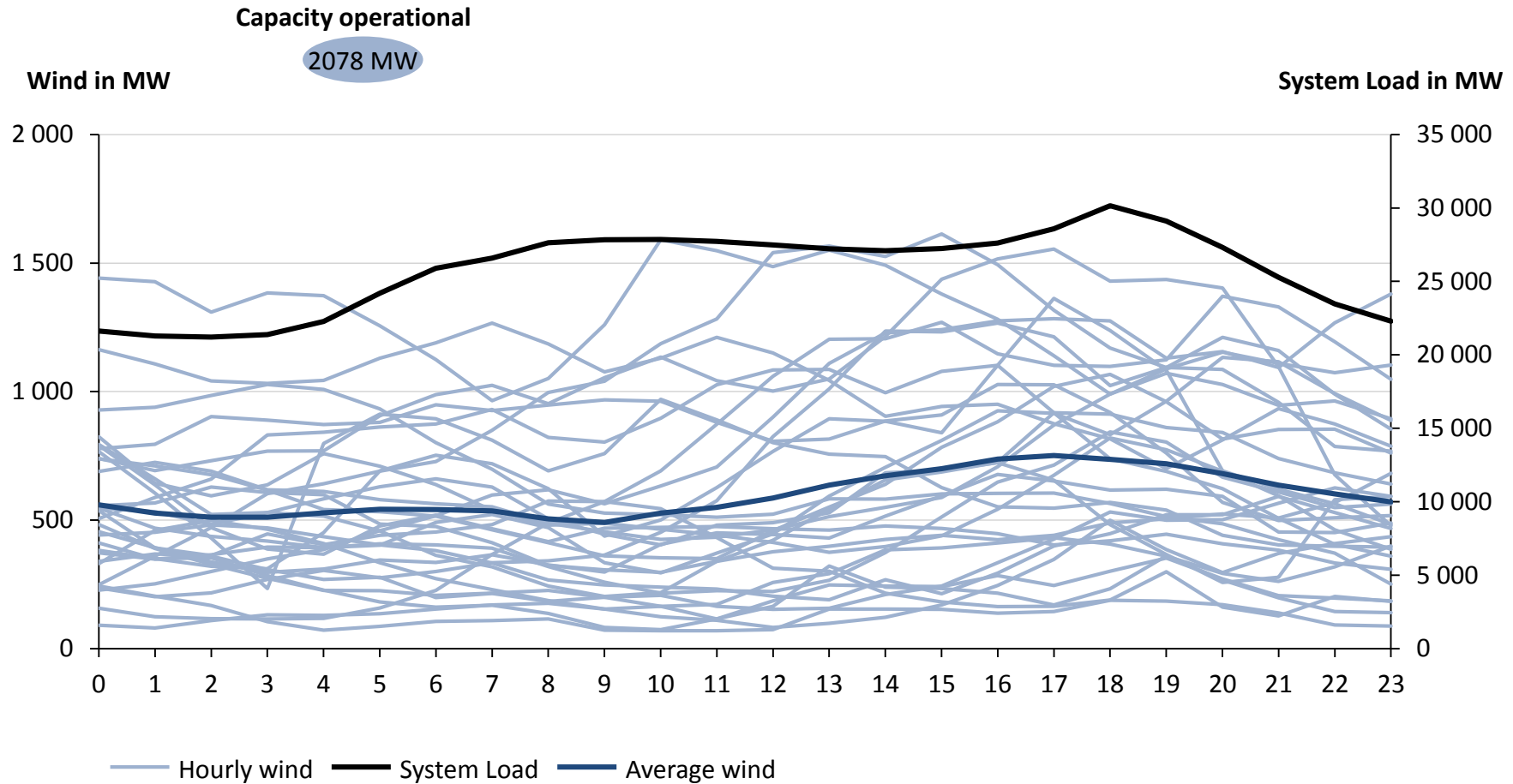
Hourly wind production for all 31 days of March 2018 and average system load diurnal course



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

In Apr 2018, wind supplies in the evenings

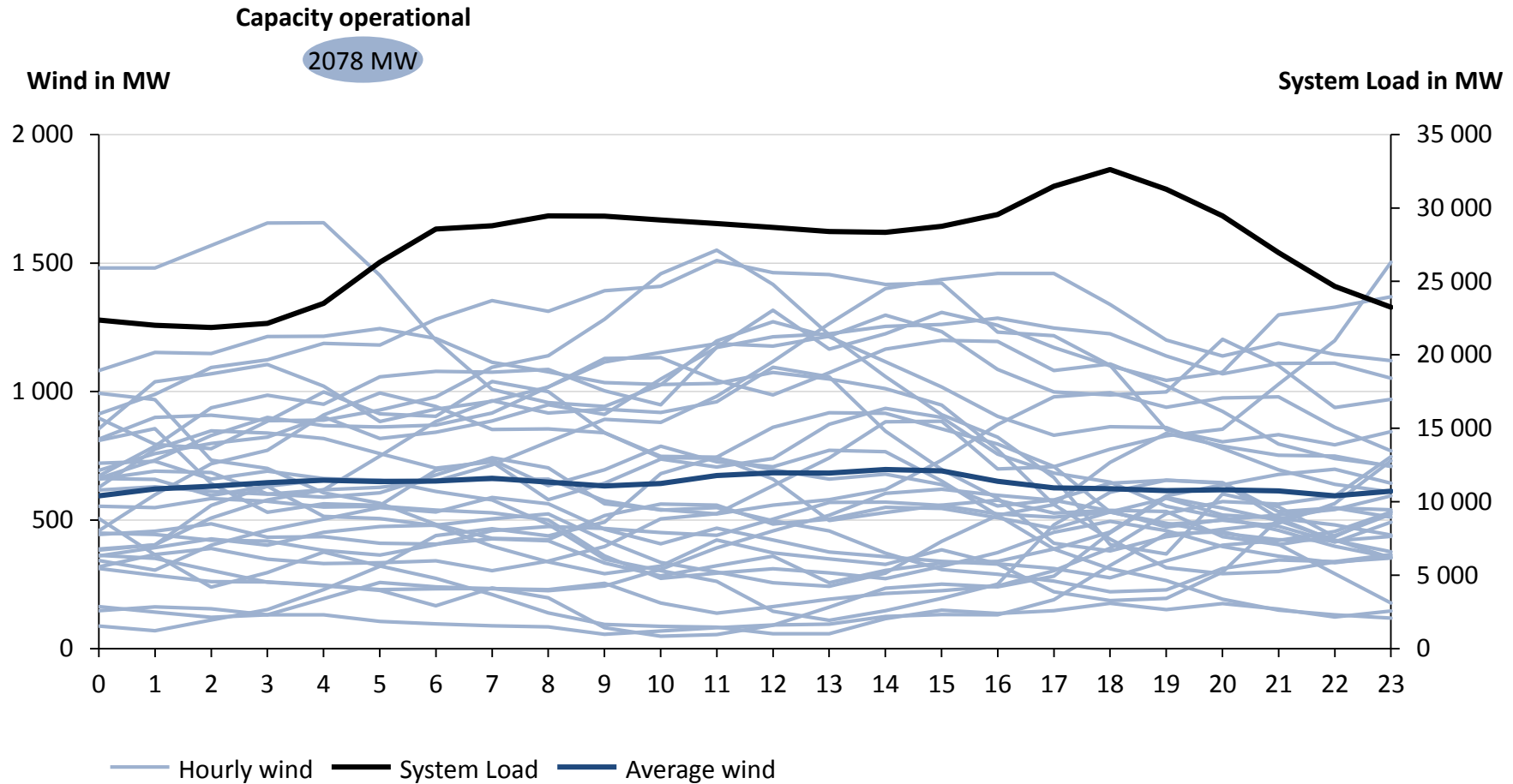
Hourly wind production for all 30 days of April 2018 and average system load diurnal course



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

In May 2018, wind fluctuated day-to-day

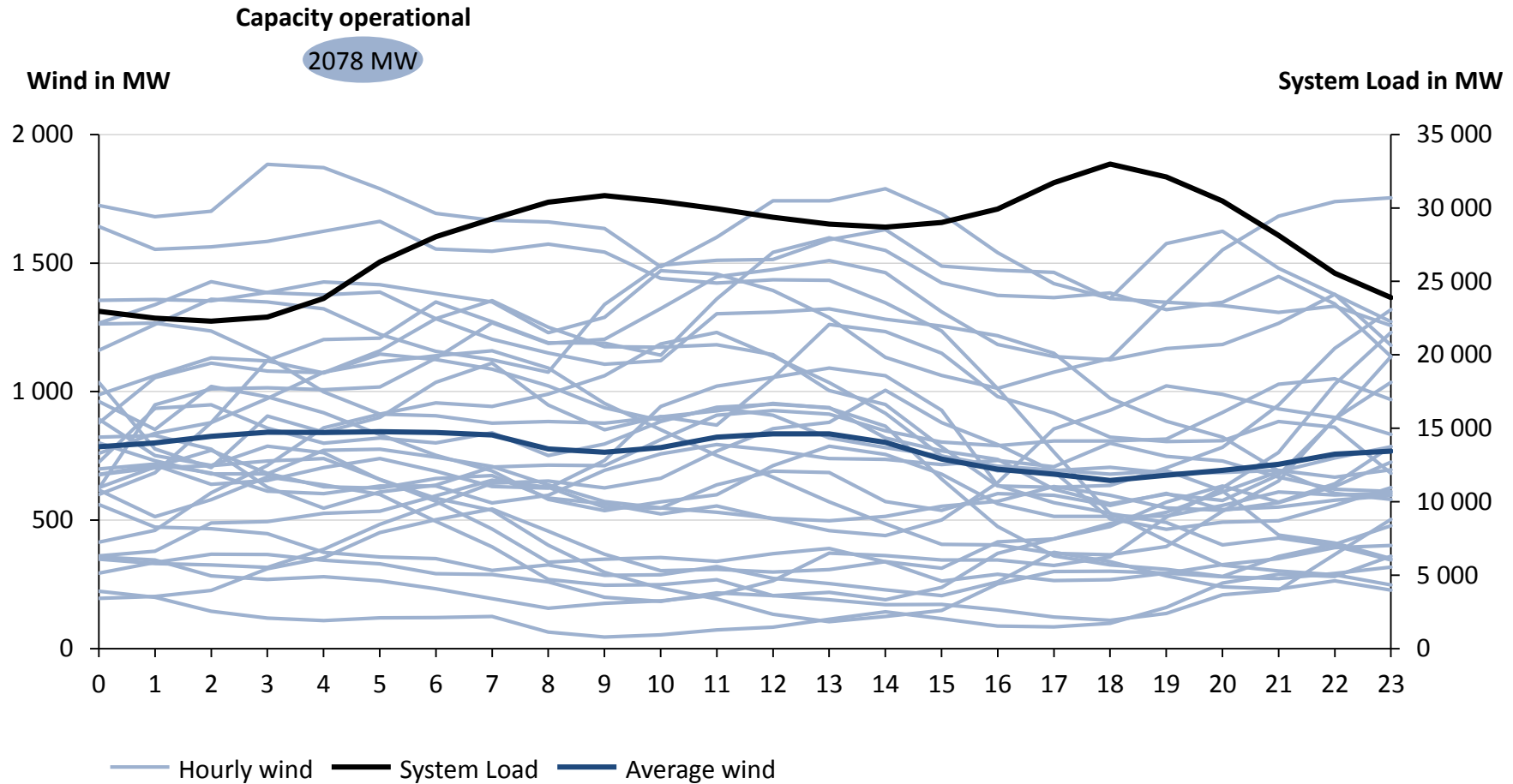
Hourly wind production for all 31 days of May 2018 and average system load diurnal course



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

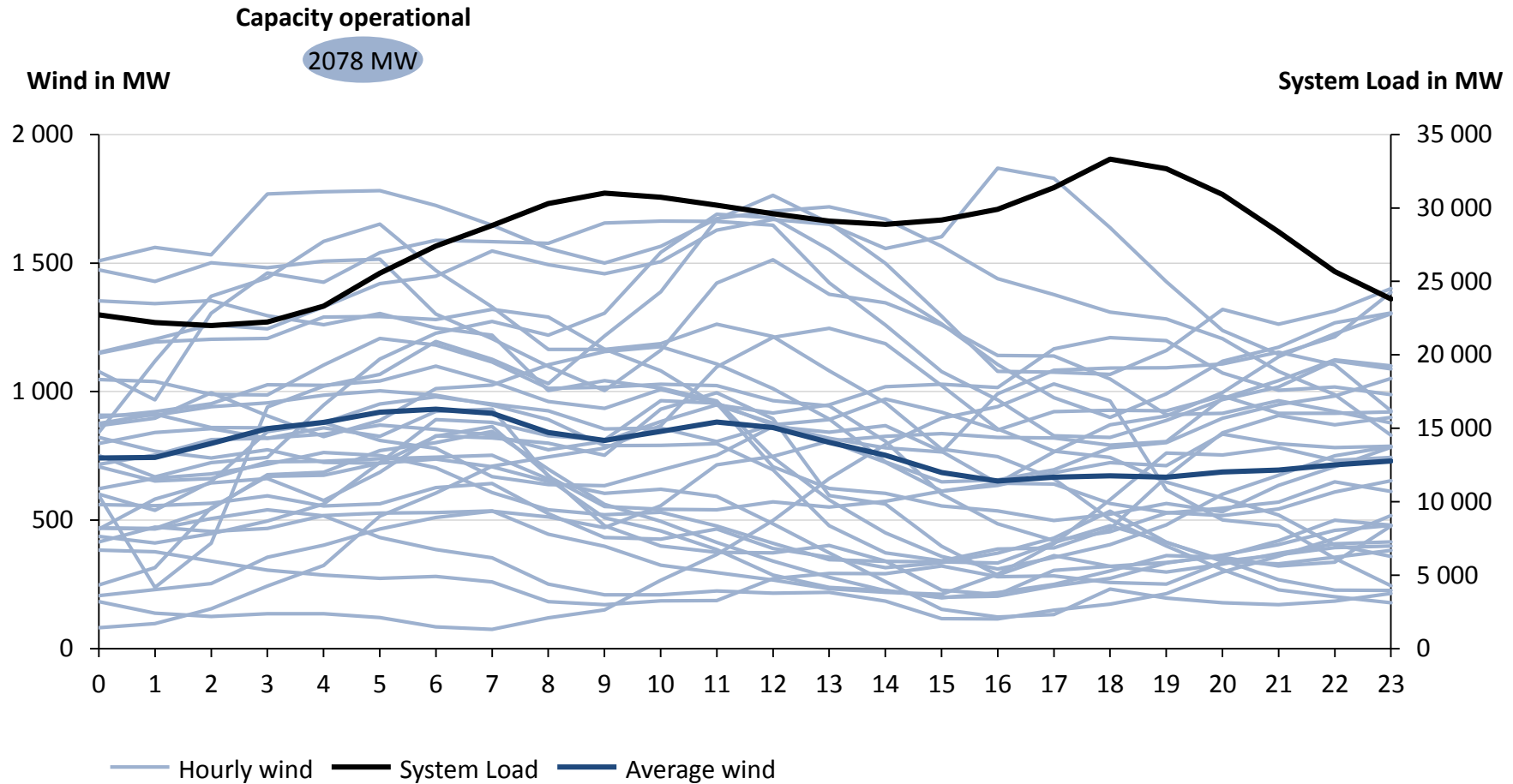
In Jun 2018, wind fluctuated day-to-day

Hourly wind production for all 30 days of June 2018 and average system load diurnal course



In Jul 2018, wind fluctuated day-to-day

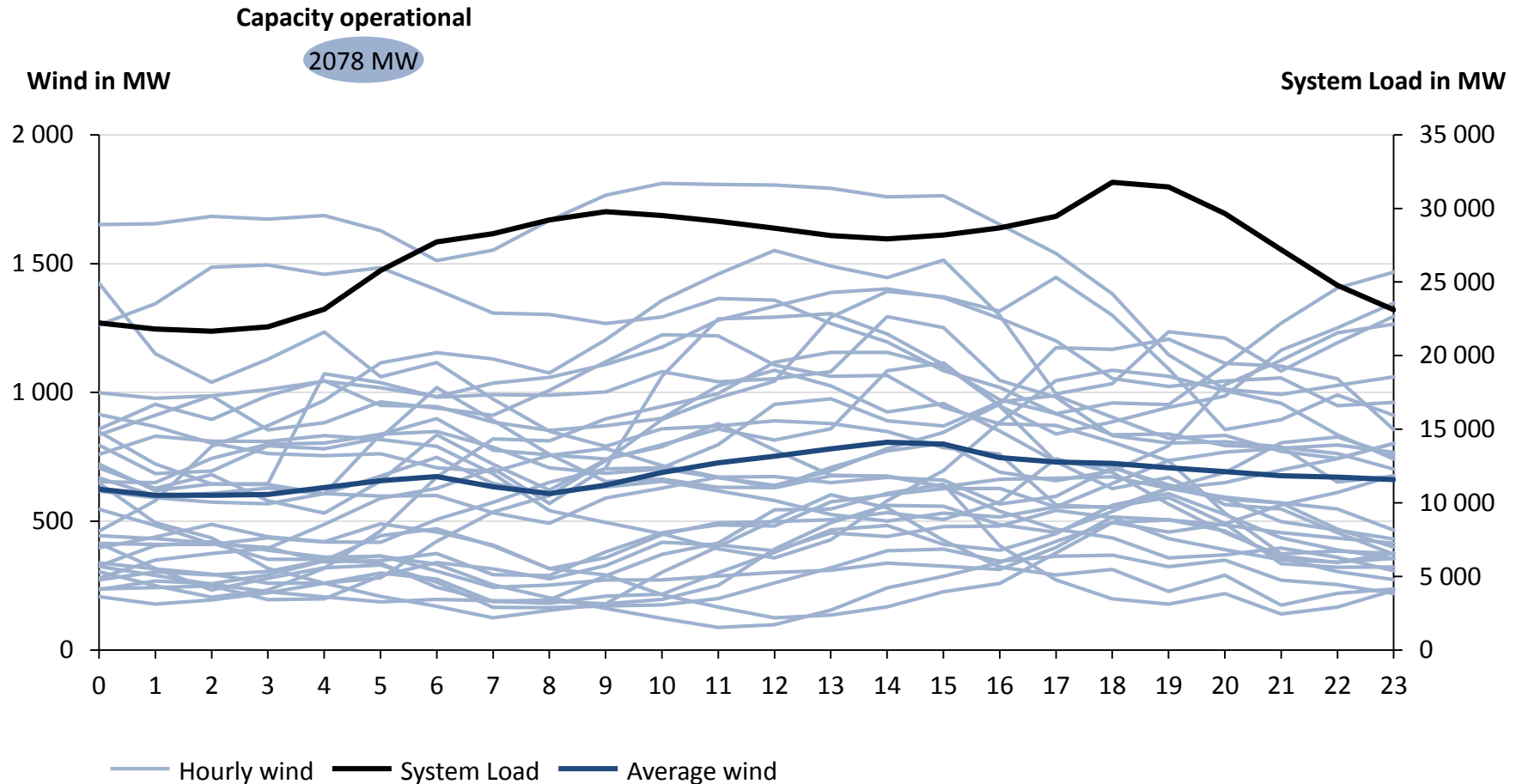
Hourly wind production for all 31 days of July 2018 and average system load diurnal course



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

In Aug 2018, wind fluctuated day-to-day

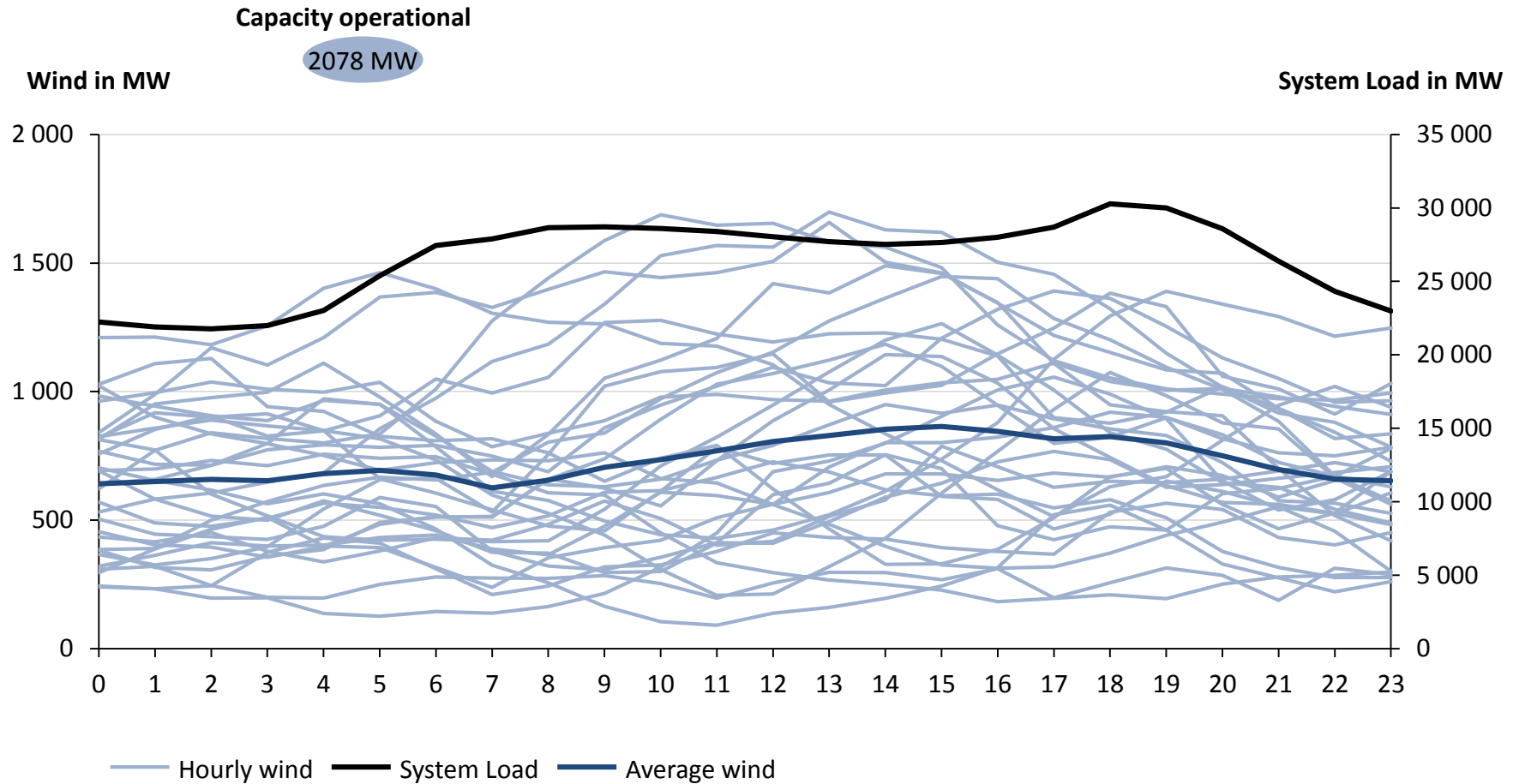
Hourly wind production for all 31 days of August 2018 and average system load diurnal course



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

In Sep 2018, wind fluctuated day-to-day

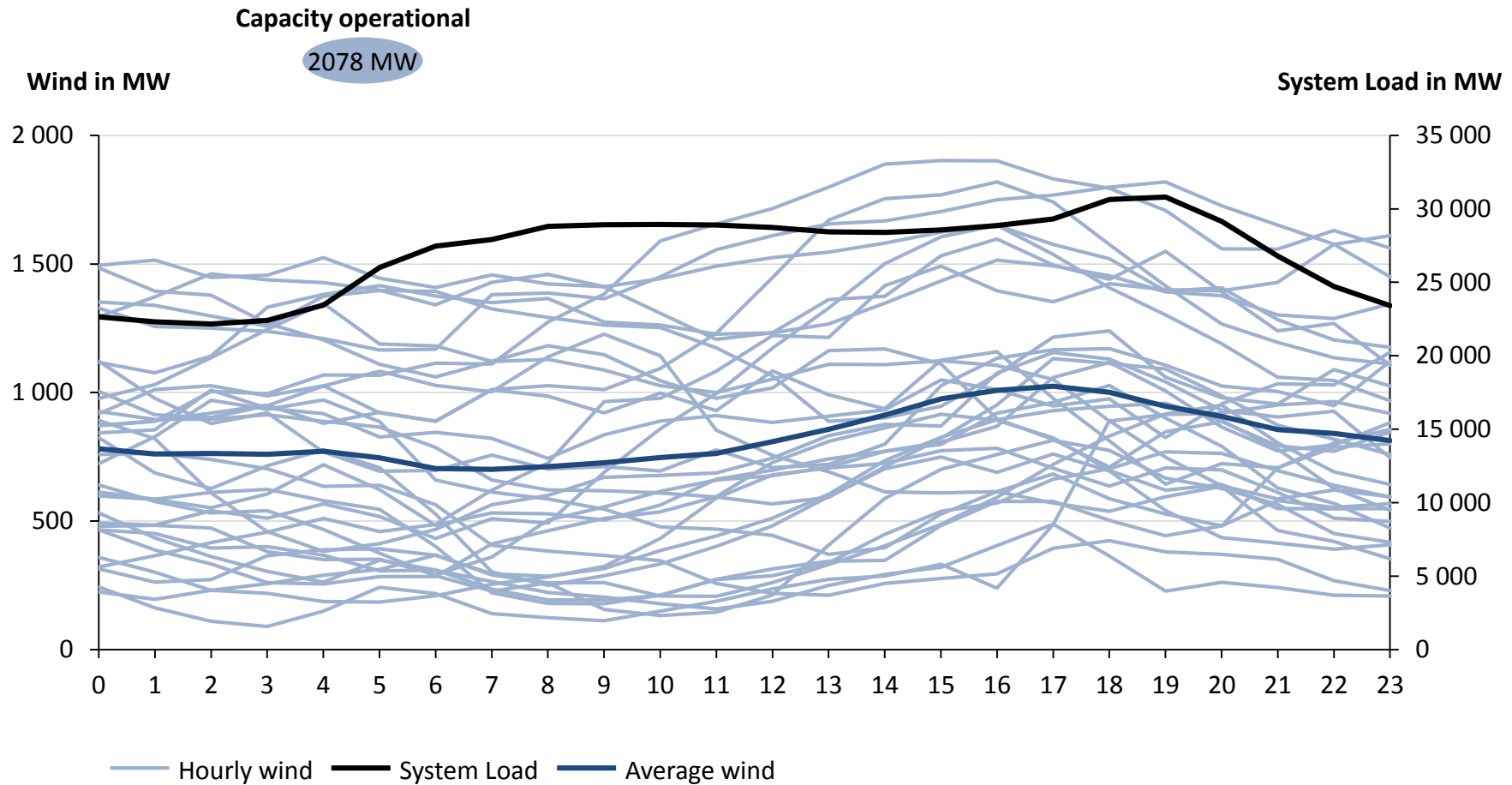
Hourly wind production for all 30 days of September 2018 and average system load diurnal course



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

In Oct 2018, wind supplied in the evenings

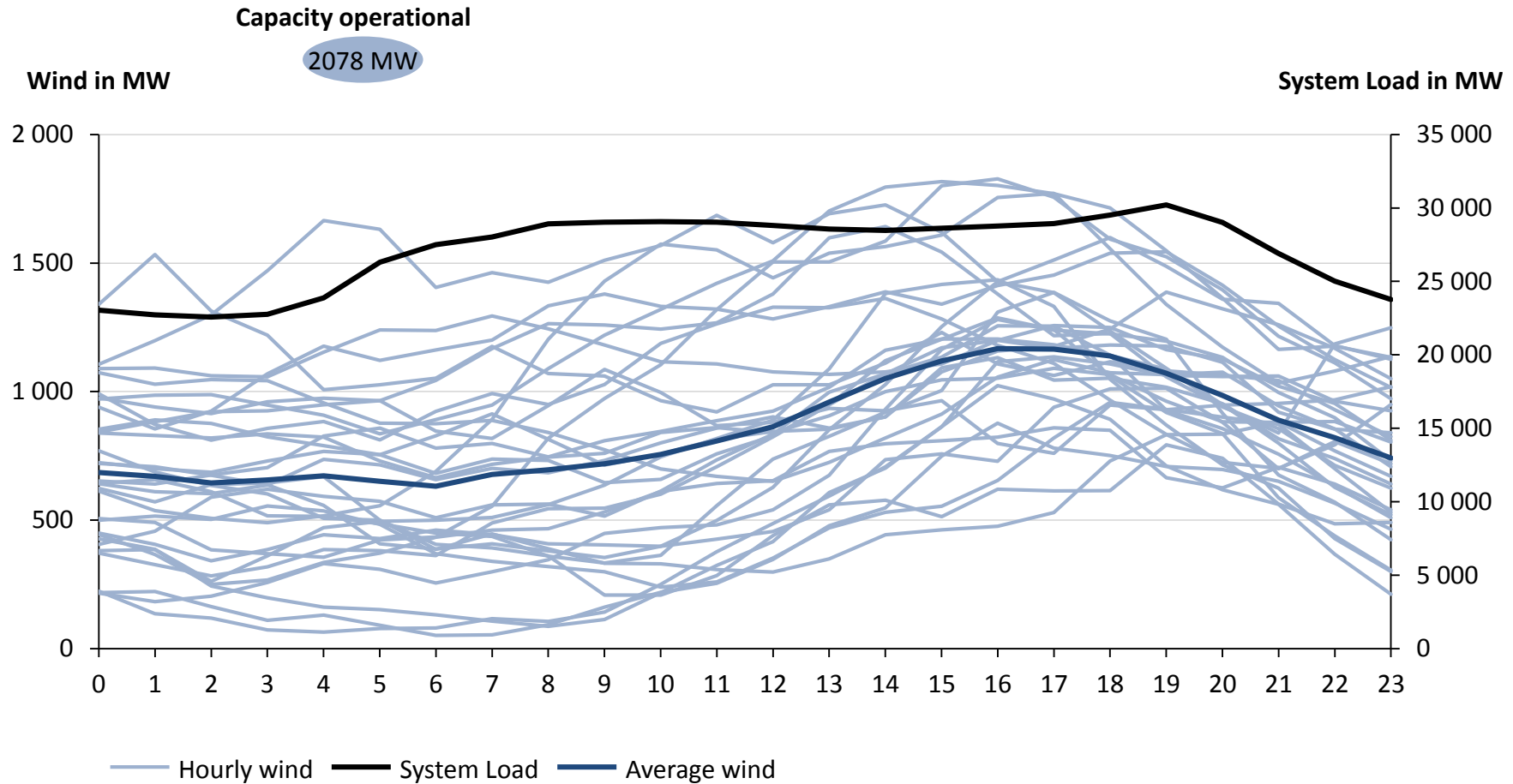
Hourly wind production for all 31 days of October 2018 and average system load diurnal course



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

In Nov 2018, wind supplied in the evenings

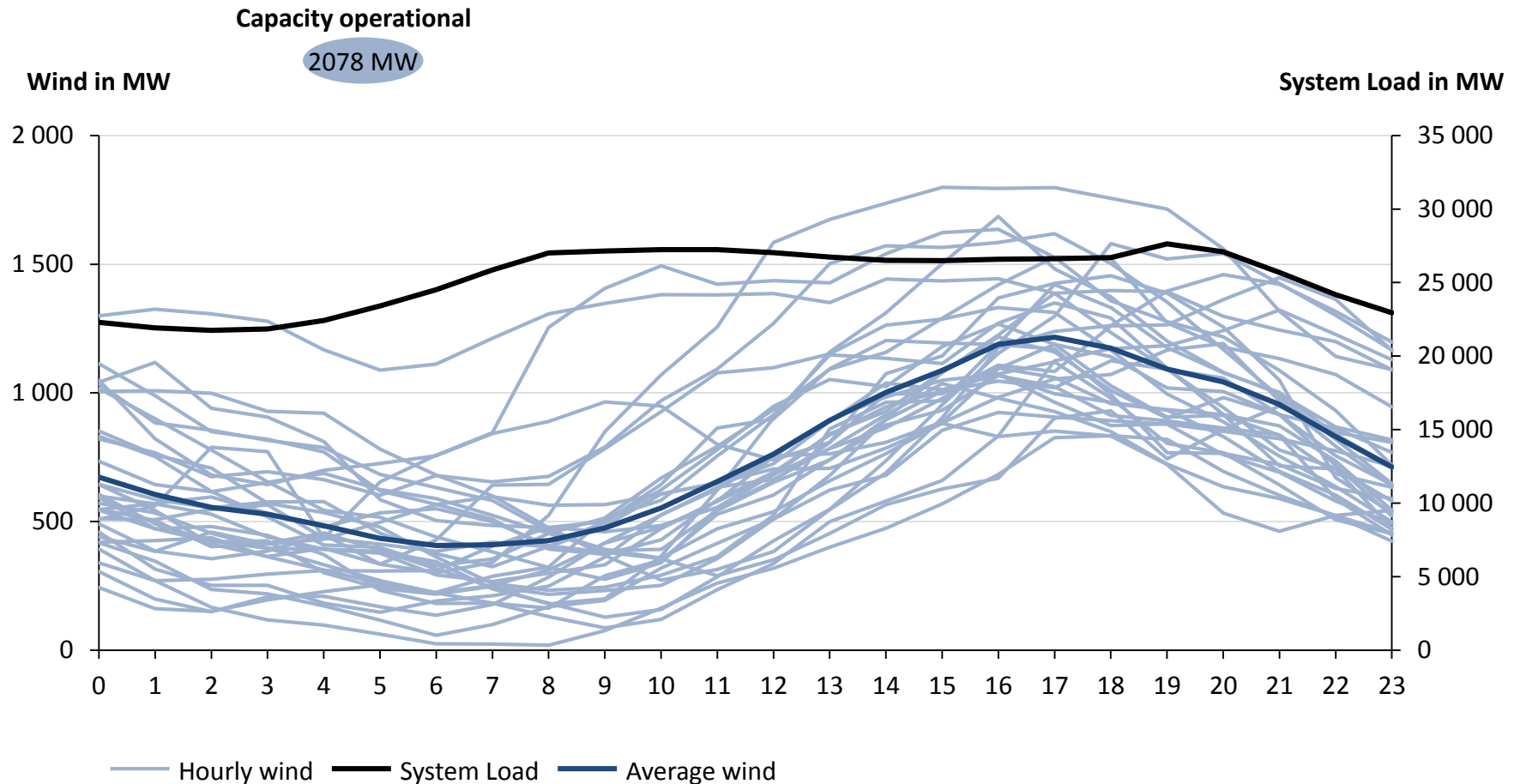
Hourly wind production for all 30 days of November 2018 and average system load diurnal course



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

In Dec 2018, wind supplied in the evenings

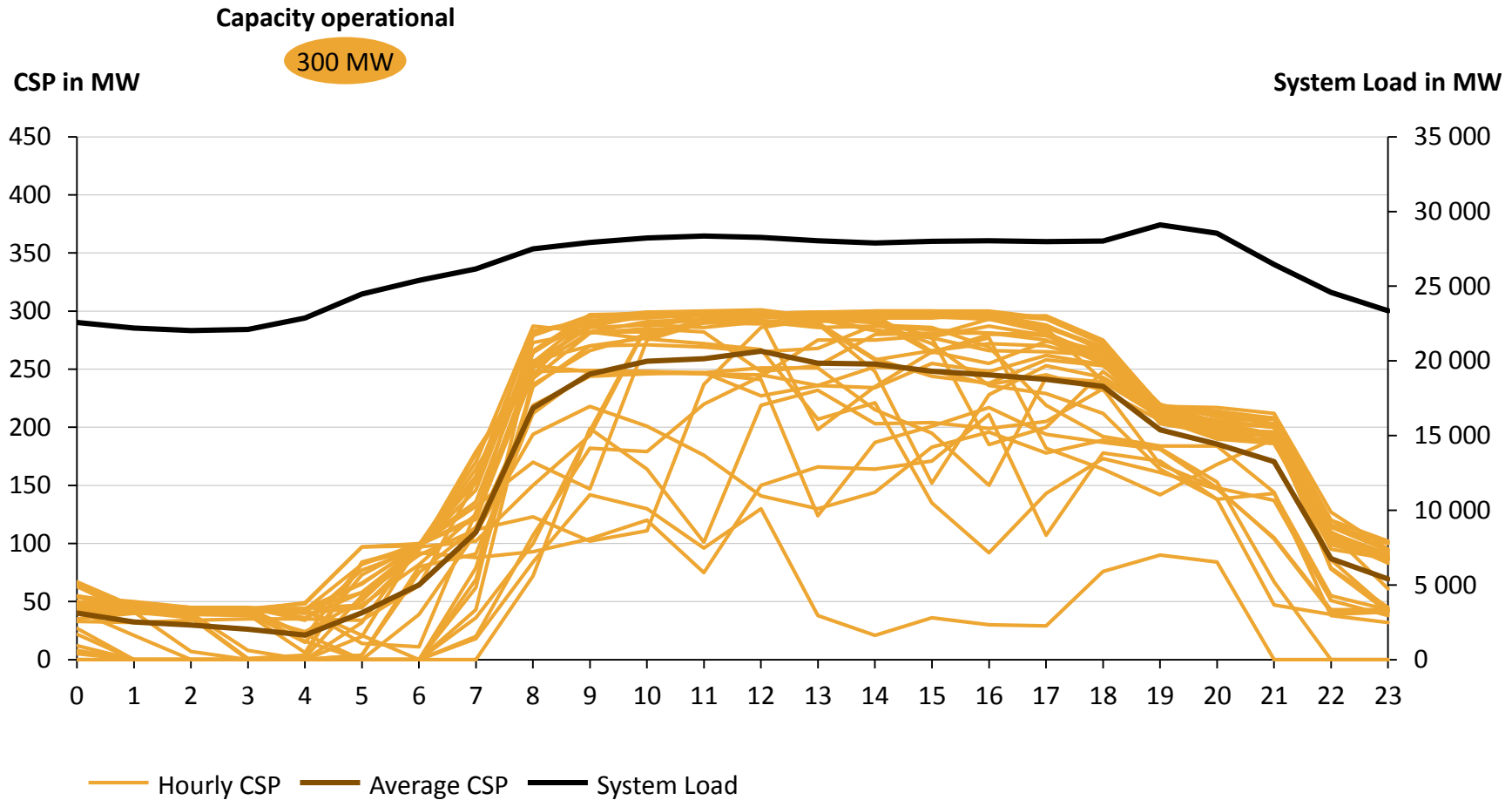
Hourly wind production for all 31 days of December 2018 and average system load diurnal course



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

In Jan 2018, CSP storage used in evenings

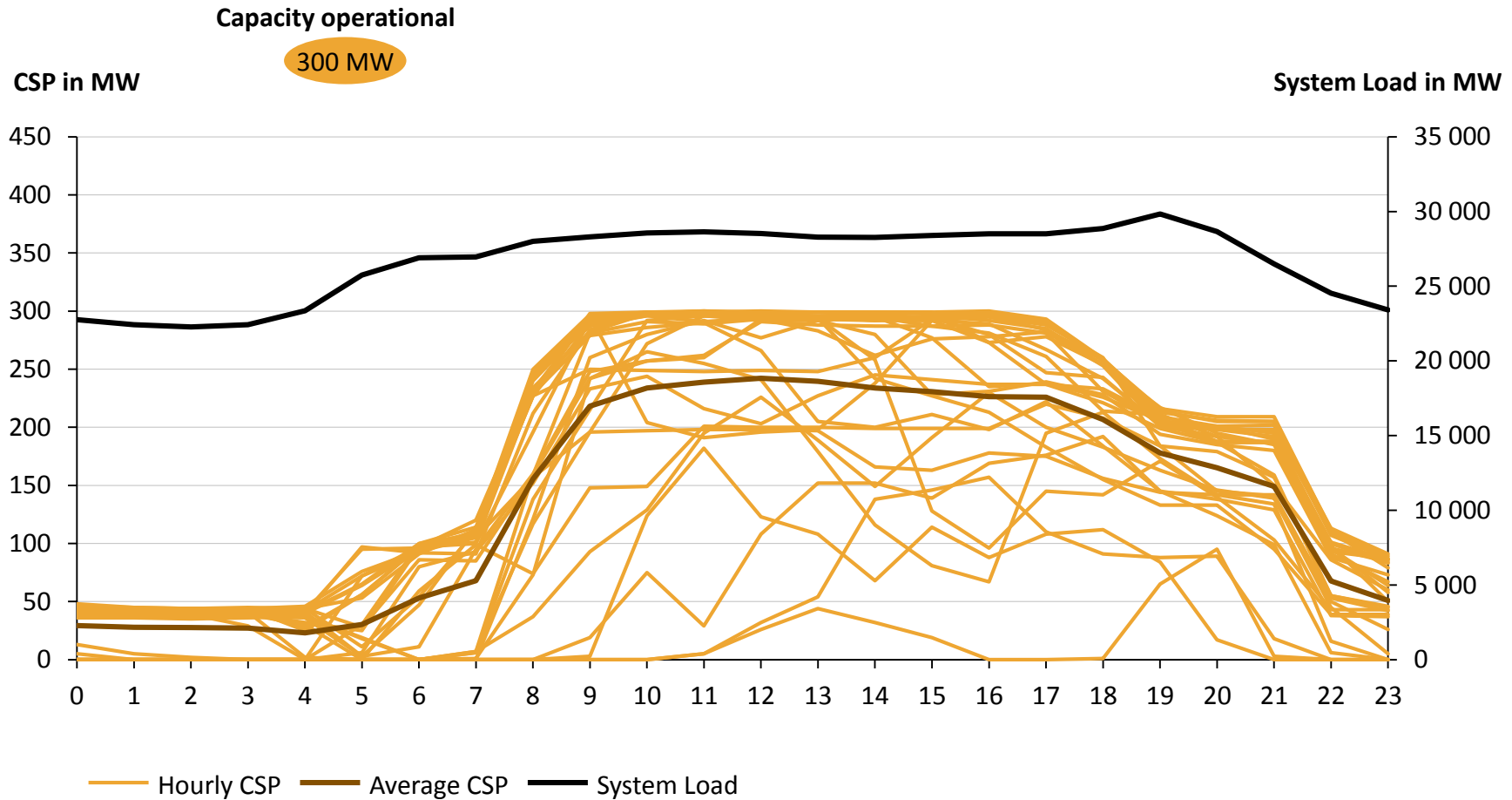
Hourly CSP production for all 31 days of January 2018 and average system load diurnal course



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

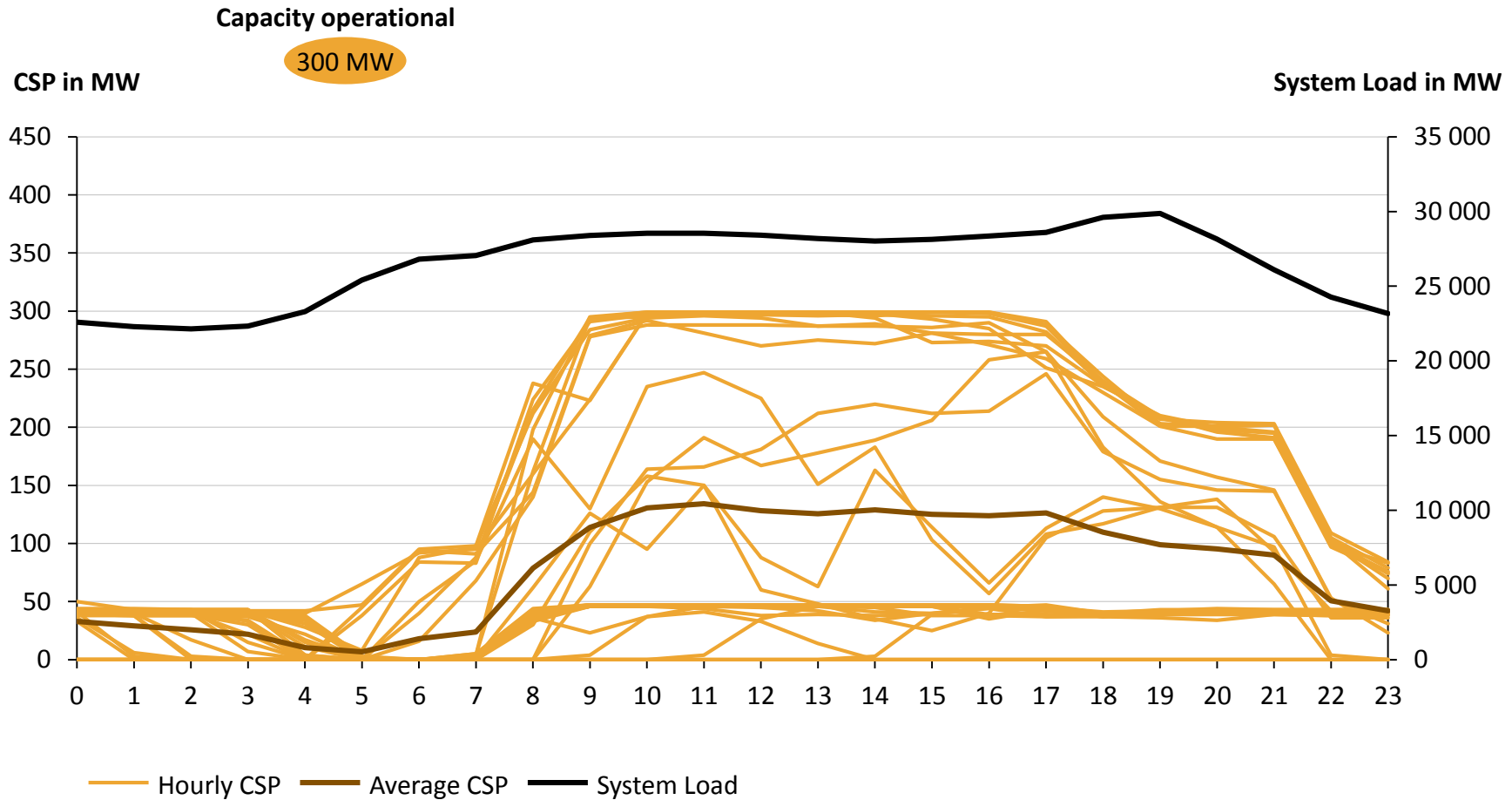
In Feb 2018, CSP storage used in evenings

Hourly CSP production for all 28 days of February 2018 and average system load diurnal course



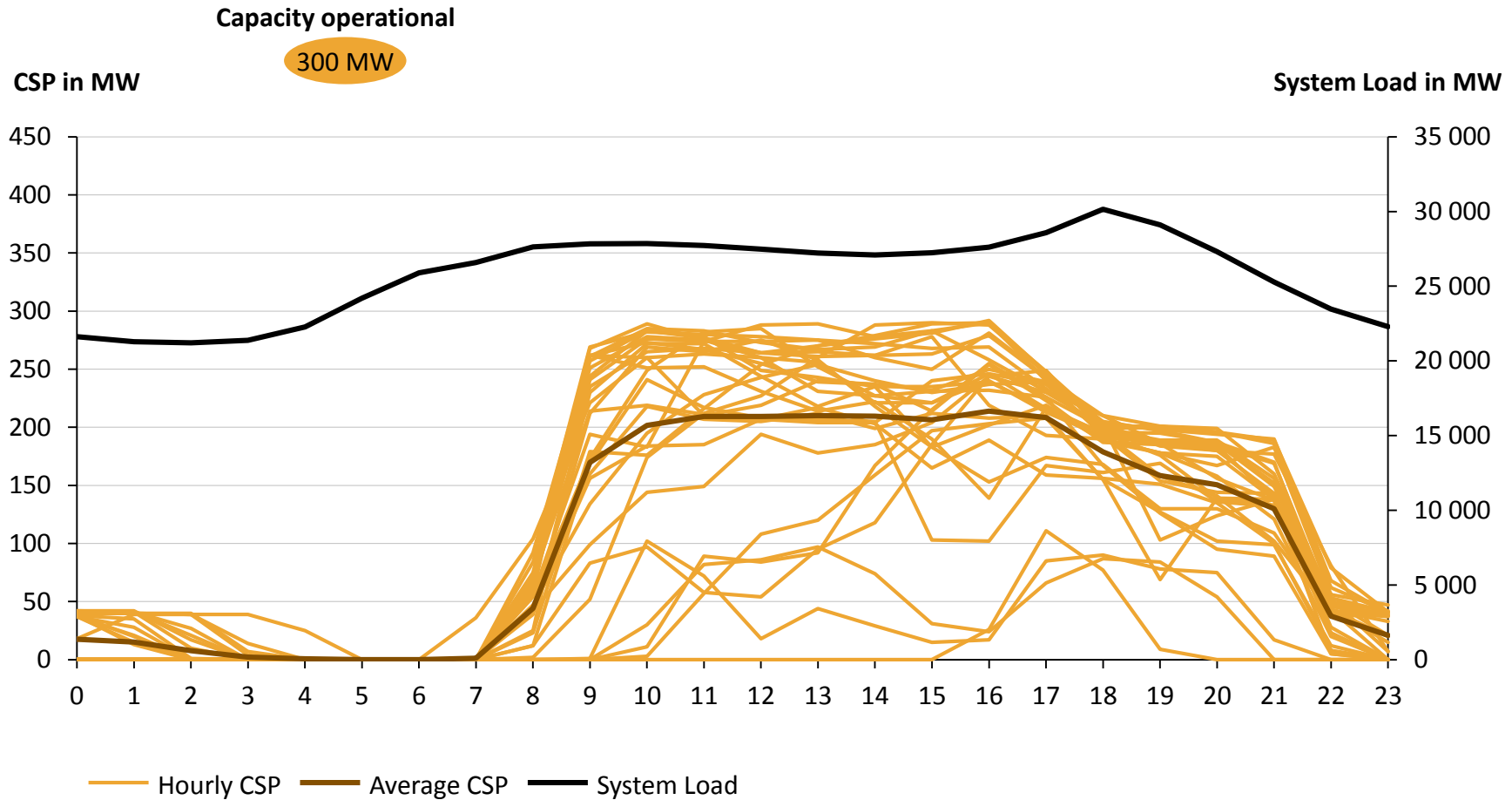
In Mar 2018, CSP storage used in evenings

Hourly CSP production for all 31 days of March 2018 and average system load diurnal course



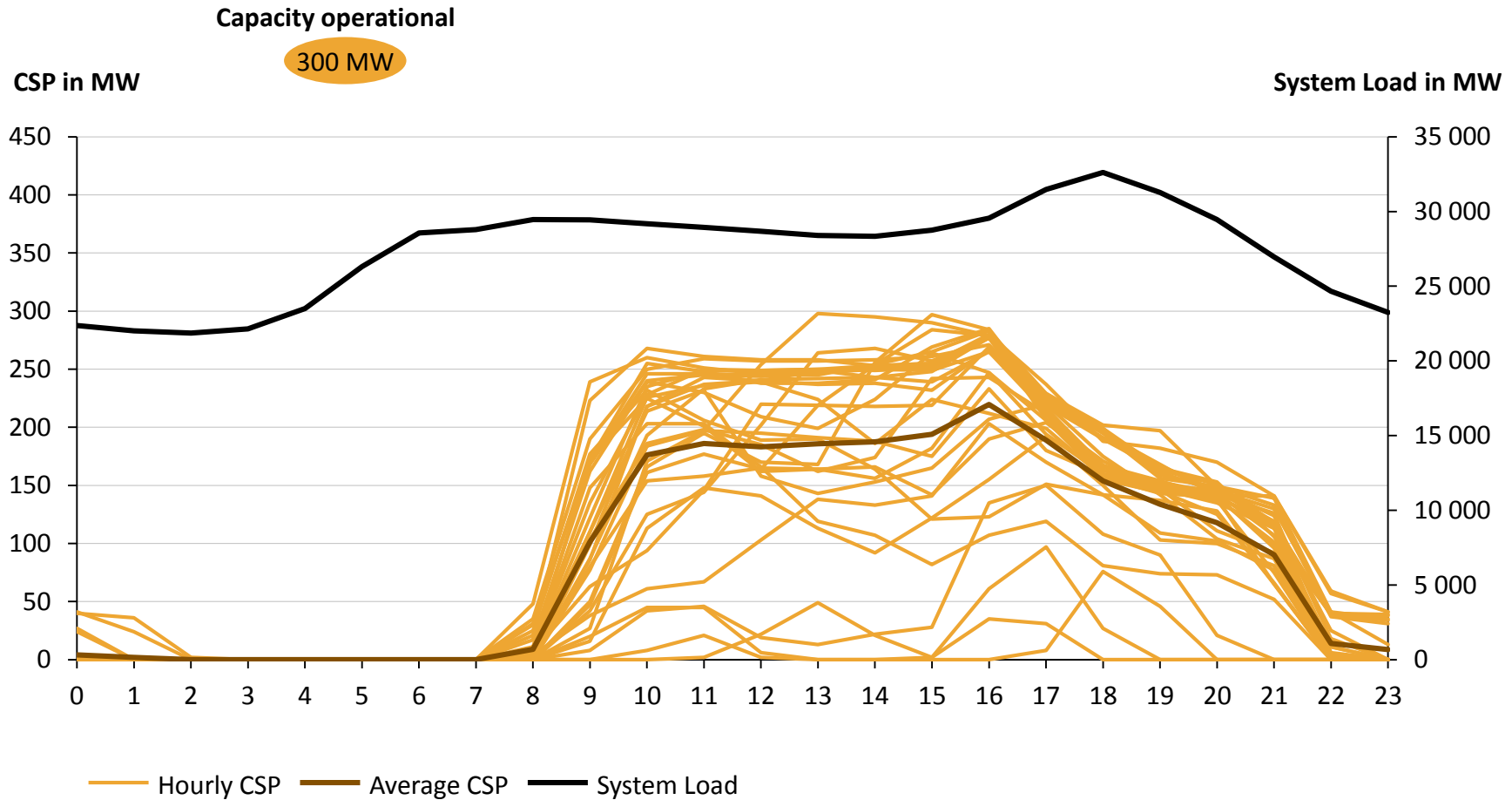
In Apr 2018, CSP storage used in evenings

Hourly CSP production for all 30 days of April 2018 and average system load diurnal course



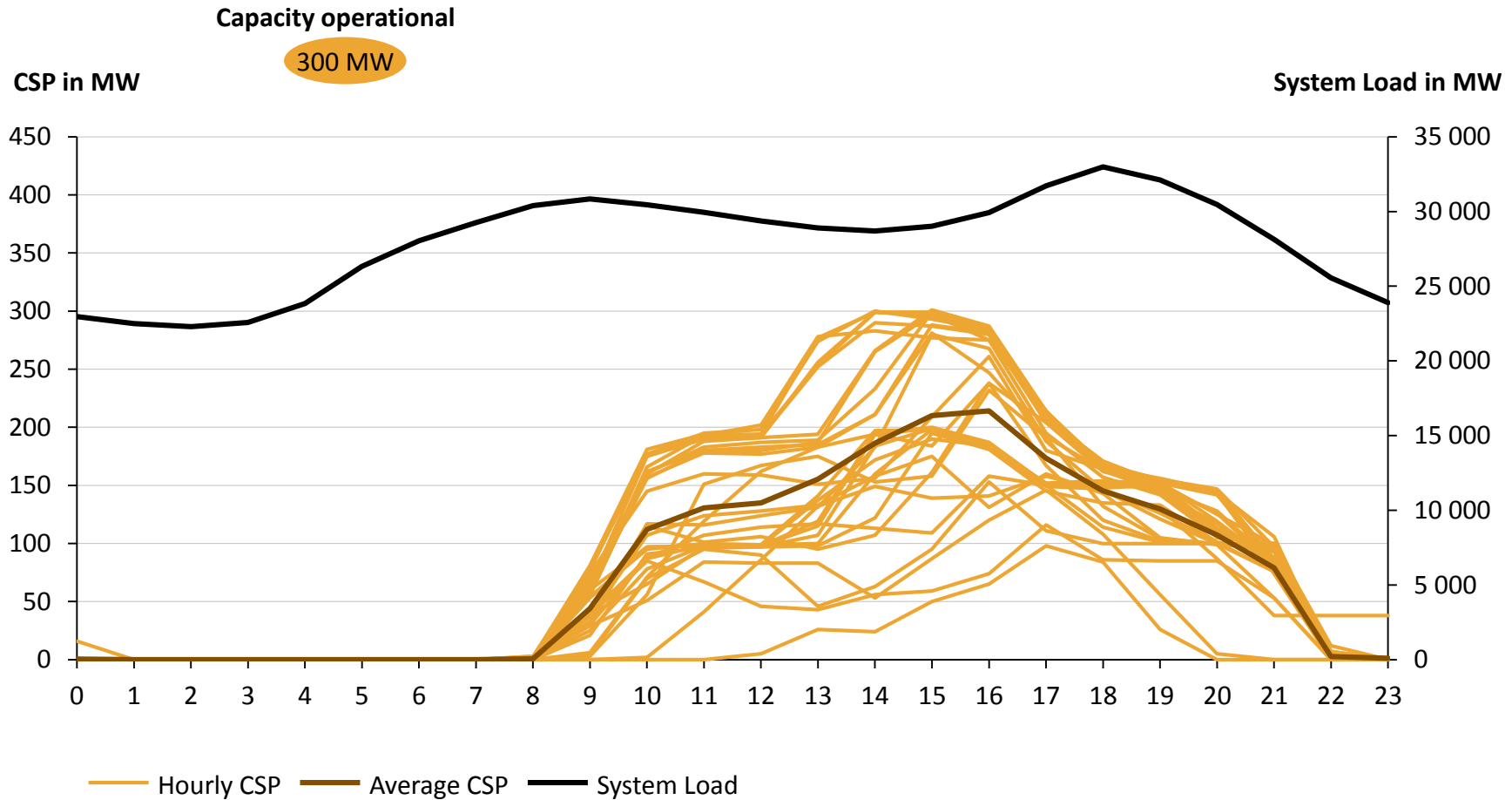
In May 2018, CSP storage used in evenings

Hourly CSP production for all 31 days of May 2018 and average system load diurnal course



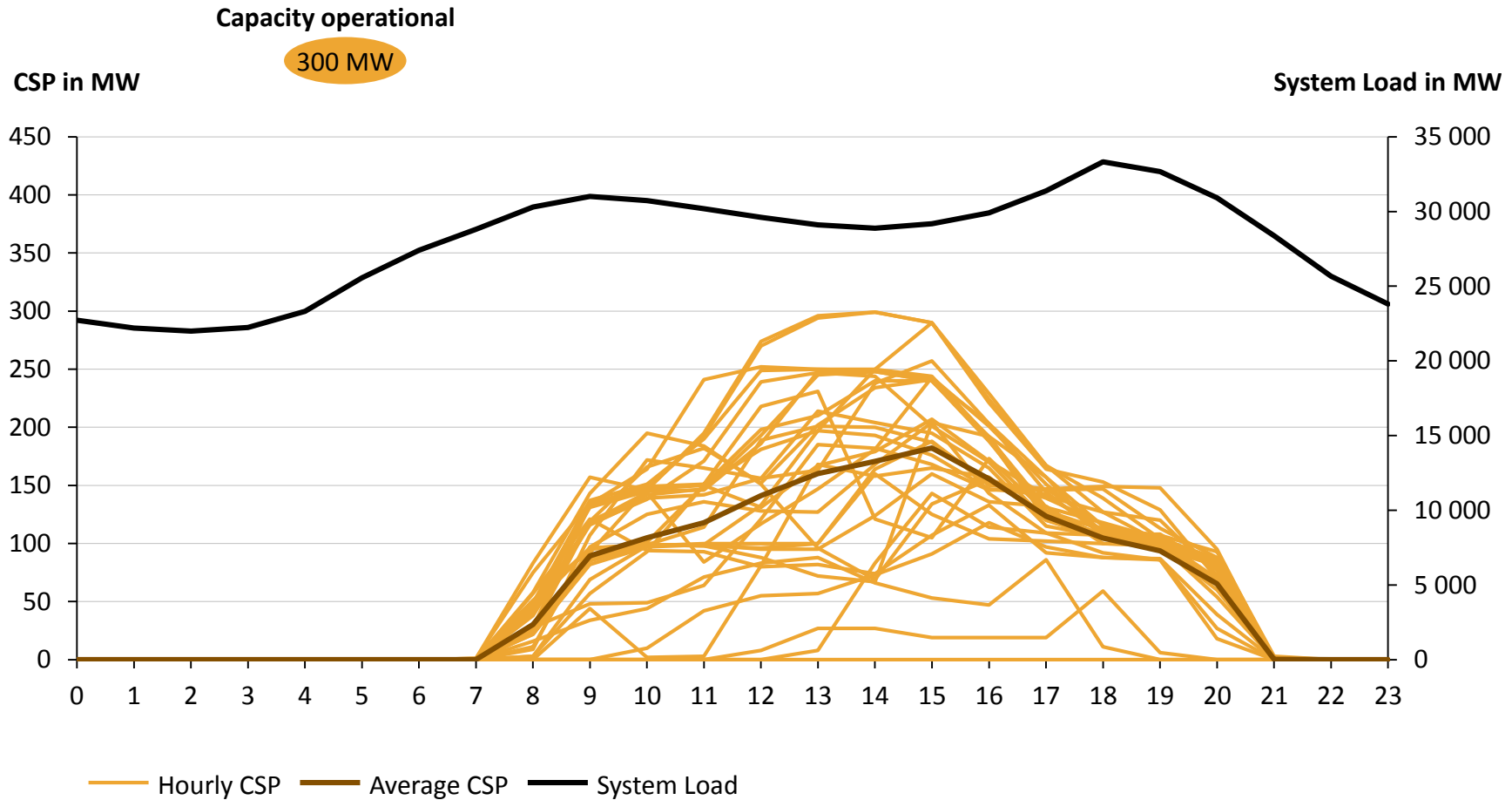
In Jun 2018, CSP storage used in evenings

Hourly CSP production for all 30 days of June 2018 and average system load diurnal course



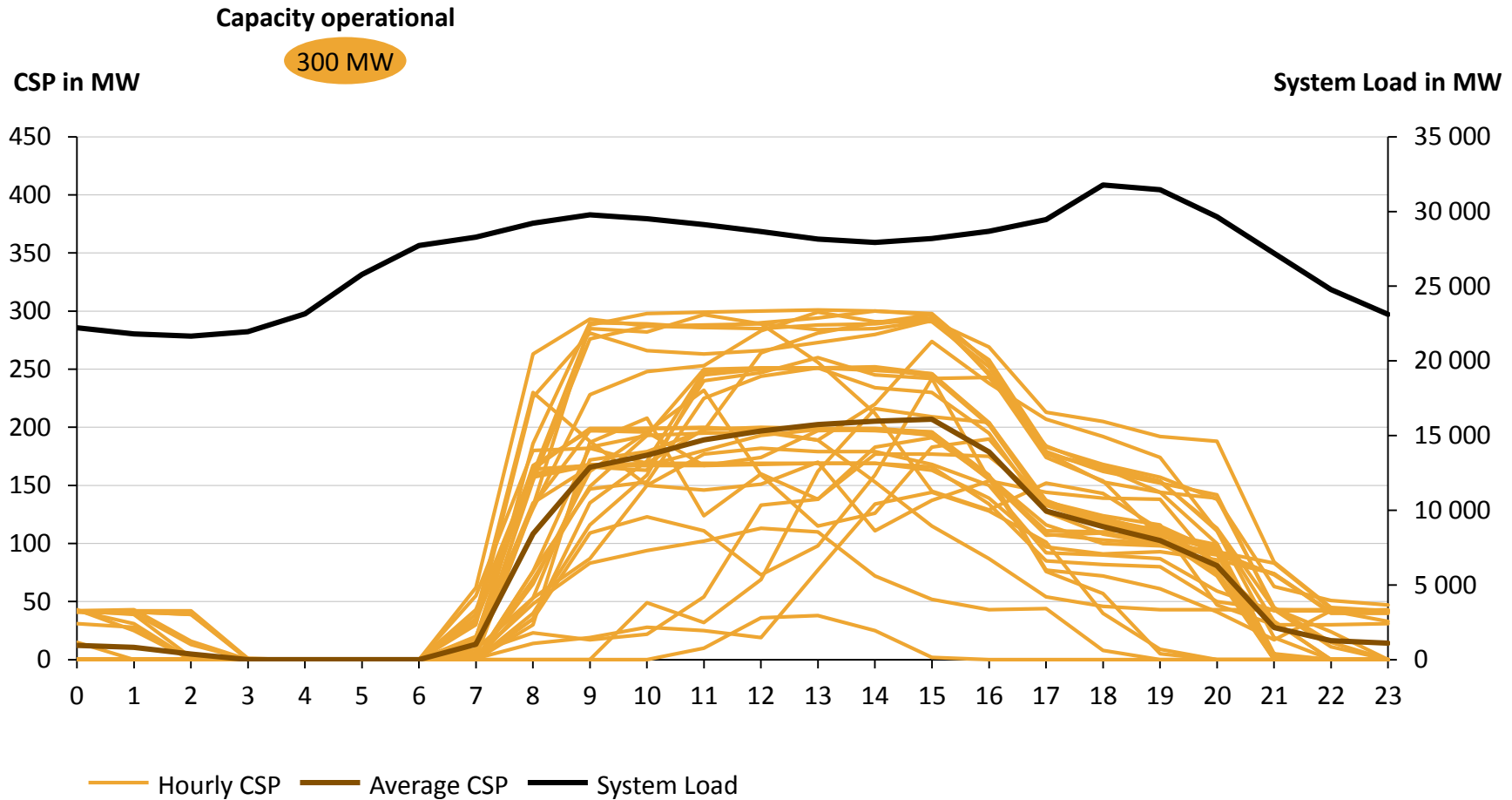
In Jul 2018, CSP storage used in evenings

Hourly CSP production for all 31 days of July 2018 and average system load diurnal course



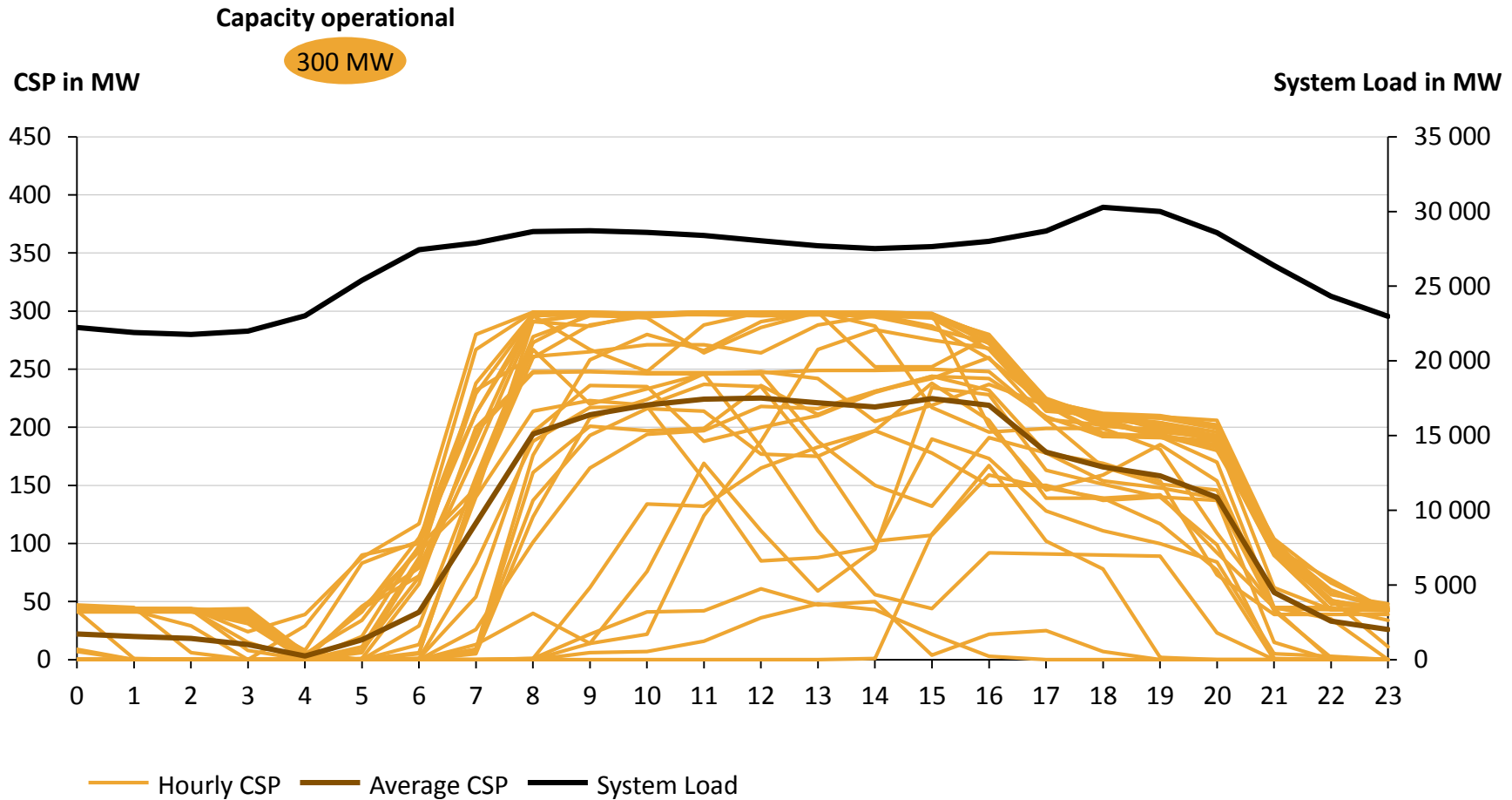
In Aug 2018, CSP storage used in evenings

Hourly CSP production for all 31 days of August 2018 and average system load diurnal course



In Sep 2018, CSP storage used in evenings

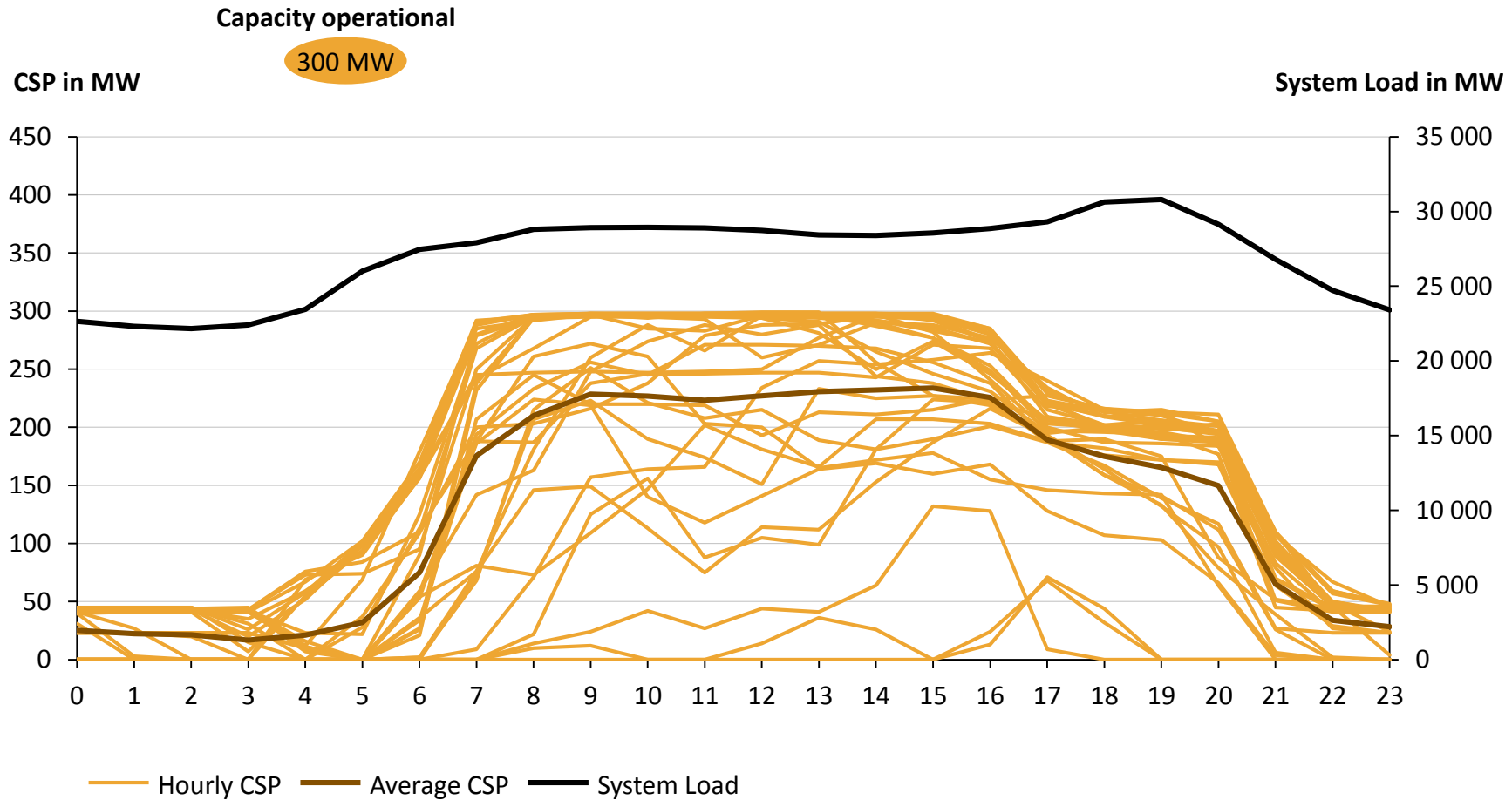
Hourly CSP production for all 30 days of September 2018 and average system load diurnal course



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

In Oct 2018, CSP storage used in evenings

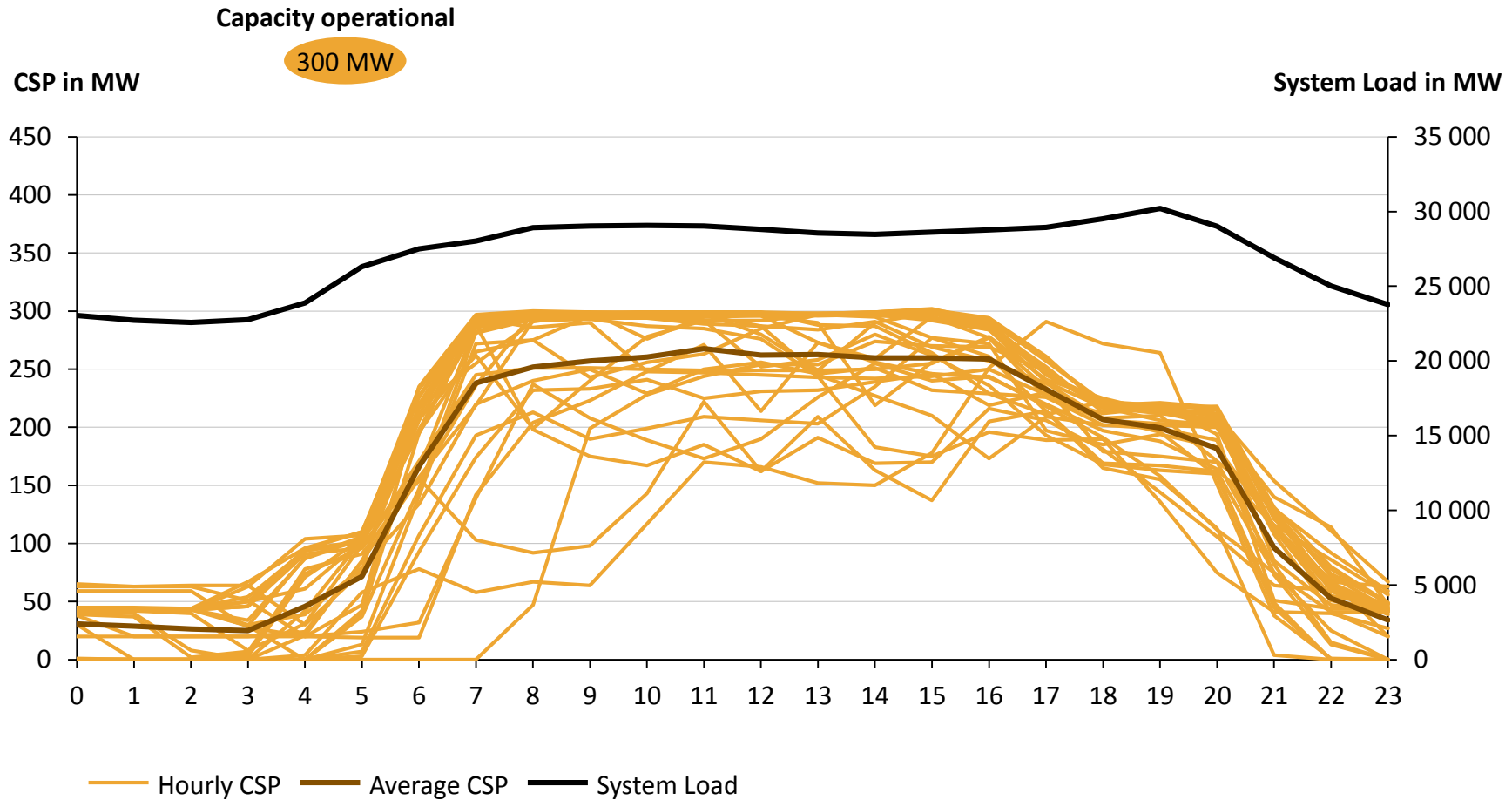
Hourly CSP production for all 31 days of October 2018 and average system load diurnal course



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

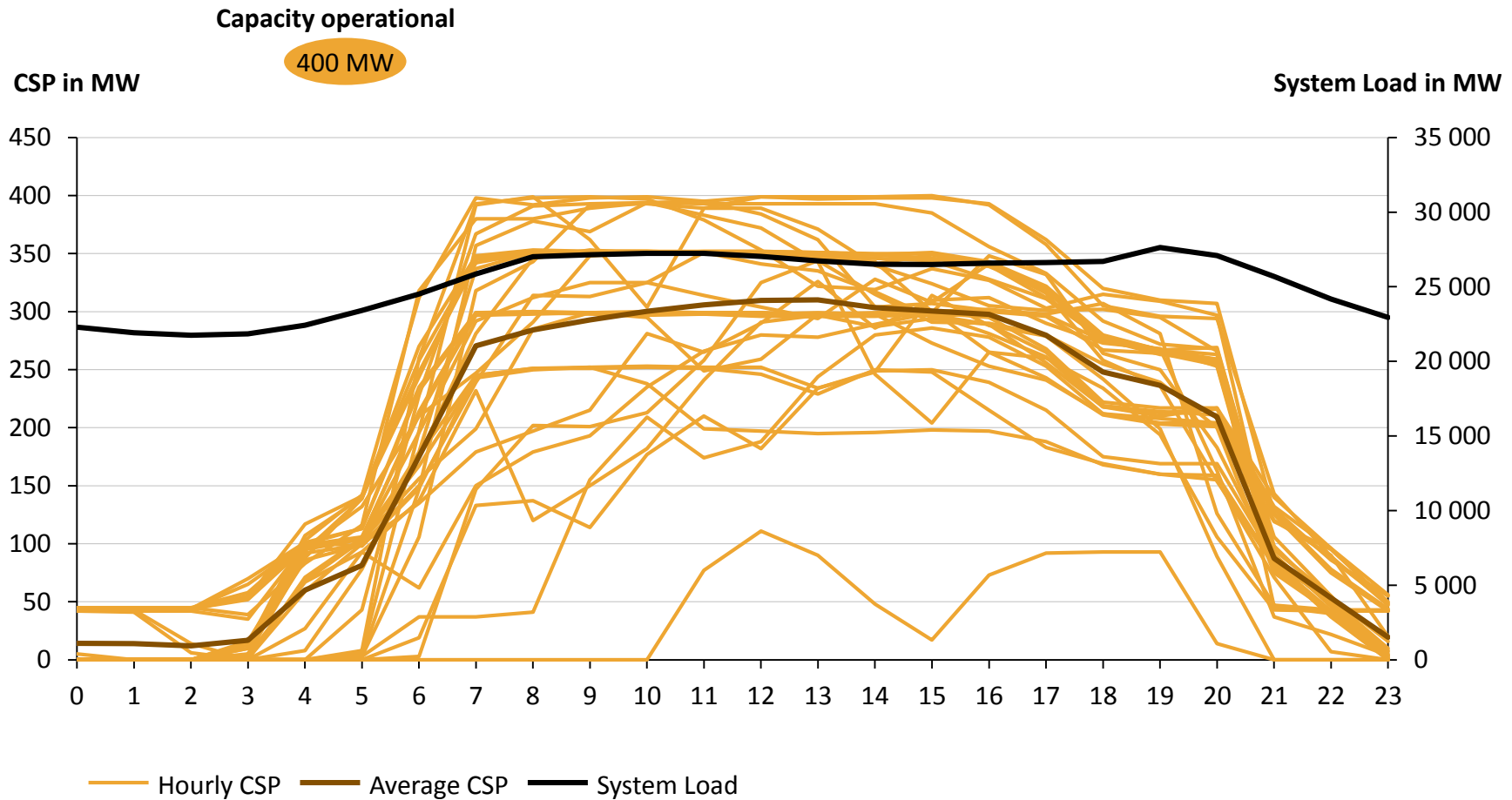
In Nov 2018, CSP storage used in evenings

Hourly CSP production for all 30 days of November 2018 and average system load diurnal course



In Dec 2018, CSP storage used in evenings

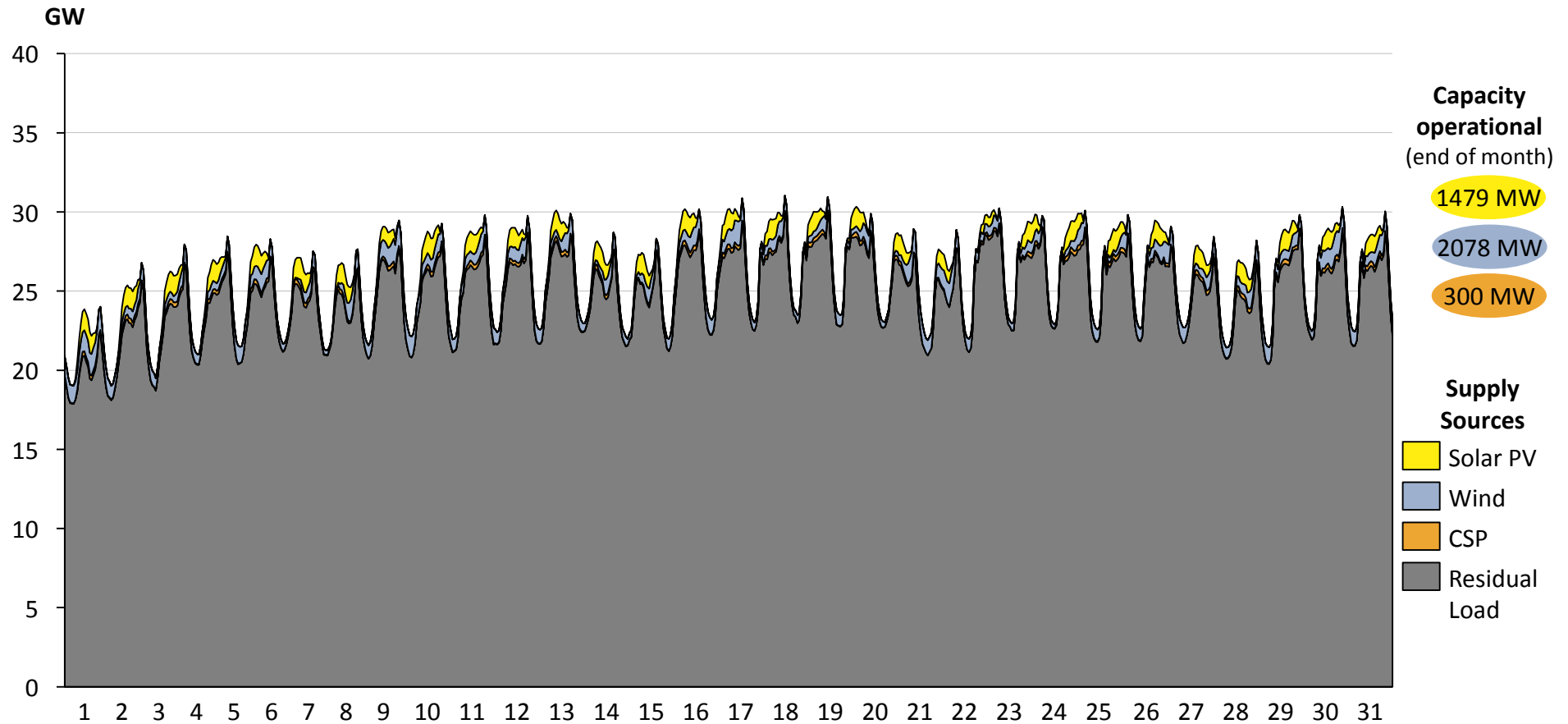
Hourly CSP production for all 31 days of December 2018 and average system load diurnal course



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

Hourly electricity production in Jan 2018

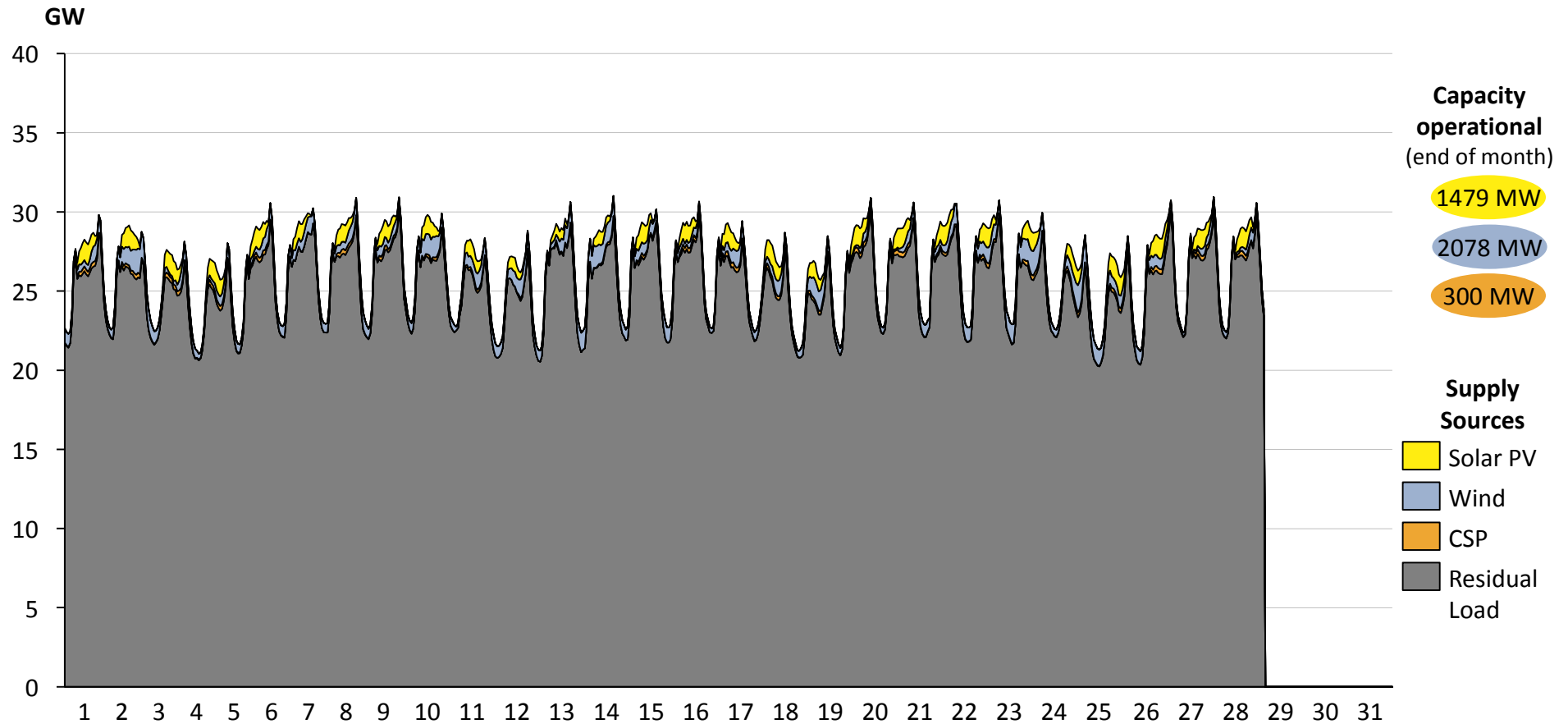
Actual hourly production from all power supply sources in RSA for January 2018



- Maximum power of 31.0 GW between 19h00 and 20h00 on 17 Jan 2018
- Minimum power of 19.0 GWh between 02h00 and 03h00 on 2 Jan 2018

Hourly electricity production in Feb 2018

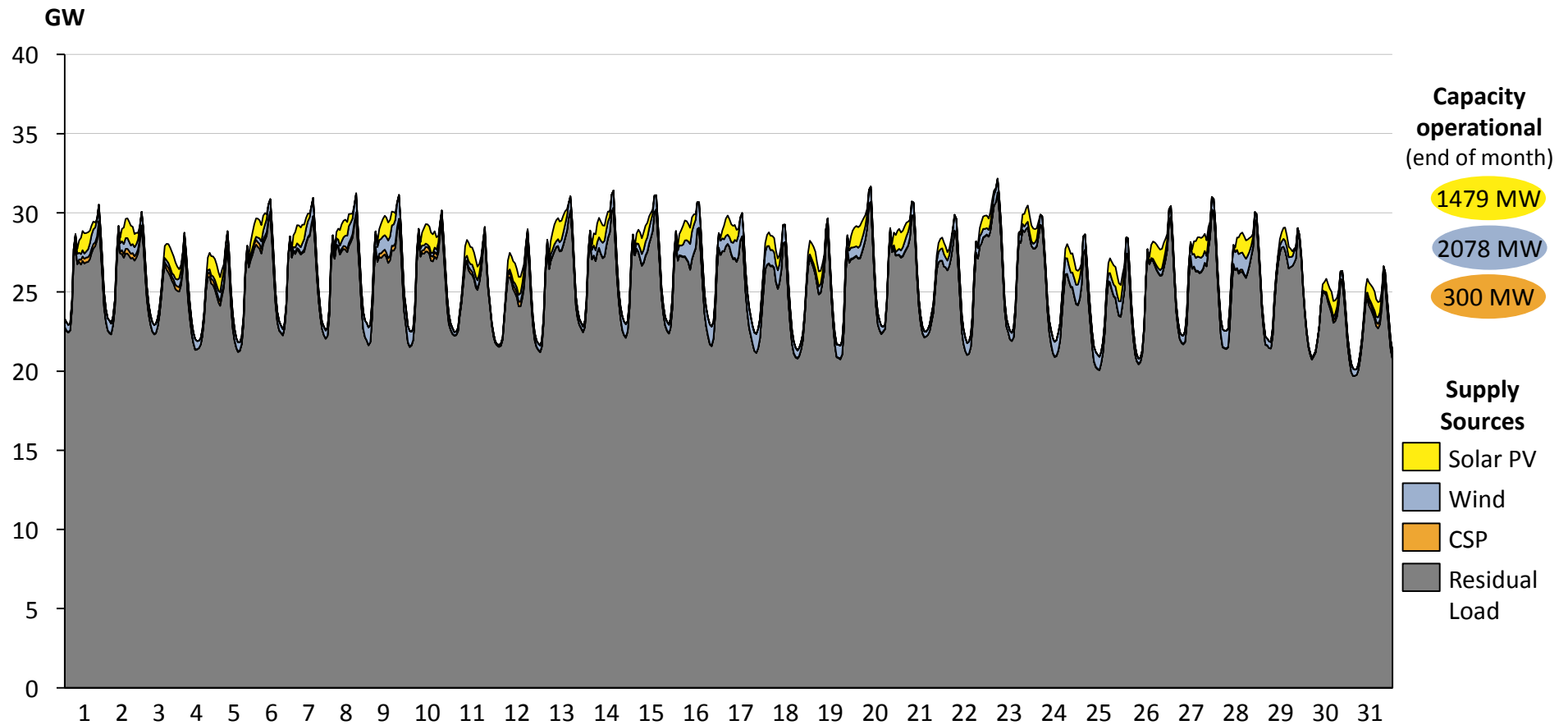
Actual hourly production from all power supply sources in RSA for February 2018



- Maximum power of 31.0 GW between 19h00 and 20h00 on 13 Feb 2018
- Minimum power of 21.0 GWh between 03h00 and 04h00 on 4 Feb 2018

Hourly electricity production in Mar 2018

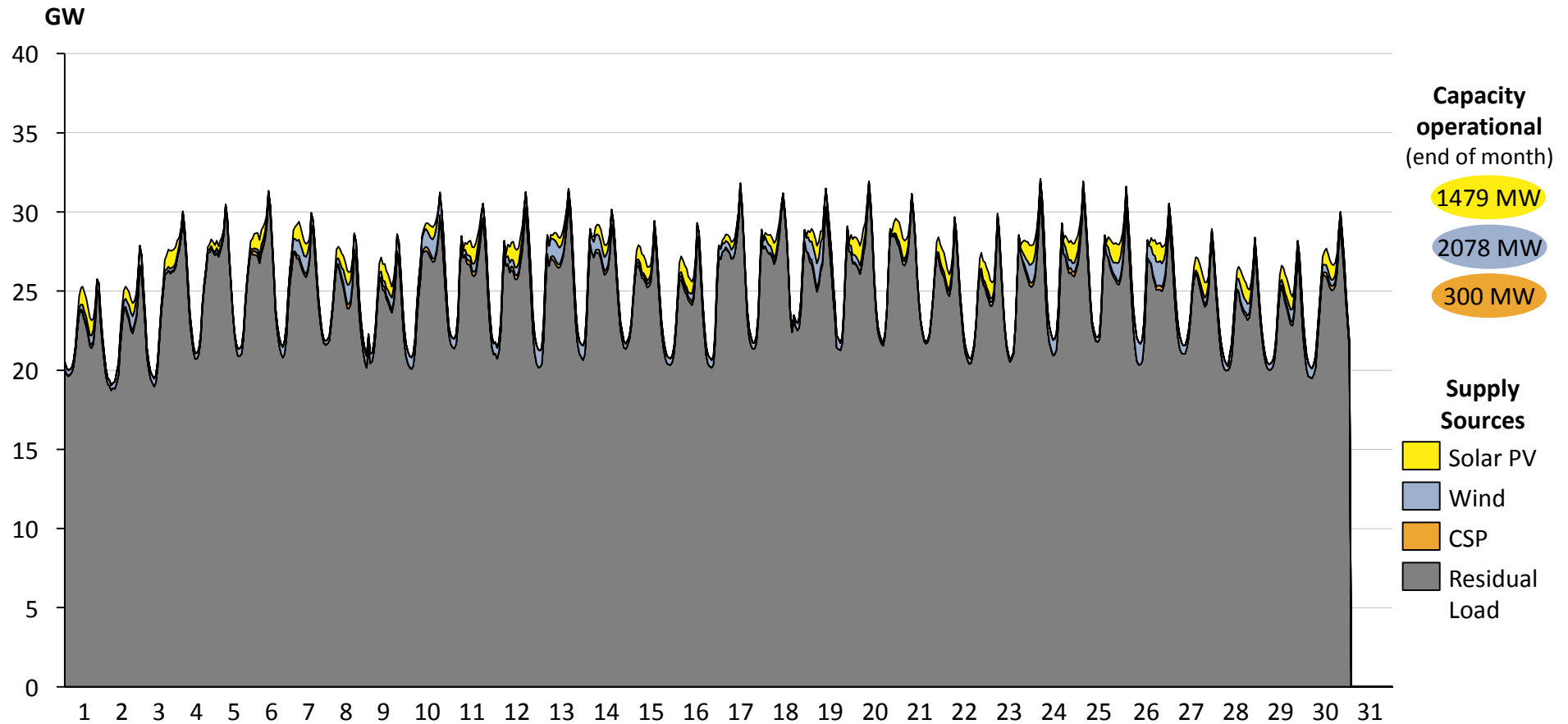
Actual hourly production from all power supply sources in RSA for March 2018



- Maximum power of 32.2 GW between 18h00 and 19h00 on 22 Mar 2018
- Minimum power of 20.0 GWh between 02h00 and 03h00 on 31 Mar 2018

Hourly electricity production in Apr 2018

Actual hourly production from all power supply sources in RSA for April 2018

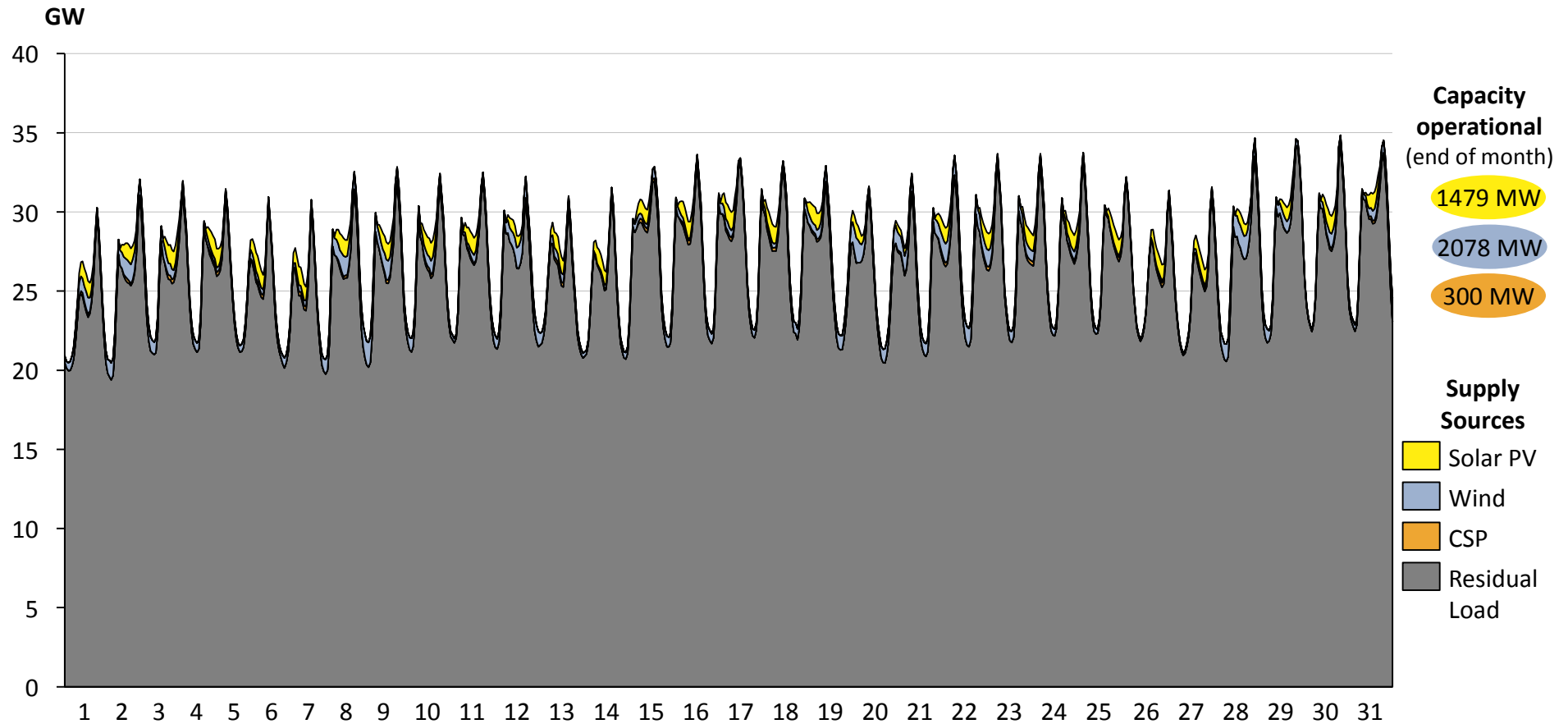


- Maximum power of 32.1 GW between 18h00 and 19h00 on 23 Apr 2018
- Minimum power of 19.1 GWh between 02h00 and 03h00 on 2 Apr 2018

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

Hourly electricity production in May 2018

Actual hourly production from all power supply sources in RSA for May 2018

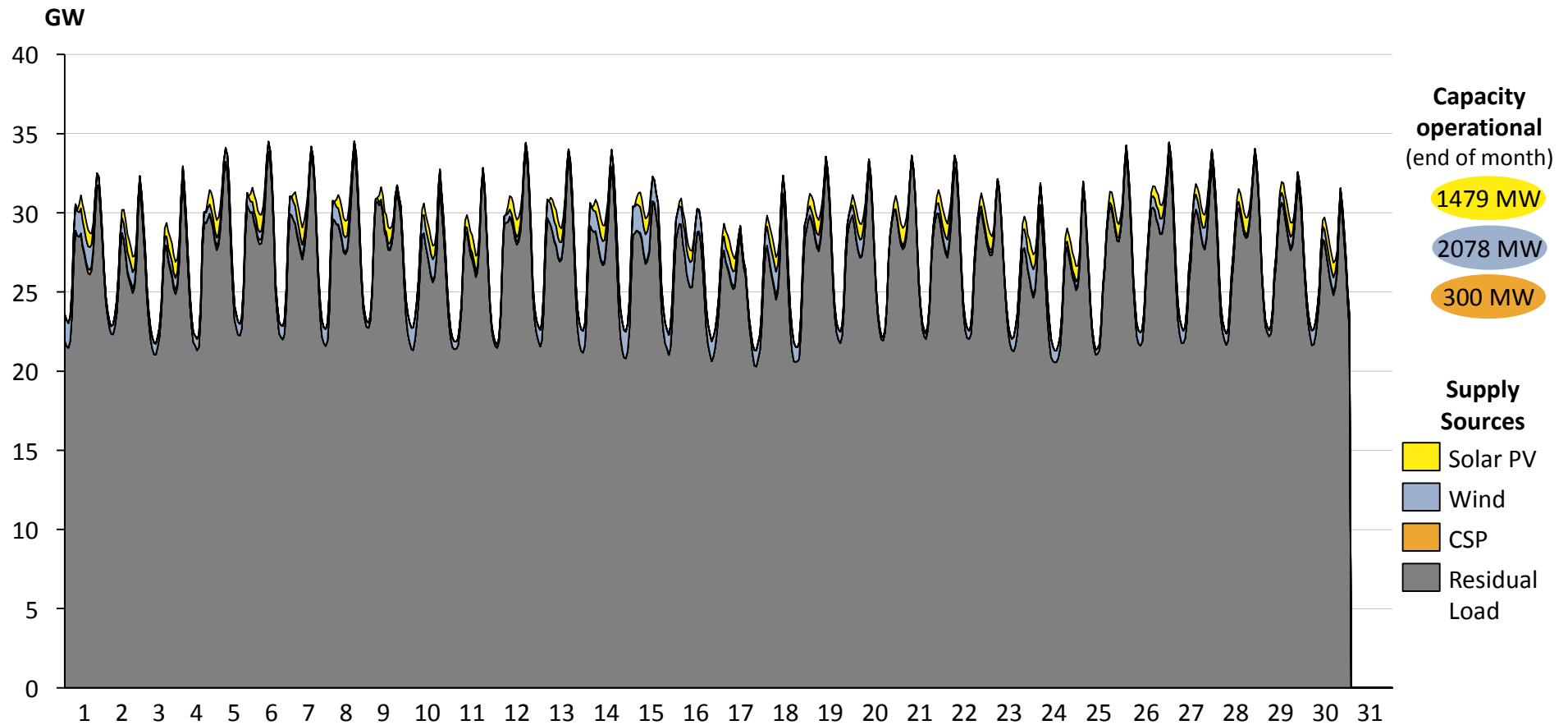


- Maximum power of 34.8 GW between 18h00 and 19h00 on 30 May 2018
- Minimum power of 20.5 GWh between 02h00 and 03h00 on 2 May 2018

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

Hourly electricity production in Jun 2018

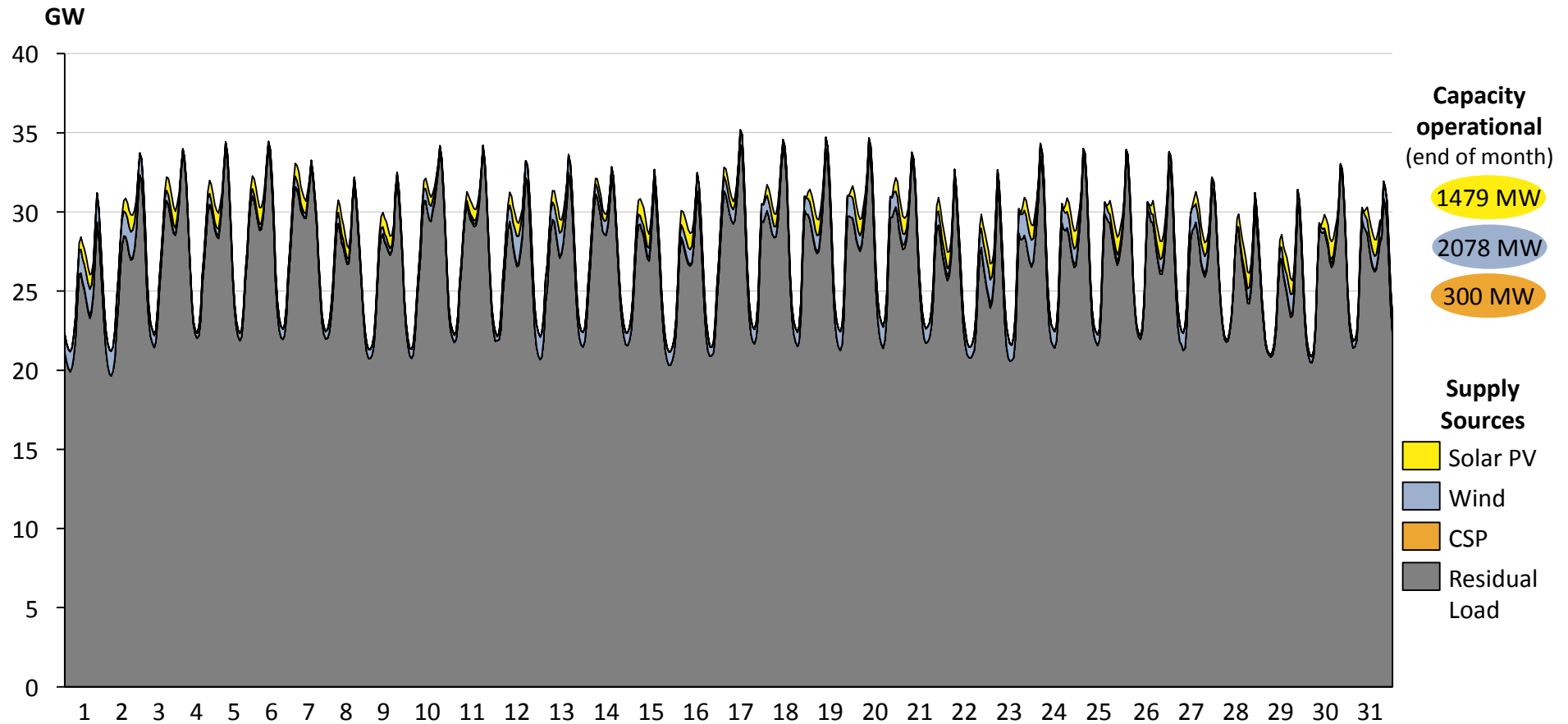
Actual hourly production from all power supply sources in RSA for June 2018



- Maximum power of 34.5 GW between 18h00 and 19h00 on 7 Jun 2018
- Minimum power of 21.3 GWh between 03h00 and 04h00 on 24 Jun 2018

Hourly electricity production in Jul 2018

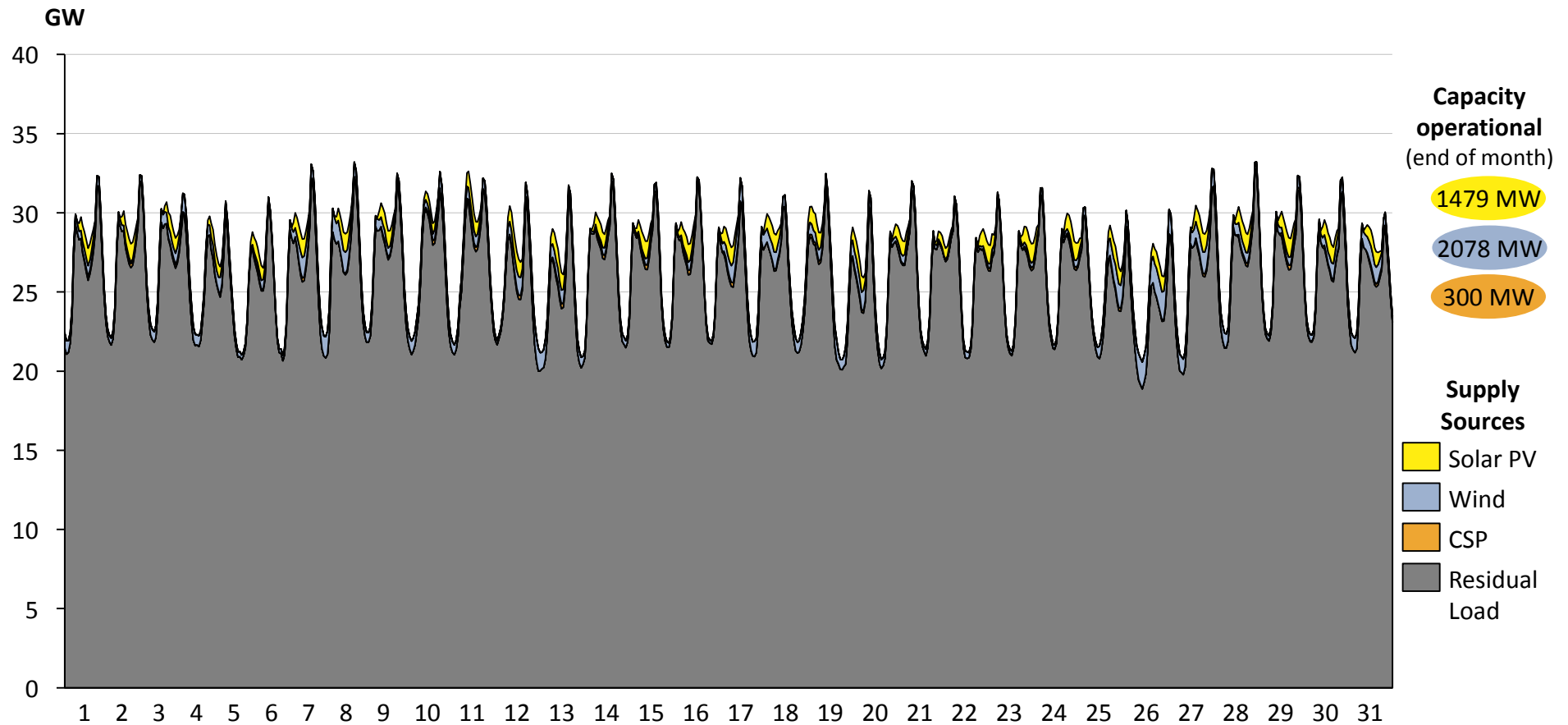
Actual hourly production from all power supply sources in RSA for July 2018



- Maximum power of 35.2 GW between 18h00 and 19h00 on 16 Jul 2018
- Minimum power of 20.9 GWh between 02h00 and 03h00 on 30 Jul 2018

Hourly electricity production in Aug 2018

Actual hourly production from all power supply sources in RSA for August 2018

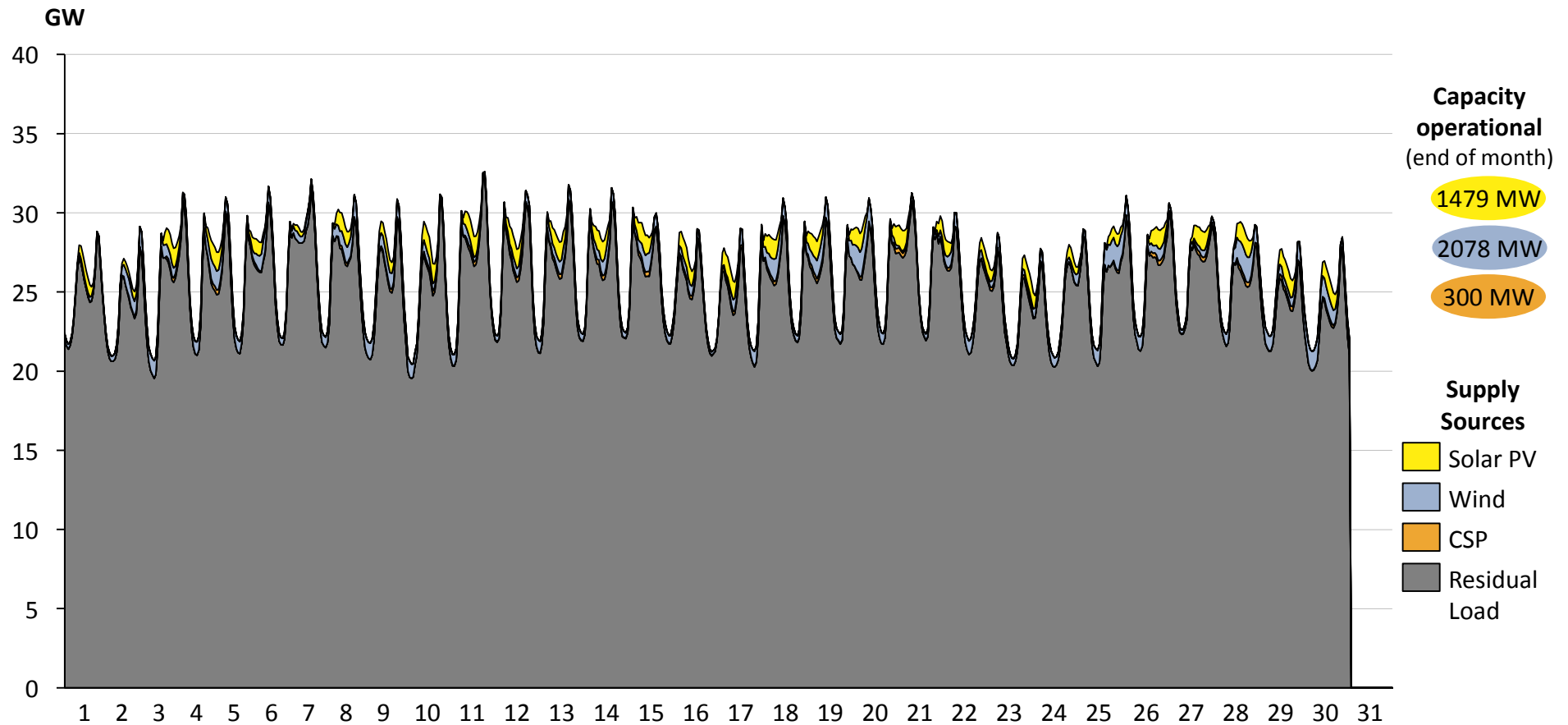


- Maximum power of 33.2 GW between 19h00 and 20h00 on 28 Aug 2018
- Minimum power of 20.6 GWh between 03h00 and 04h00 on 26 Aug 2018

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

Hourly electricity production in Sep 2018

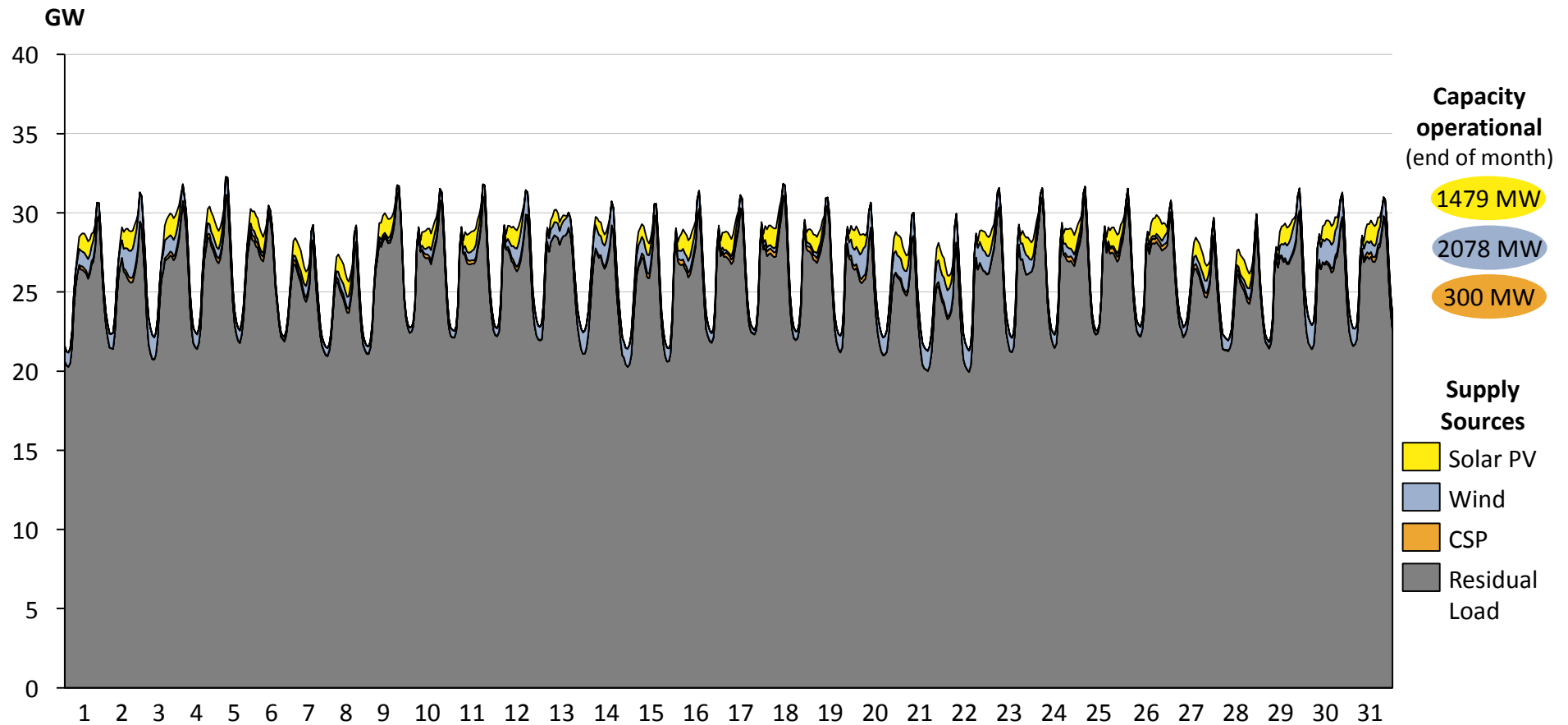
Actual hourly production from all power supply sources in RSA for September 2018



- Maximum power of 32.6 GW between 19h00 and 20h00 on 10 Sep 2018
- Minimum power of 20.4 GWh between 03h00 and 04h00 on 9 Sep 2018

Hourly electricity production in Oct 2018

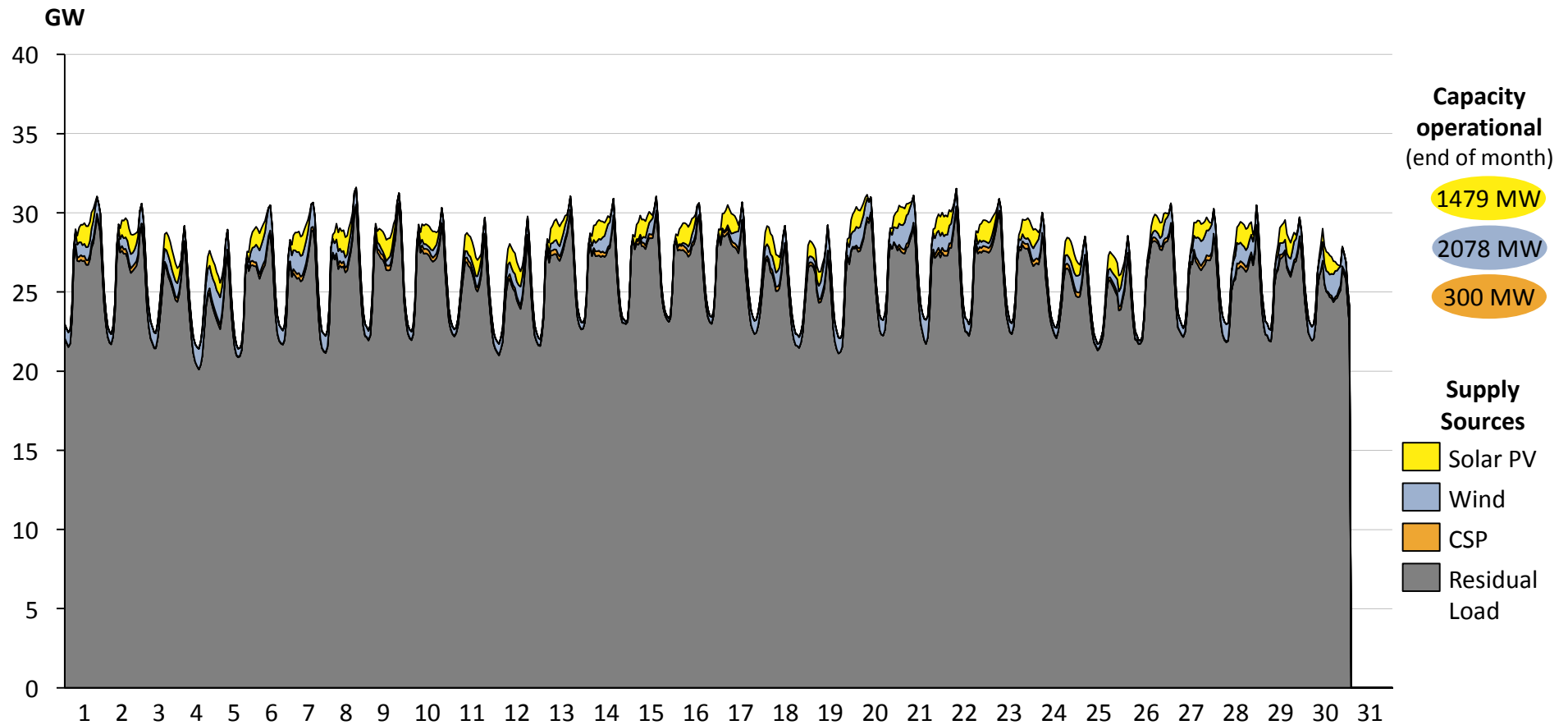
Actual hourly production from all power supply sources in RSA for October 2018



- Maximum power of 32.3 GW between 18h00 and 19h00 on 4 Oct 2018
- Minimum power of 21.2 GWh between 02h00 and 03h00 on 1 Oct 2018

Hourly electricity production in Nov 2018

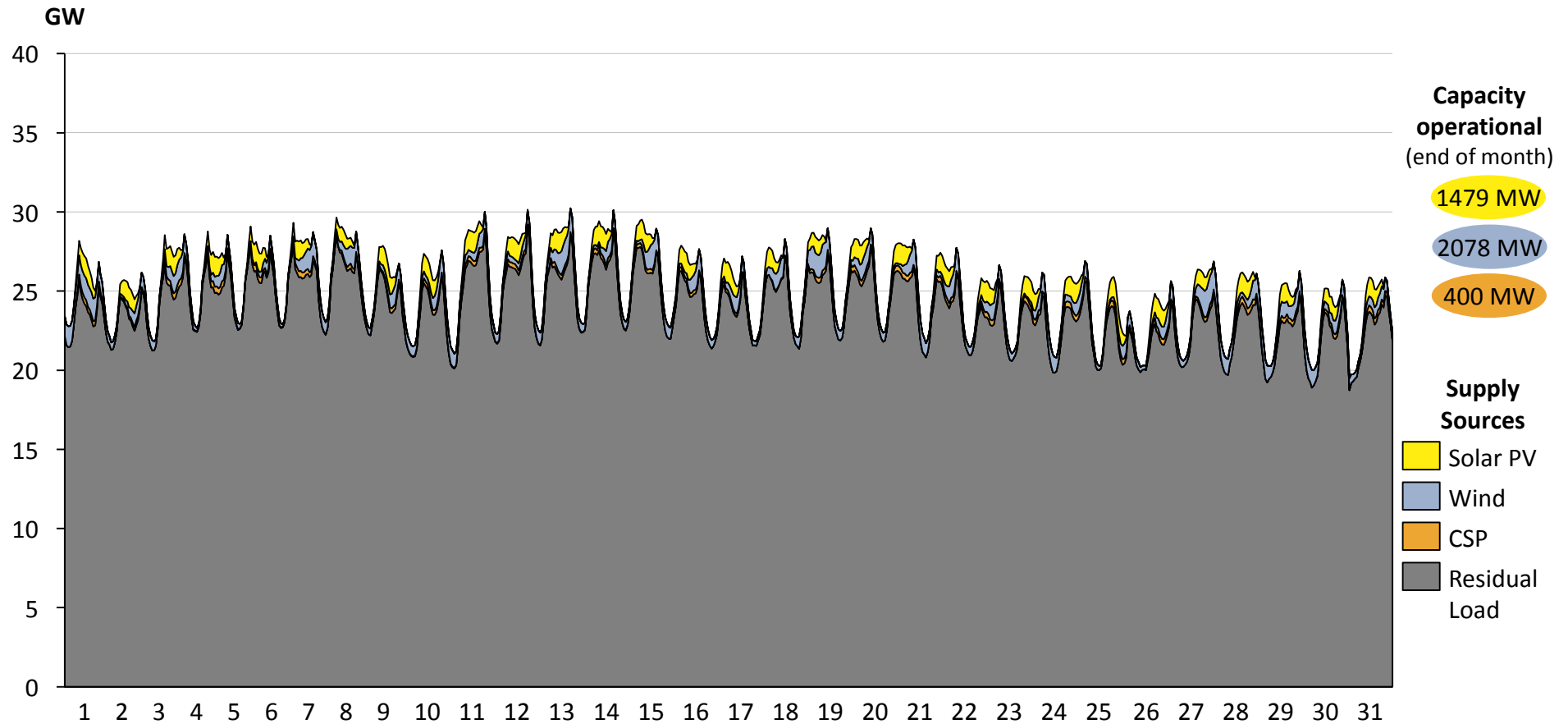
Actual hourly production from all power supply sources in RSA for November 2018



- Maximum power of 31.6 GW between 19h00 and 20h00 on 7 Nov 2018
- Minimum power of 21.4 GWh between 03h00 and 04h00 on 4 Nov 2018

Hourly electricity production in Dec 2018

Actual hourly production from all power supply sources in RSA for December 2018

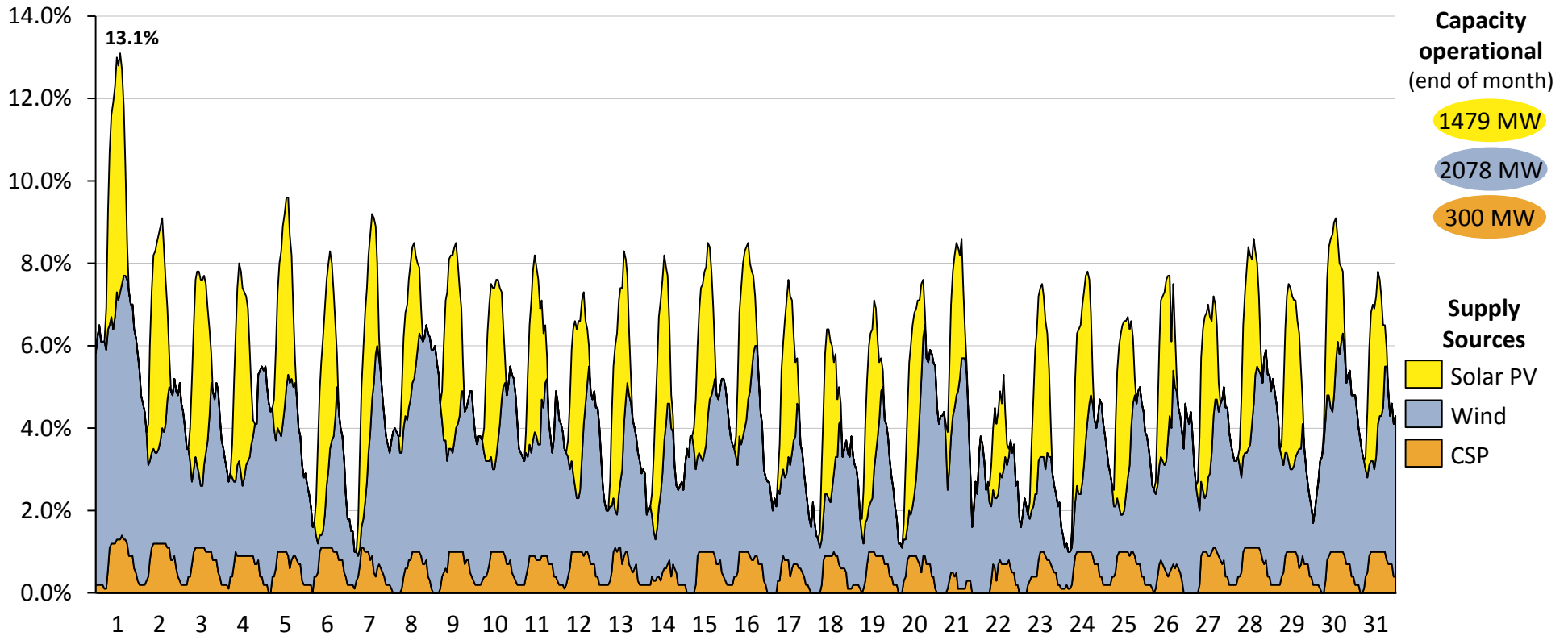


- Maximum power of 30.2 GW between 19h00 and 20h00 on 12 Dec 2018
- Minimum power of 19.5 GWh between 23h00 and 00h00 on 31 Dec 2018

Hourly solar PV, wind & CSP contribution of 0.5-13.1% in Jan 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for January 2018

Relative hourly contribution

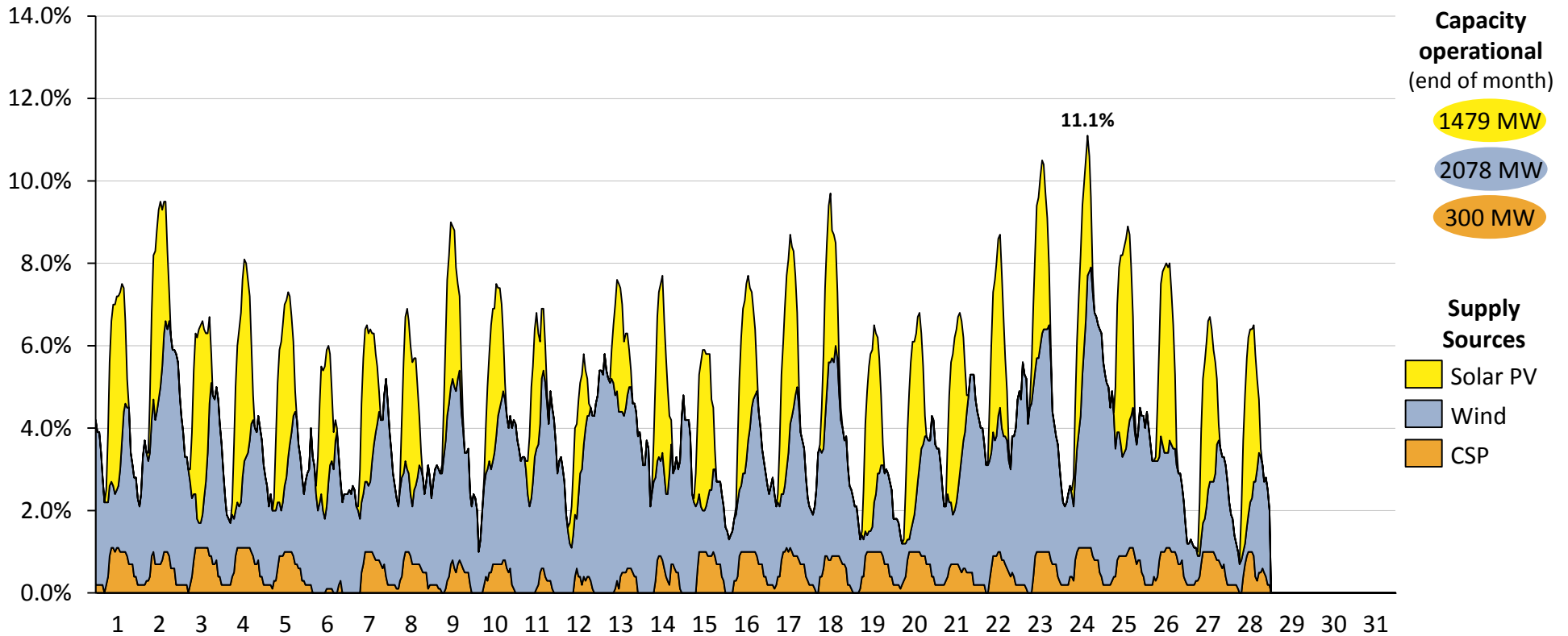


- Solar PV maximum relative contribution of 5.8% between 14h00 and 15h00 on 1 Jan 2018 - National Holiday
- Wind maximum relative contribution of 6.4% between 19h00 and 20h00 on 1 Jan 2018
- CSP maximum relative contribution of 1.4% between 15h00 and 16h00 on 1 Jan 2018

Hourly solar PV, wind & CSP contribution of 0.6-11.1% in Feb 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for February 2018

Relative hourly contribution

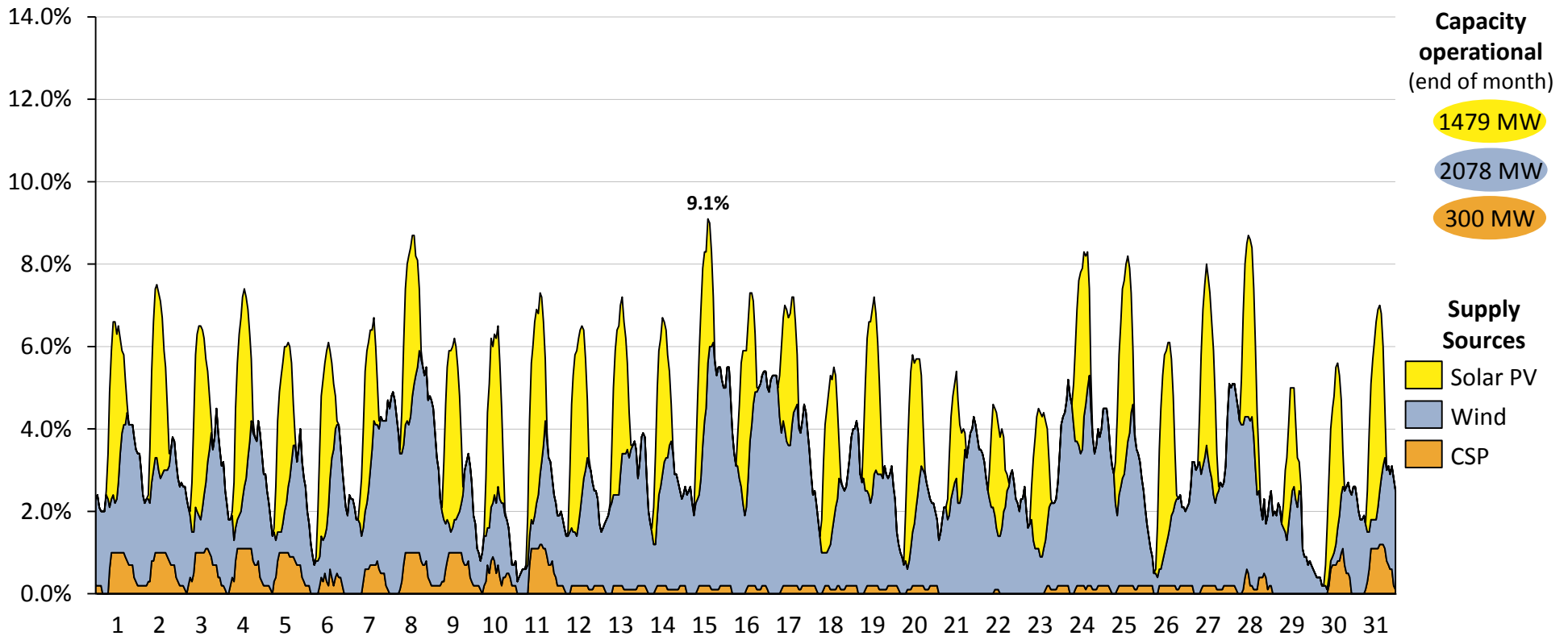


- Maximum solar PV relative contribution of 5.1% between 13h00 and 14h00 on 25 Feb 2018
- Maximum wind relative contribution of 6.8% between 17h00 and 18h00 on 24 Feb 2018
- Maximum CSP relative contribution of 1.1% between 16h00 and 17h00 on 25 Feb 2018

Hourly solar PV, wind & CSP contribution of 0.1-9.1% in Mar 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for March 2018

Relative hourly contribution

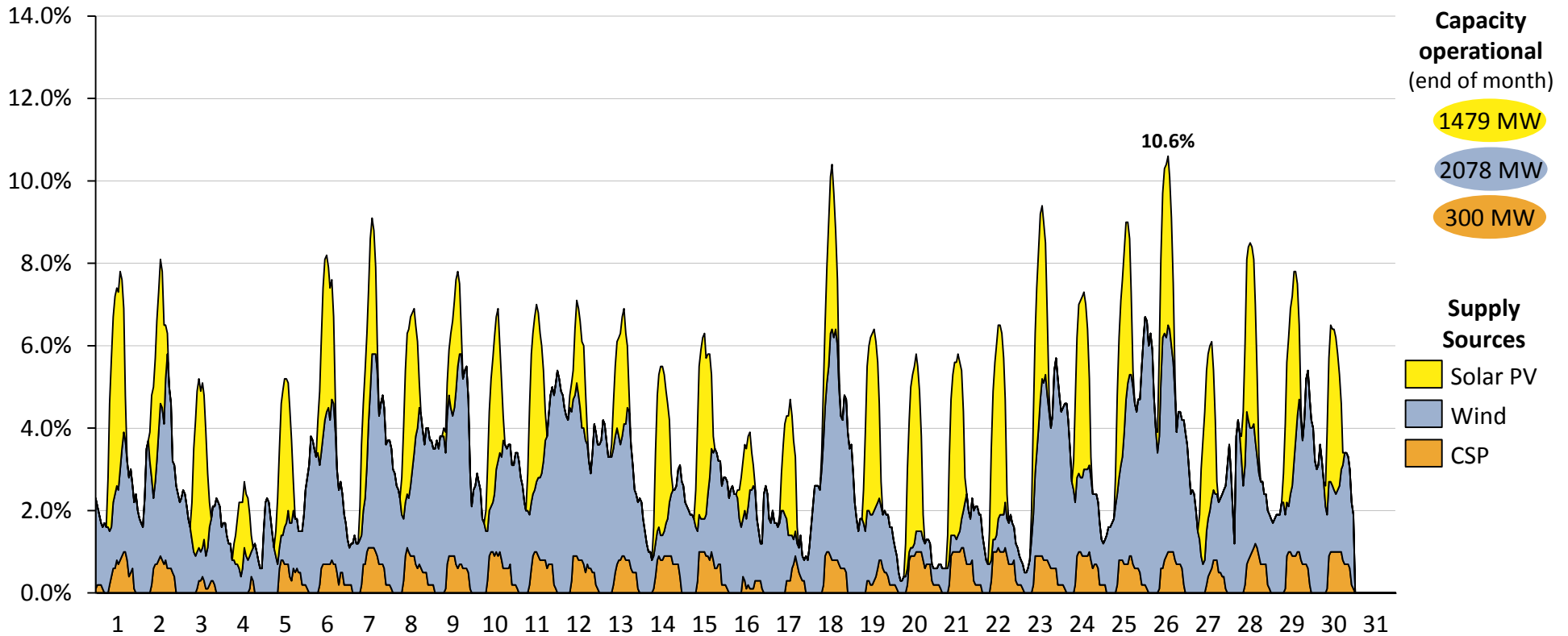


- Maximum solar PV relative contribution of 4.9% between 14h00 and 15h00 on 4 Mar 2018
- Maximum wind relative contribution of 6.0% between 17h00 and 18h00 on 15 Mar 2018
- Maximum CSP relative contribution of 1.2% between 16h00 and 17h00 on 31 Mar 2018

Hourly solar PV, wind & CSP contribution of 0.3-10.6% in Apr 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for April 2018

Relative hourly contribution

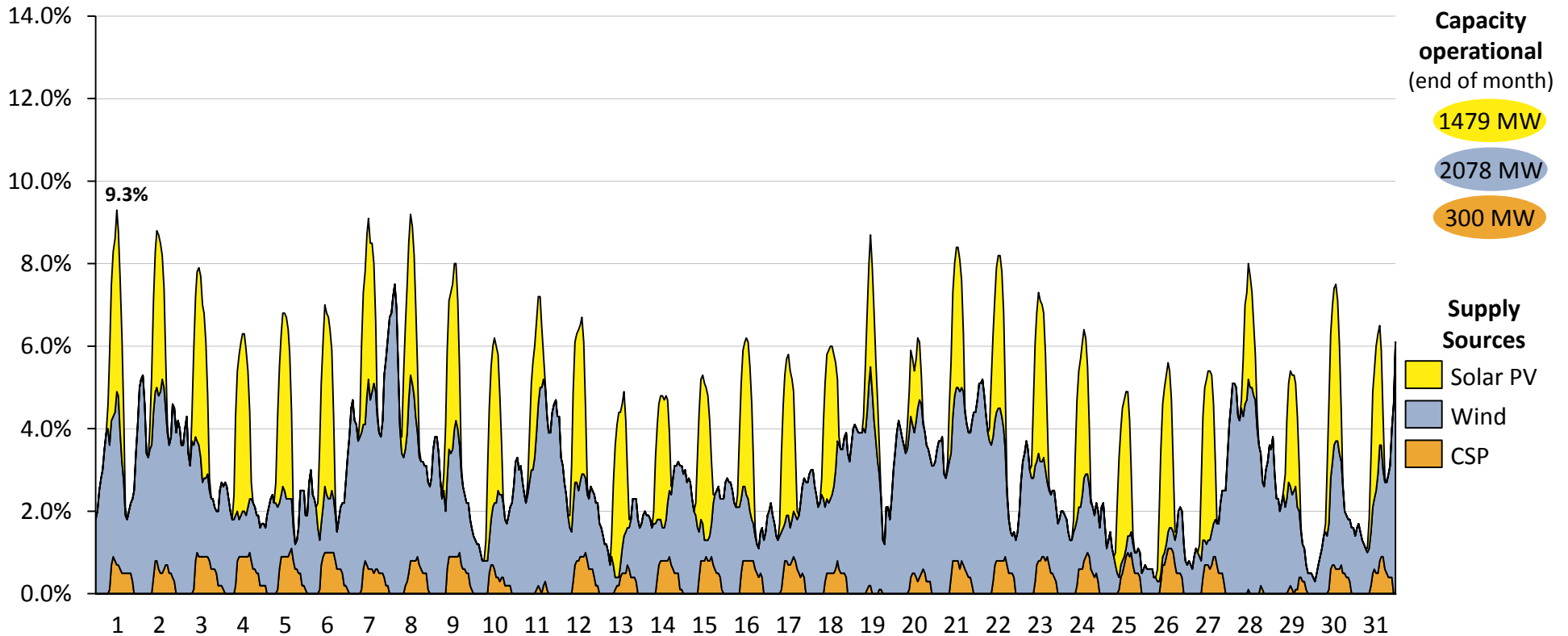


- Maximum solar PV relative contribution of 4.8% between 11h00 and 12h00 on 1 Apr 2018
- Maximum wind relative contribution of 6.5% between 01h00 and 02h00 on 26 Apr 2018
- Maximum CSP relative contribution of 1.2% between 15h00 and 16h00 on 28 Apr 2018

Hourly solar PV, wind & CSP contribution of 0.3-9.3% in May 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for May 2018

Relative hourly contribution

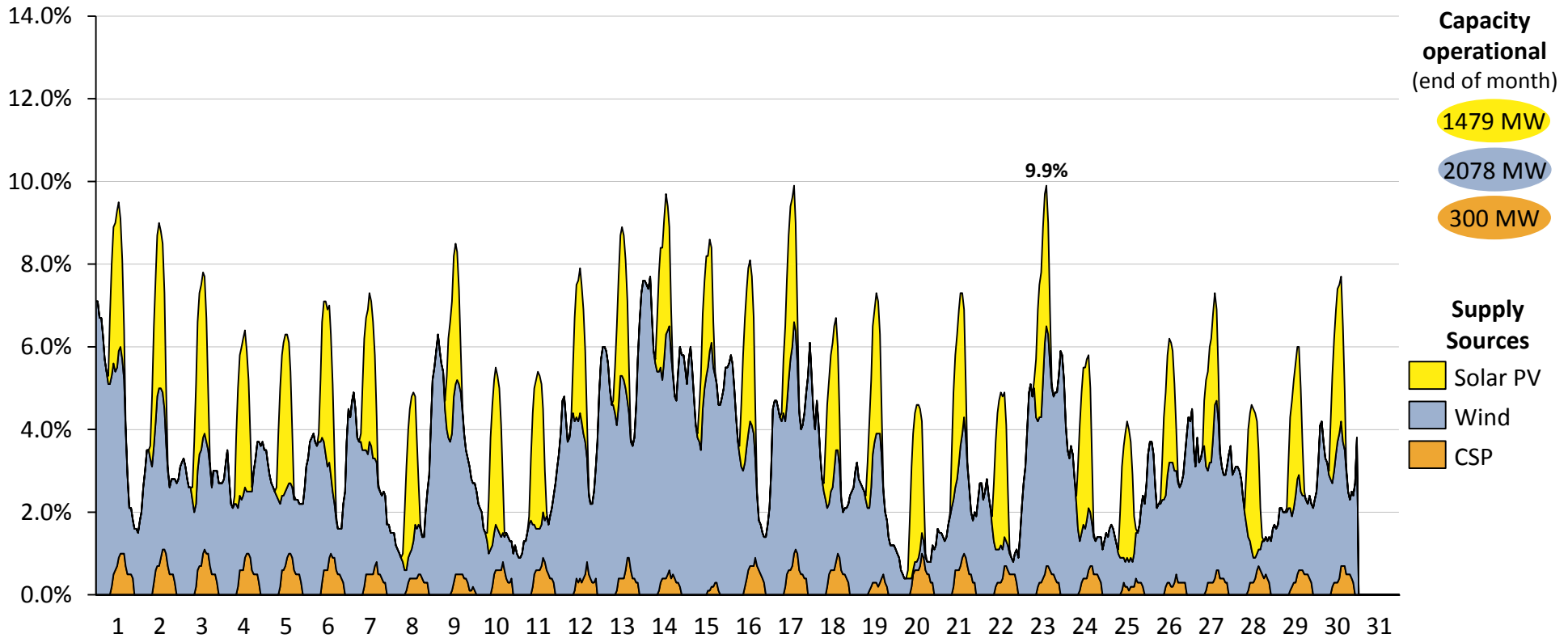


- Maximum solar PV relative contribution of 4.4% between 12h00 and 13h00 on 6 May 2018
- Maximum wind relative contribution of 7.5% between 03h00 and 04h00 on 8 May 2018
- Maximum CSP relative contribution of 1.1% between 14h00 and 15h00 on 26 May 2018

Hourly solar PV, wind & CSP contribution of 0.2-9.9% in Jun 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for June 2018

Relative hourly contribution

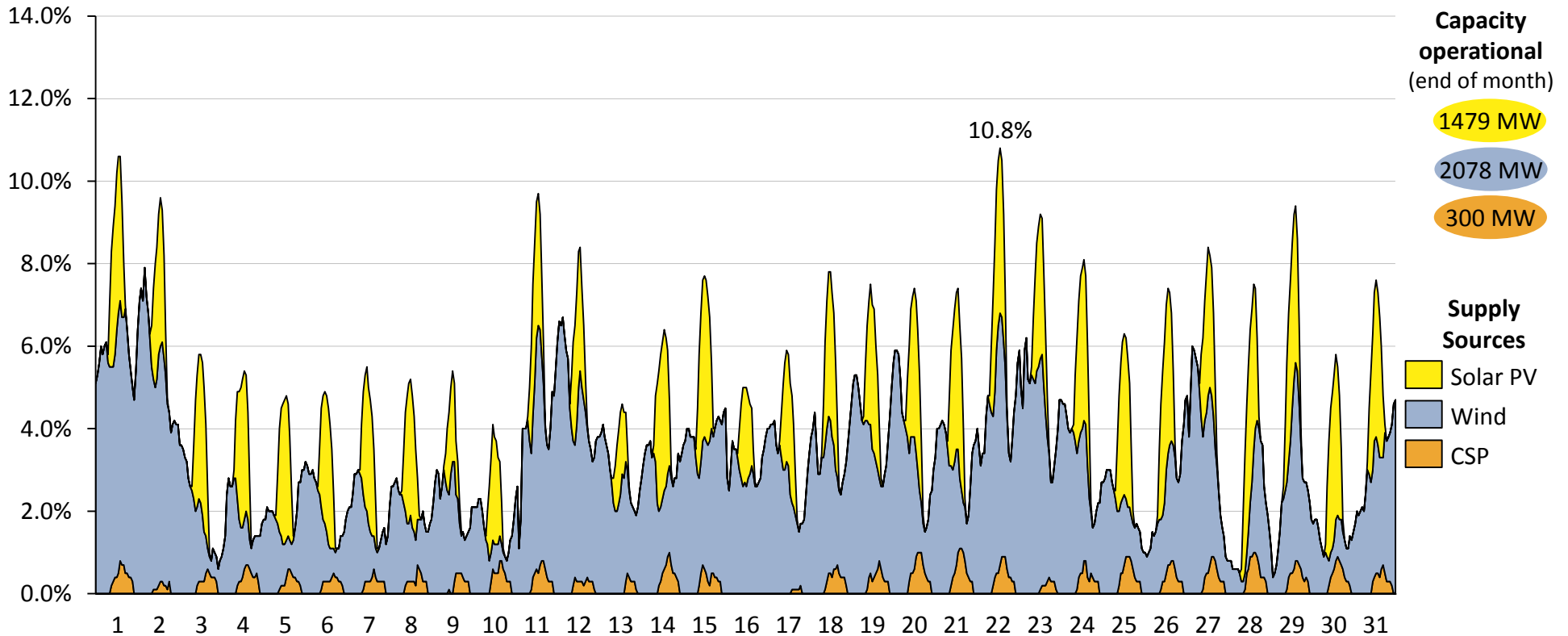


- Maximum solar PV relative contribution of 4.0% between 13h00 and 14h00 on 4 Jun 2018
- Maximum wind relative contribution of 7.7% between 04h00 and 05h00 on 14 Jun 2018
- Maximum CSP relative contribution of 1.1% between 14h00 and 15h00 on 2 Jun 2018

Hourly solar PV, wind & CSP contribution of 0.4-10.8% in Jul 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for July 2018

Relative hourly contribution

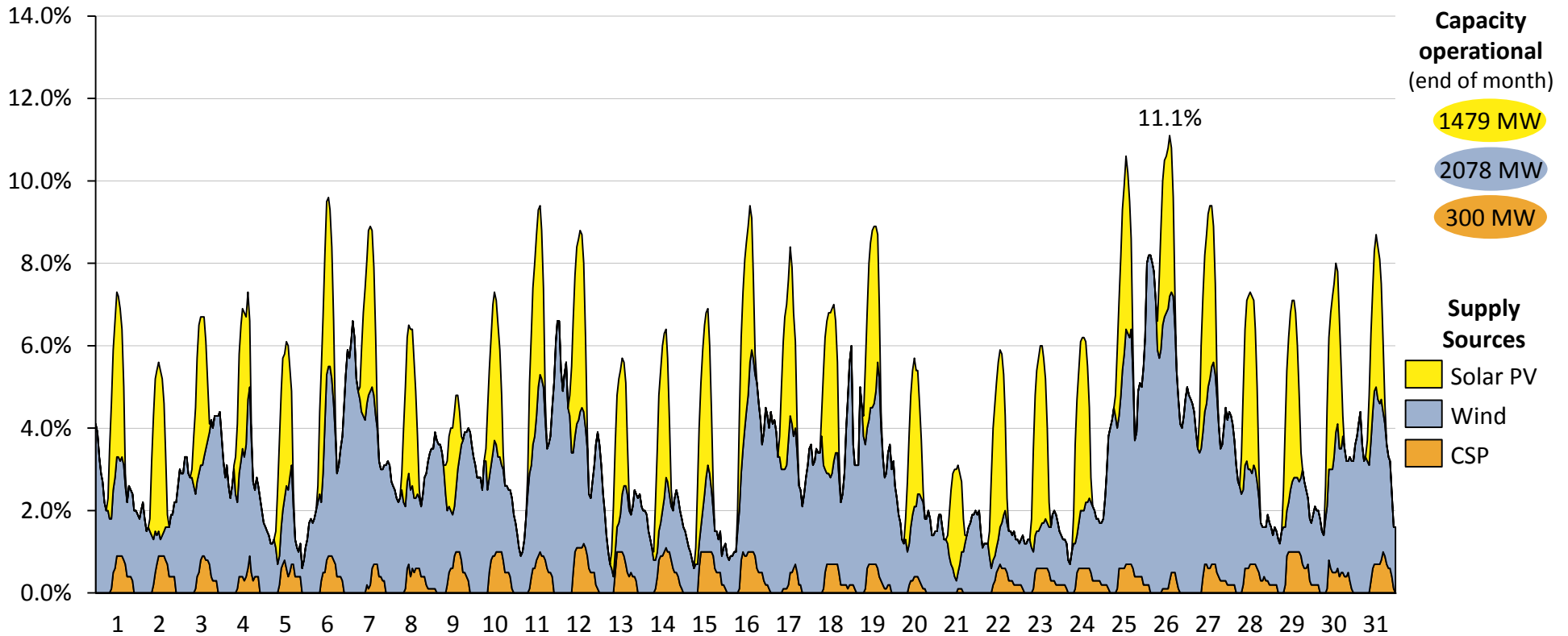


- Maximum solar PV relative contribution of 4.2% between 13h00 and 14h00 on 28 Jul 2018
- Maximum wind relative contribution of 7.9% between 04h00 and 05h00 on 2 Jul 2018
- Maximum CSP relative contribution of 1.1% between 15h00 and 16h00 on 21 Jul 2018

Hourly solar PV, wind & CSP contribution of 0.6-11.1% in Aug 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for August 2018

Relative hourly contribution

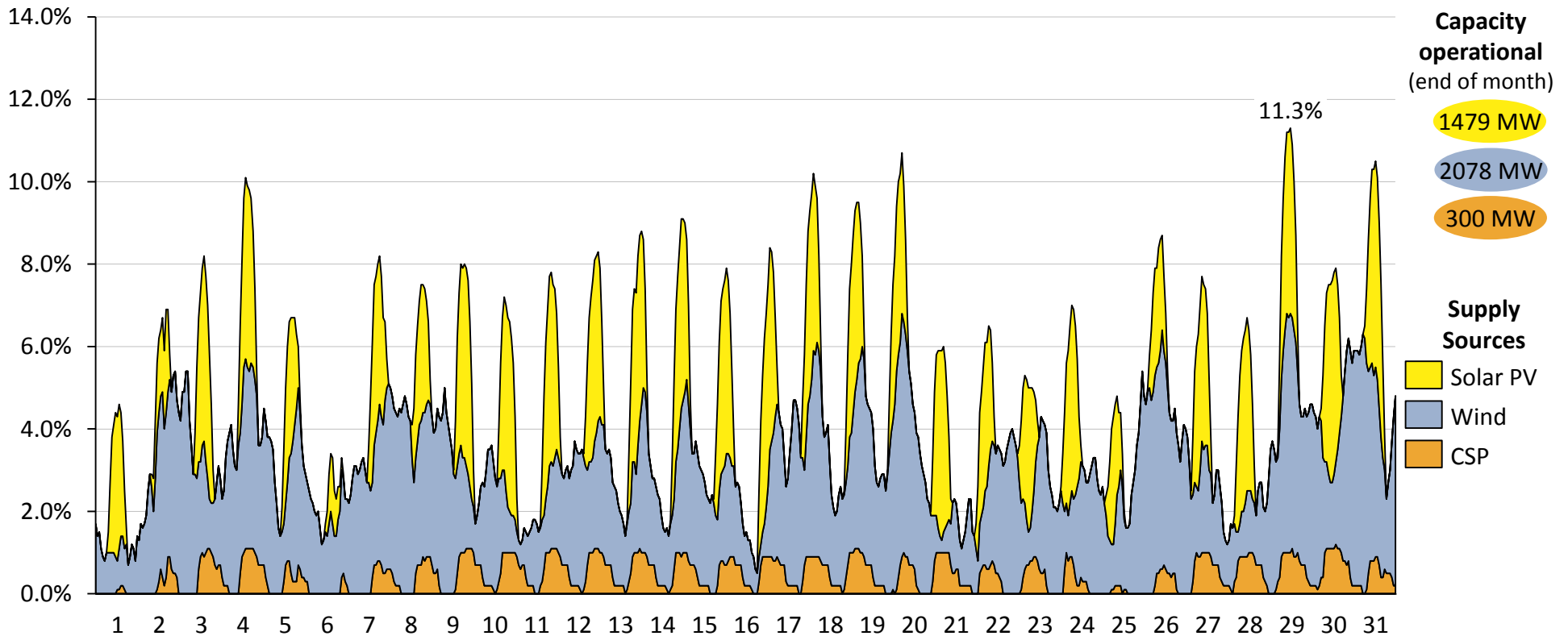


- Maximum solar PV relative contribution of 4.4% between 13h00 and 14h00 on 12 Aug 2018
- Maximum wind relative contribution of 8.2% between 03h00 and 04h00 on 26 Aug 2018
- Maximum CSP relative contribution of 1.2% between 15h00 and 16h00 on 12 Aug 2018

Hourly solar PV, wind & CSP contribution of 0.6-11.3% in Sep 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for September 2018

Relative hourly contribution

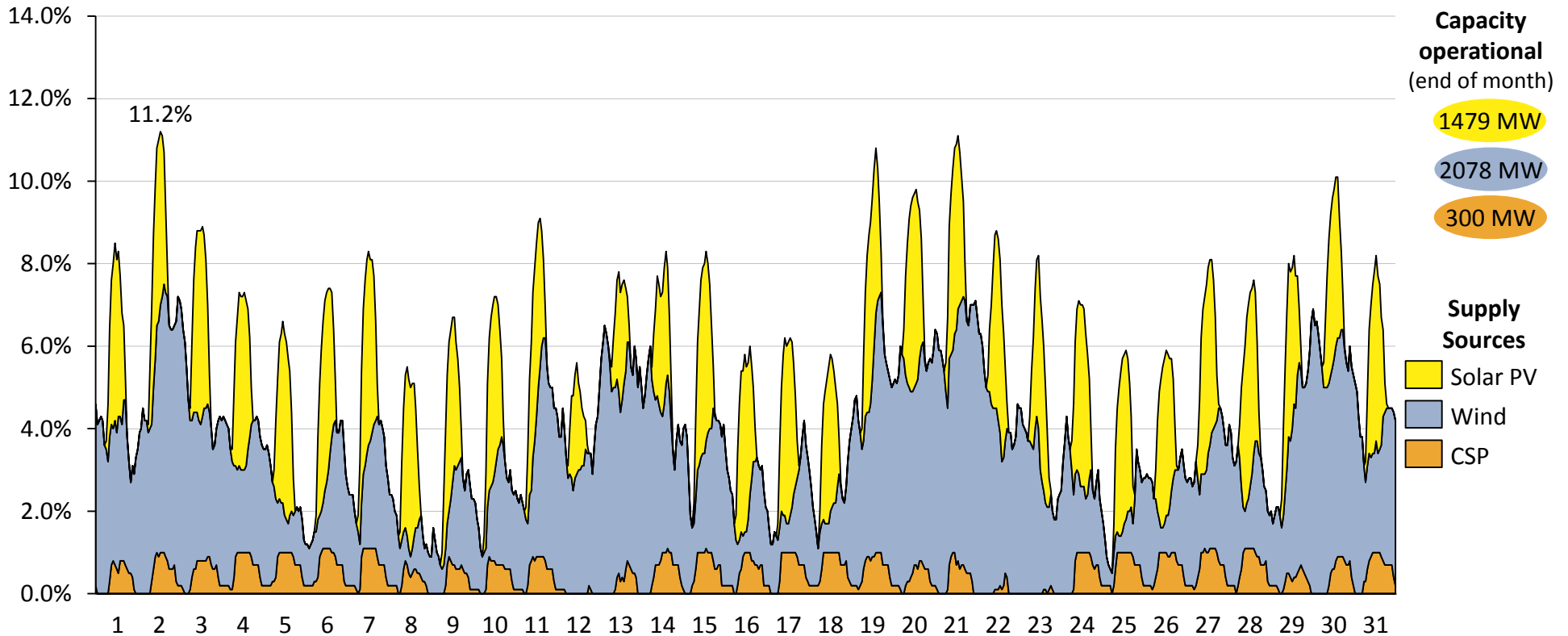


- Maximum solar PV relative contribution of 5.0% between 12h00 and 13h00 on 30 Sep 2018
- Maximum wind relative contribution of 6.3% between 05h00 and 06h00 on 30 Sep 2018
- Maximum CSP relative contribution of 1.2% between 14h00 and 15h00 on 29 Sep 2018

Hourly solar PV, wind & CSP contribution of 0.6-11.2% in Oct 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for October 2018

Relative hourly contribution

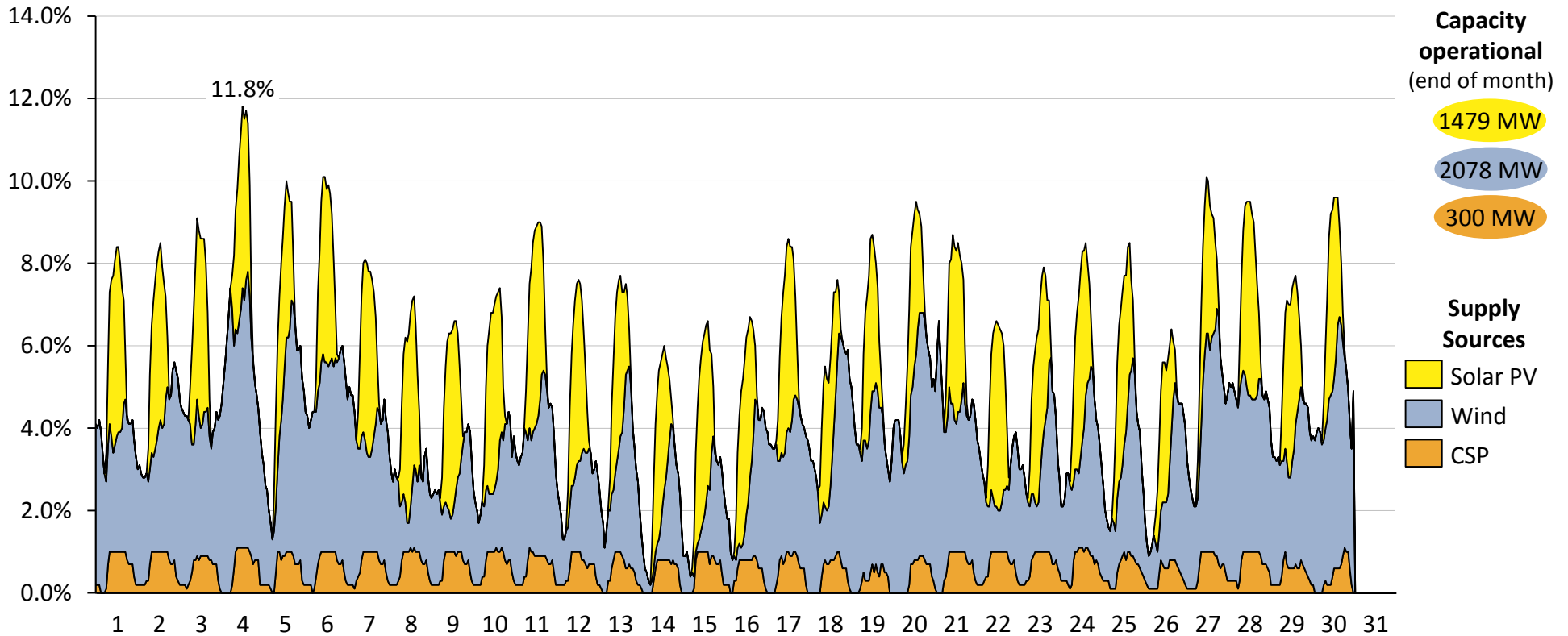


- Maximum solar PV relative contribution of 4.7% between 11h00 and 12h00 on 7 Oct 2018
- Maximum wind relative contribution of 7.1% between 23h00 and 00h00 on 22 Oct 2018
- Maximum CSP relative contribution of 1.1% between 14h00 and 15h00 on 7 Oct 2018

Hourly solar PV, wind & CSP contribution of 0.3-11.8% in Nov 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for November 2018

Relative hourly contribution

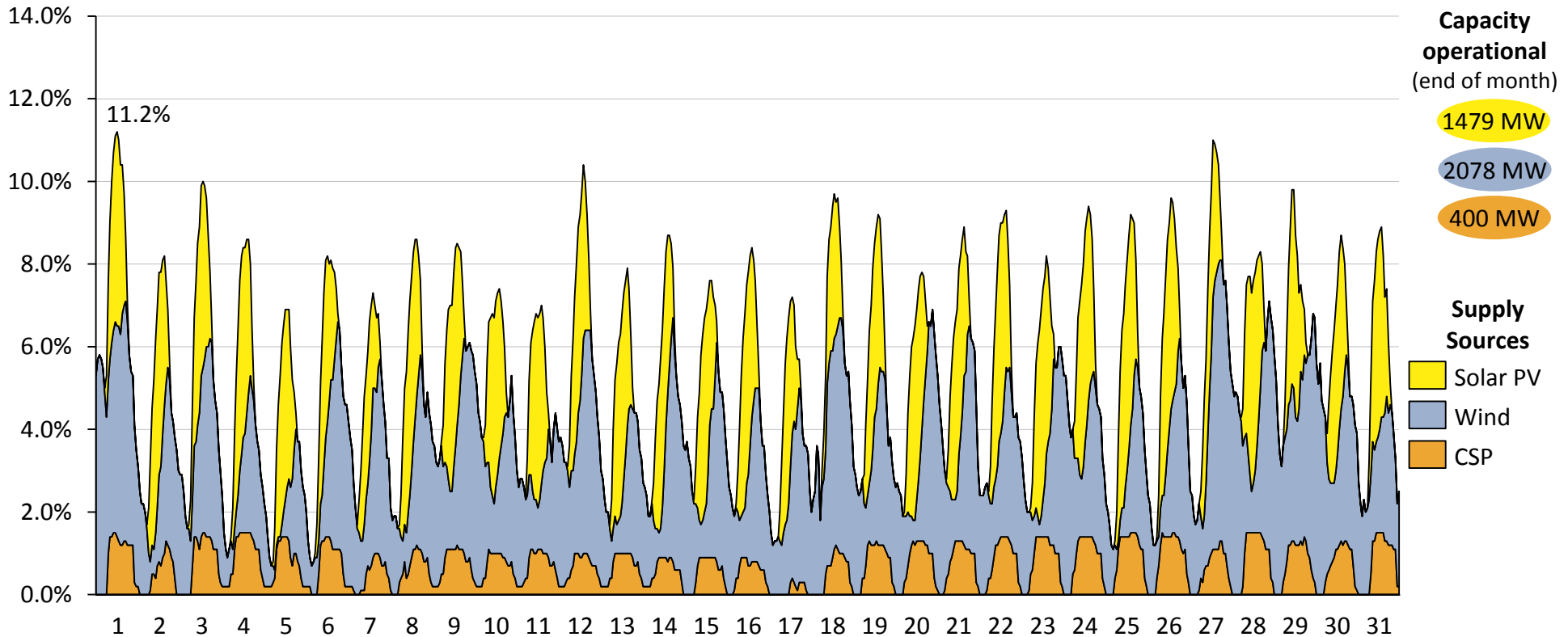


- Maximum solar PV relative contribution of 4.8% between 12h00 and 13h00 on 11 Nov 2018
- Maximum wind relative contribution of 7.4% between 05h00 and 06h00 on 4 Nov 2018
- Maximum CSP relative contribution of 1.1% between 13h00 and 14h00 on 4 Nov 2018

Hourly solar PV, wind & CSP contribution of 0.7-11.2% in Dec 2018

Actual hourly relative solar PV/wind/CSP contribution as a % of total supply in RSA for December 2018

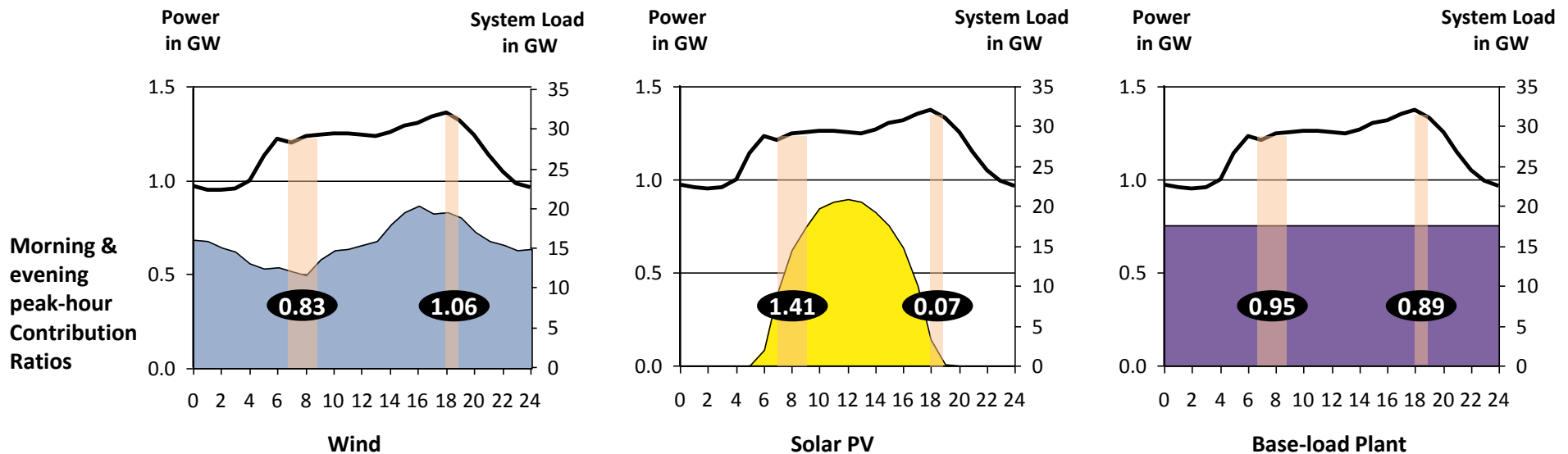
Relative hourly contribution



- Maximum solar PV relative contribution of 5.2% between 13h00 and 14h00 on 25 Dec 2018
- Maximum wind relative contribution of 6.9% between 16h00 and 17h00 on 27 Dec 2018
- Maximum CSP relative contribution of 1.5% between 16h00 and 17h00 on 25 Dec 2018

The peak-hour contribution ratios of solar PV & wind were higher than a base-load plant in the morning & evening peaks respectively

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



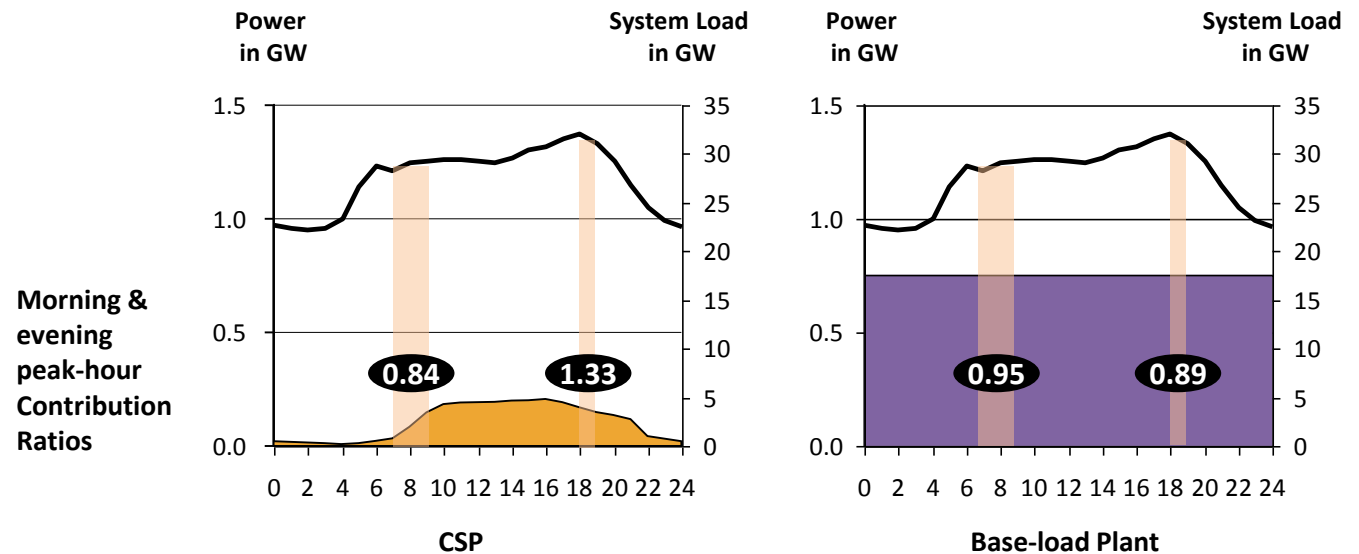
Peak-hour contribution ratio = relative energy contribution during peak / relative total energy contribution

Wind and solar PV morning and evening peak-hour contribution ratios (for all hours from Jan-Dec 2018) show that:

- Wind contributes 6% more energy during the evening peaks than it does during the other hours of the day
- Solar PV contributes 41% more energy in the morning peaks than it does during the other hours of the day

The peak-hour contribution ratio of CSP was higher than a base-load plant in the evening peak

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

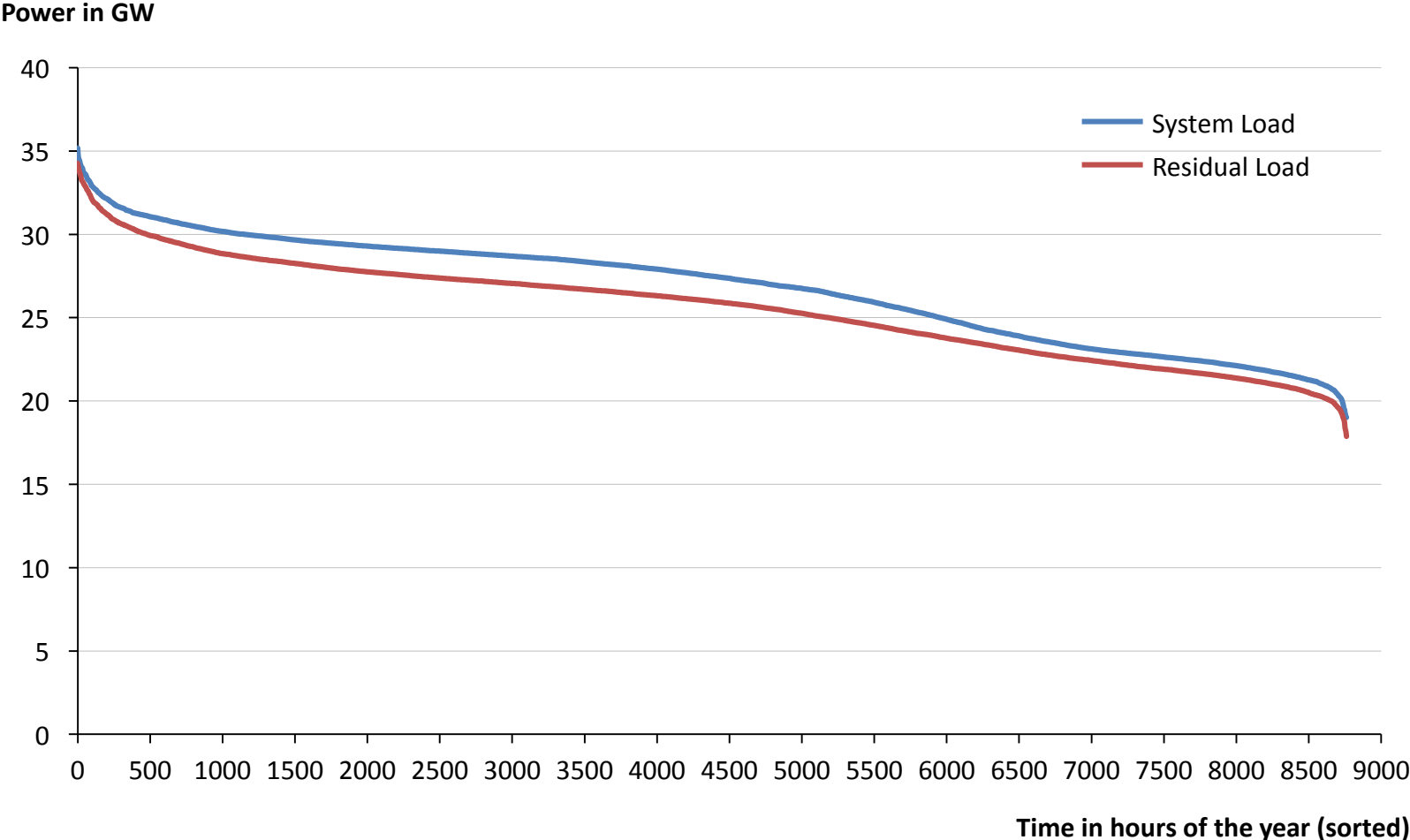


Peak-hour contribution ratio = relative energy contribution during peak / relative total energy contribution

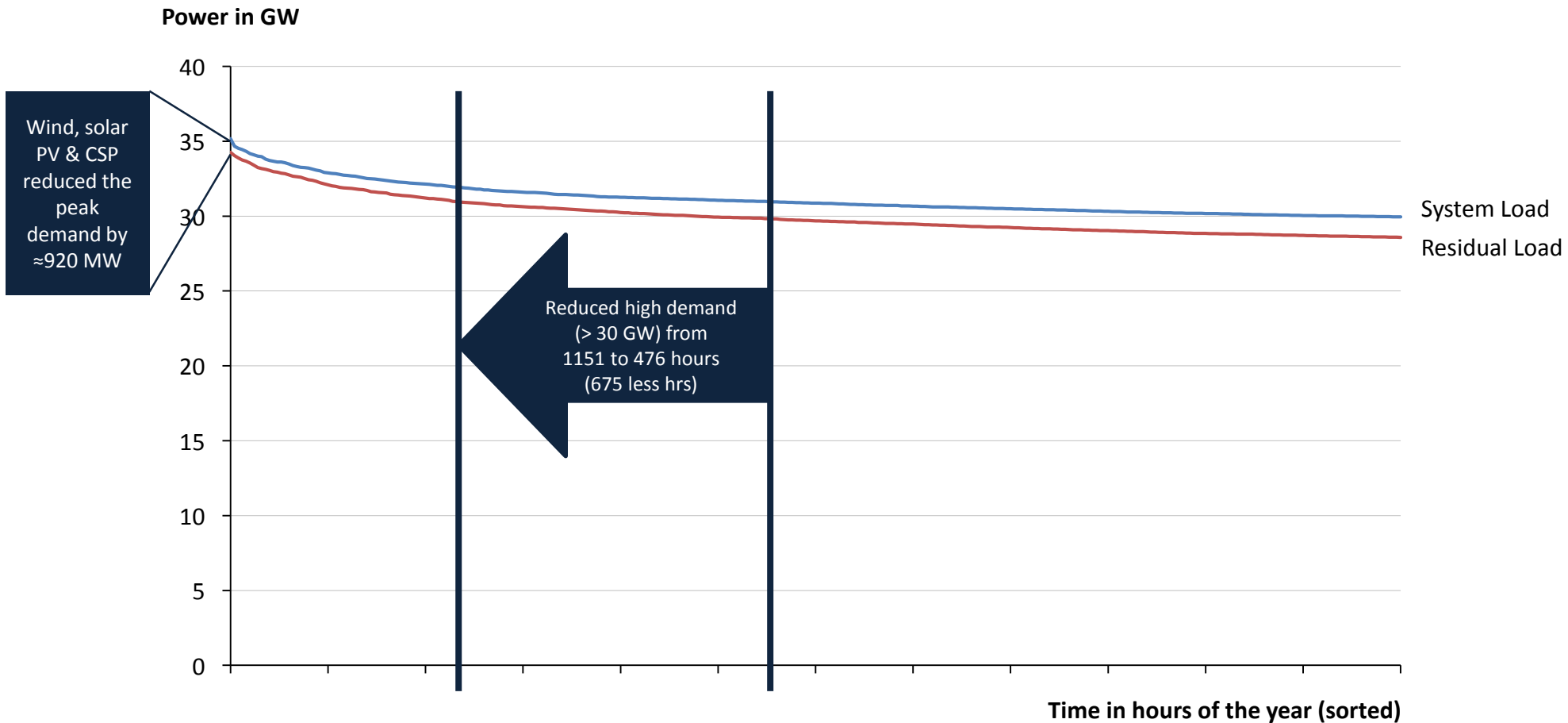
CSP morning and evening peak-hour contribution ratios (for all hours from Jan-Dec 2018) show that:

- CSP contributes 33% more energy during the evening peaks than it does during the other hours of the day

Jan - Dec 2018 system load and residual load duration curves

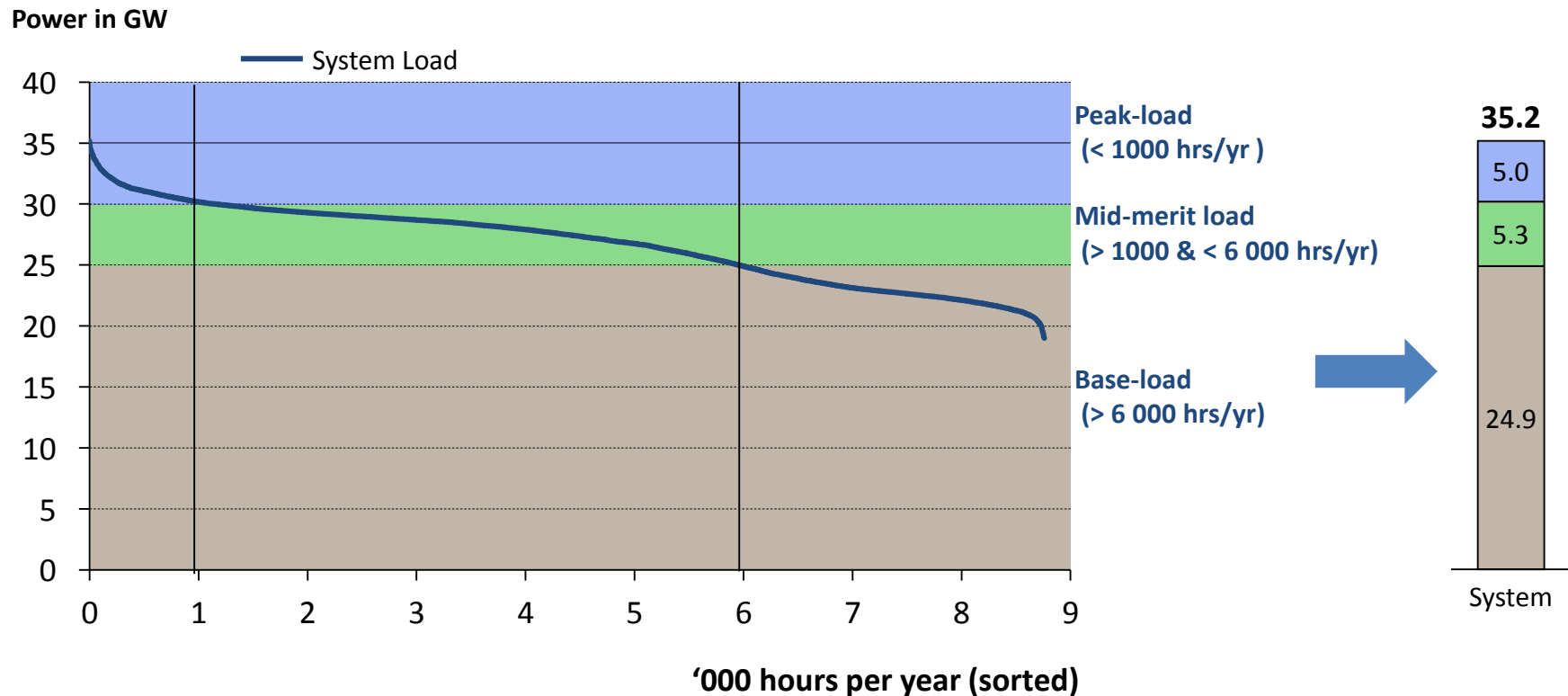


From Jan-Dec 2018 - wind, solar PV & CSP reduced the number of hours with > 30 GW total load from 1151 to 476 (~675 hours less)



System load for 2018 meant peaking type capacity of 5.0 GW, mid-merit capacity of 5.3 GW, and base-load capacity of 24.9 GW

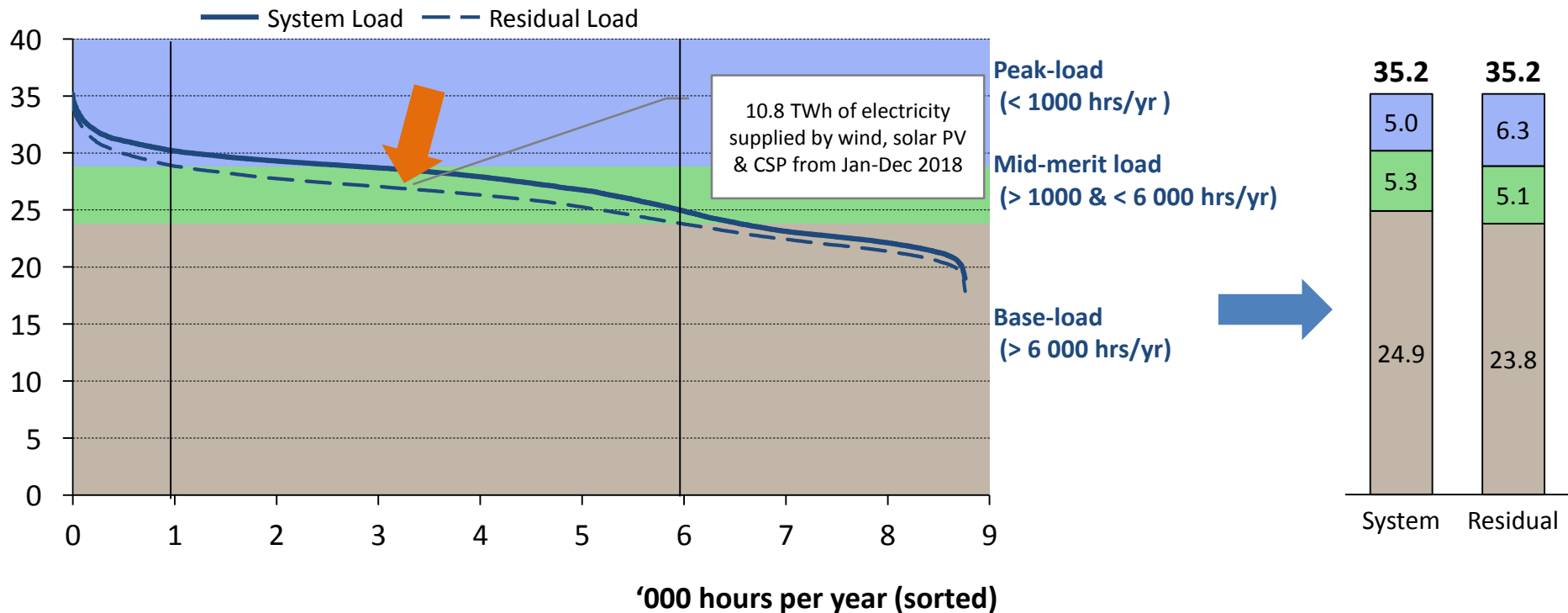
Load Duration Curve for Jan to Dec 2018 as per actual data



Wind/PV/CSP changes shape of residual load to require more peaking type capacity, less mid-merit and notably less base-load type capacity

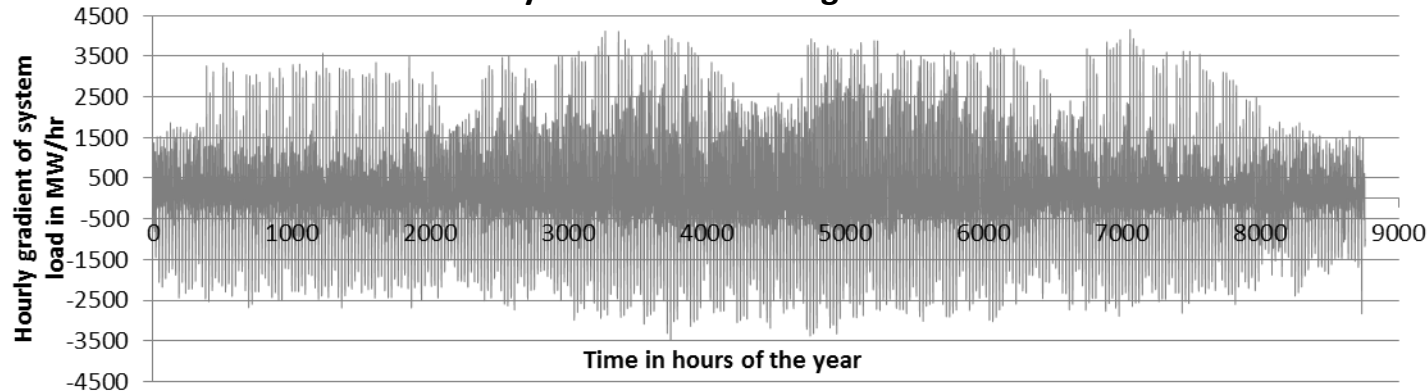
Load Duration Curve for Jan to Dec 2018 as per actual data

Power in GW



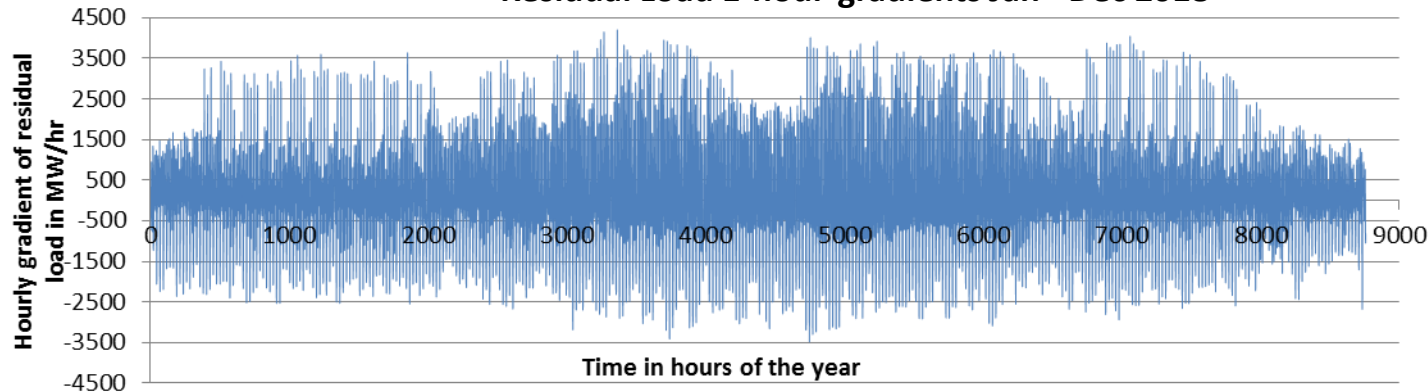
1-hour gradients minimally affected by 4 GW of wind, solar PV & CSP

System Load 1-hour-gradients Jan - Dec 2018



- Max gradient of 4 159 MW/h on 22 Oct 2018 between 05h00 and 06h00
- Min gradient of -3 422 MW/h on 5 June 2018 between 22h00 and 23h00

Residual Load 1-hour-gradients Jan - Dec 2018

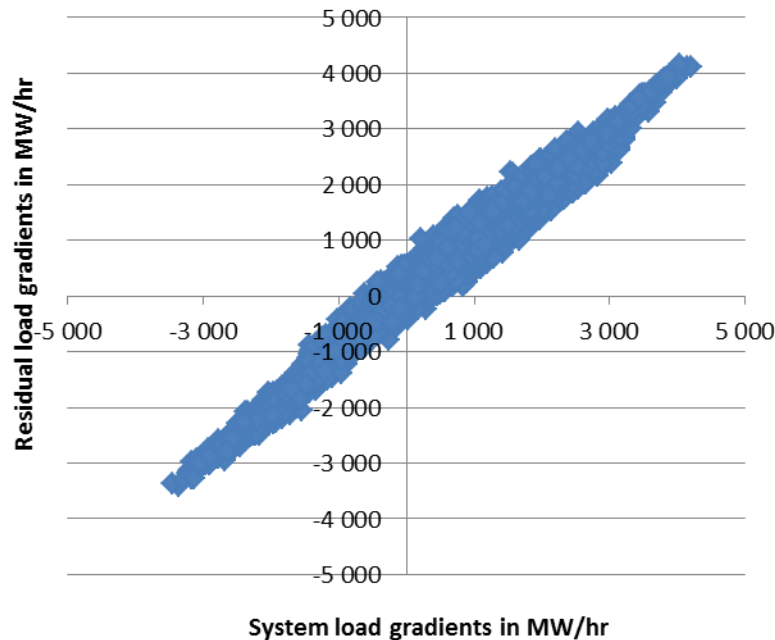


- Max gradient of 4 197 MW/h on 21 May 2018 between 05h00 and 06h00
- Min gradient of -3 462 MW/h on 17 July 2018 between 22h00 and 23h00

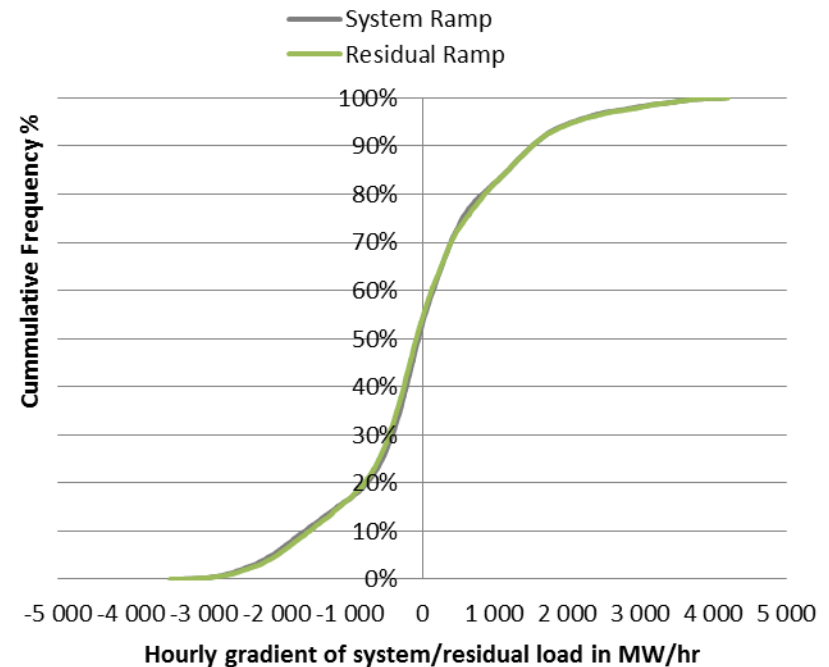
Residual load = System load - Solar PV - Wind - CSP

1-hour gradients did not increase due to 4 GW of wind, solar PV & CSP

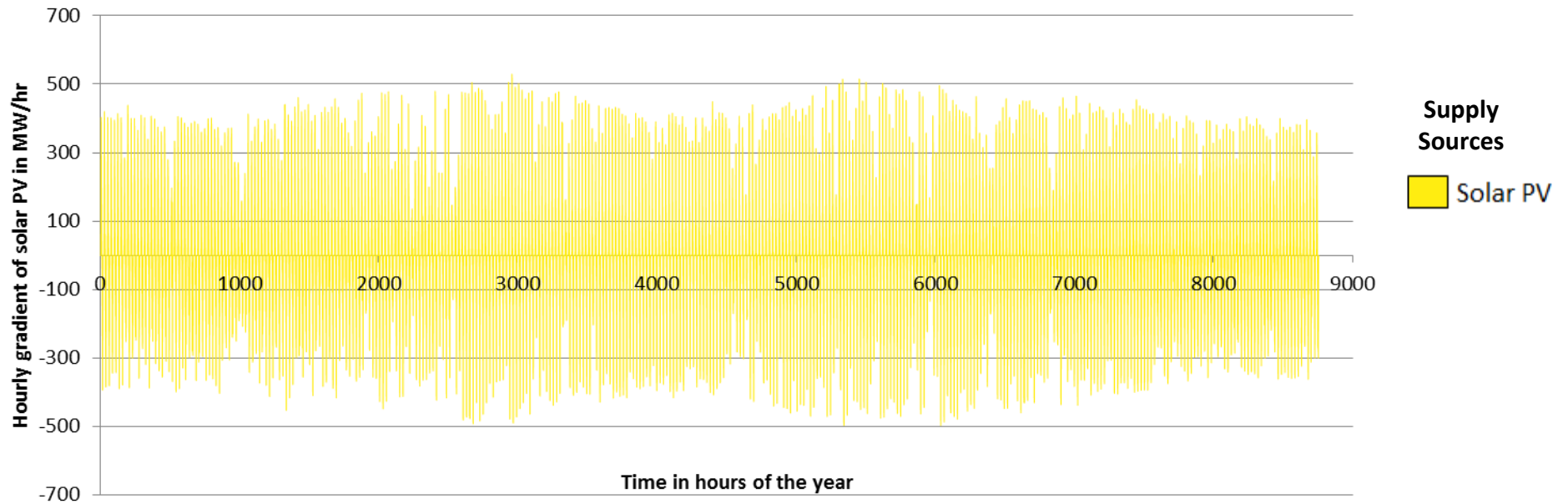
System load 1-hour gradients vs. residual load 1-hour gradients for all hours from Jan – Dec 2018



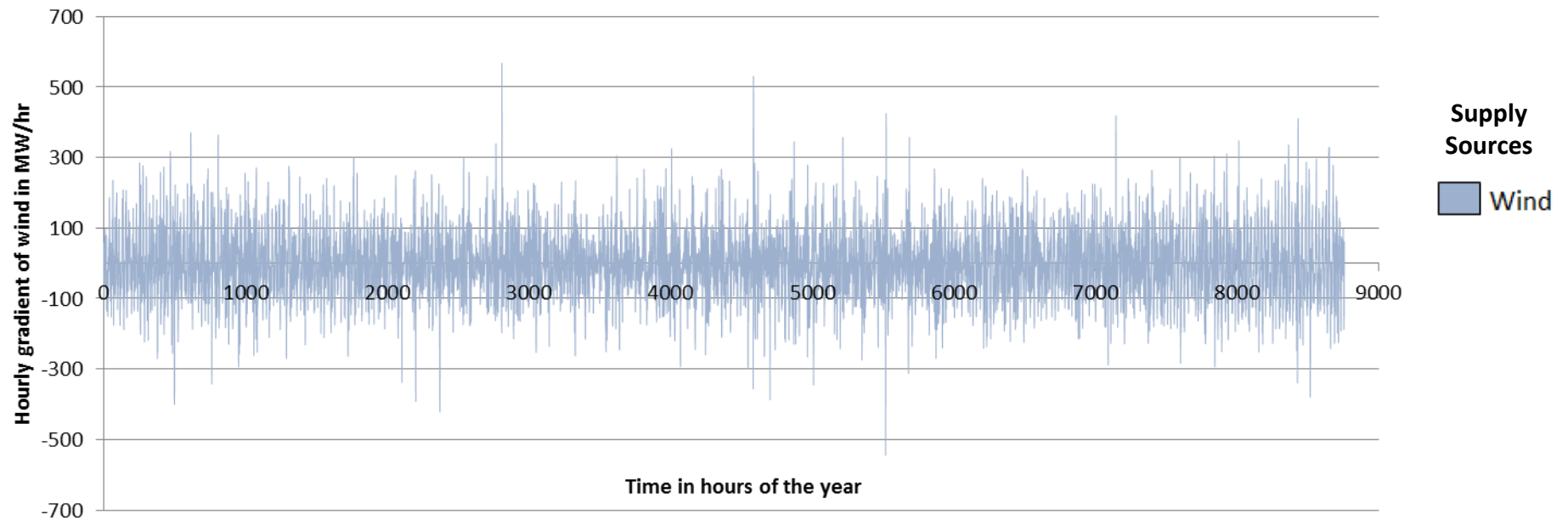
Cumulative frequency distribution of 1-hour gradients for all hours from Jan – Dec 2018



Jan - Dec 2018 1-hour gradients of solar PV supply

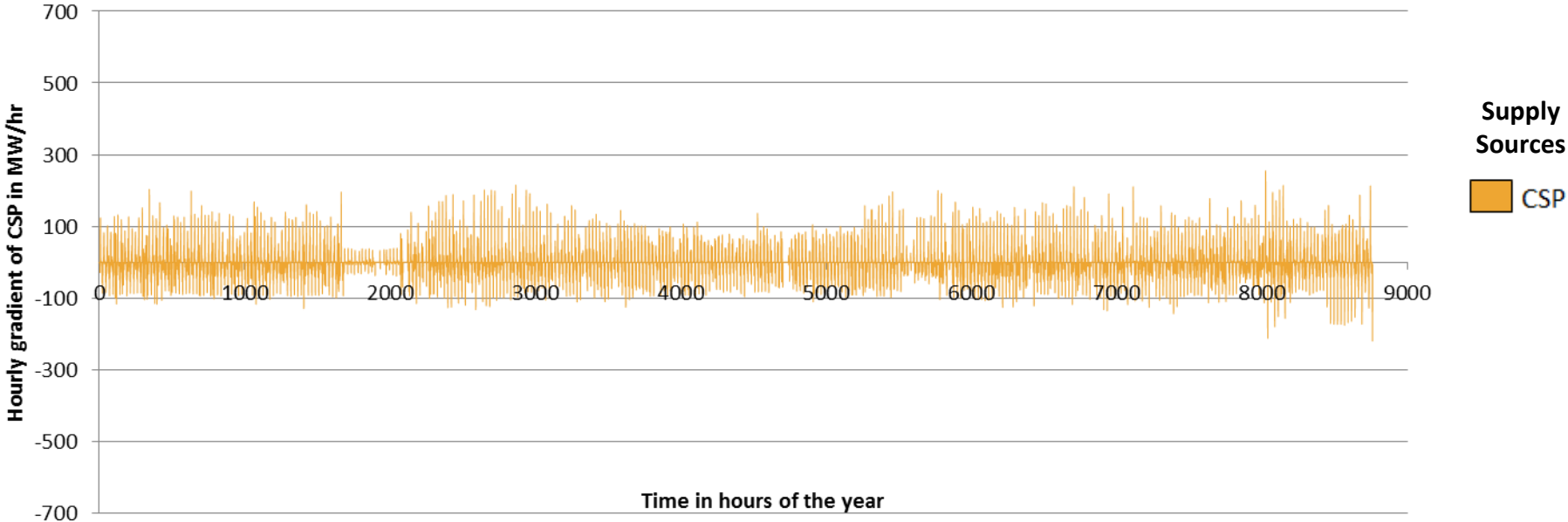


Jan - Dec 2018: 1-hour gradients of wind supply



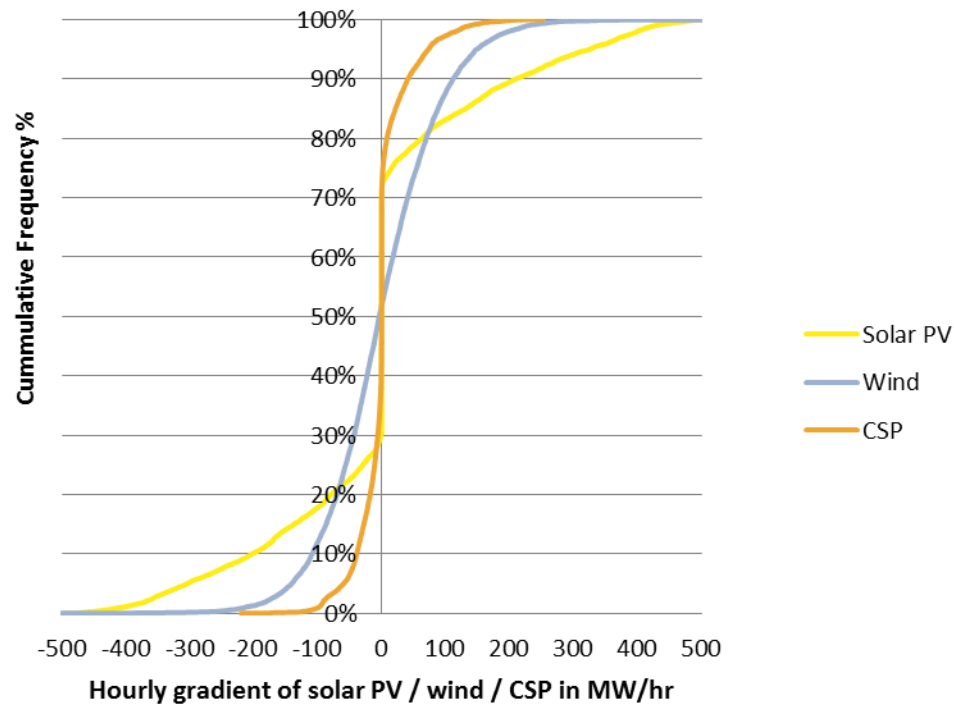
- Large wind gradient spike of 564 MW on 28 Apr 2018 between 04h00 and 05h00 due to System Operator curtailment of wind IPPs in response to a combination of minimum thermal generation constraints and low demand

Jan - Dec 2018 1-hour gradients of CSP supply

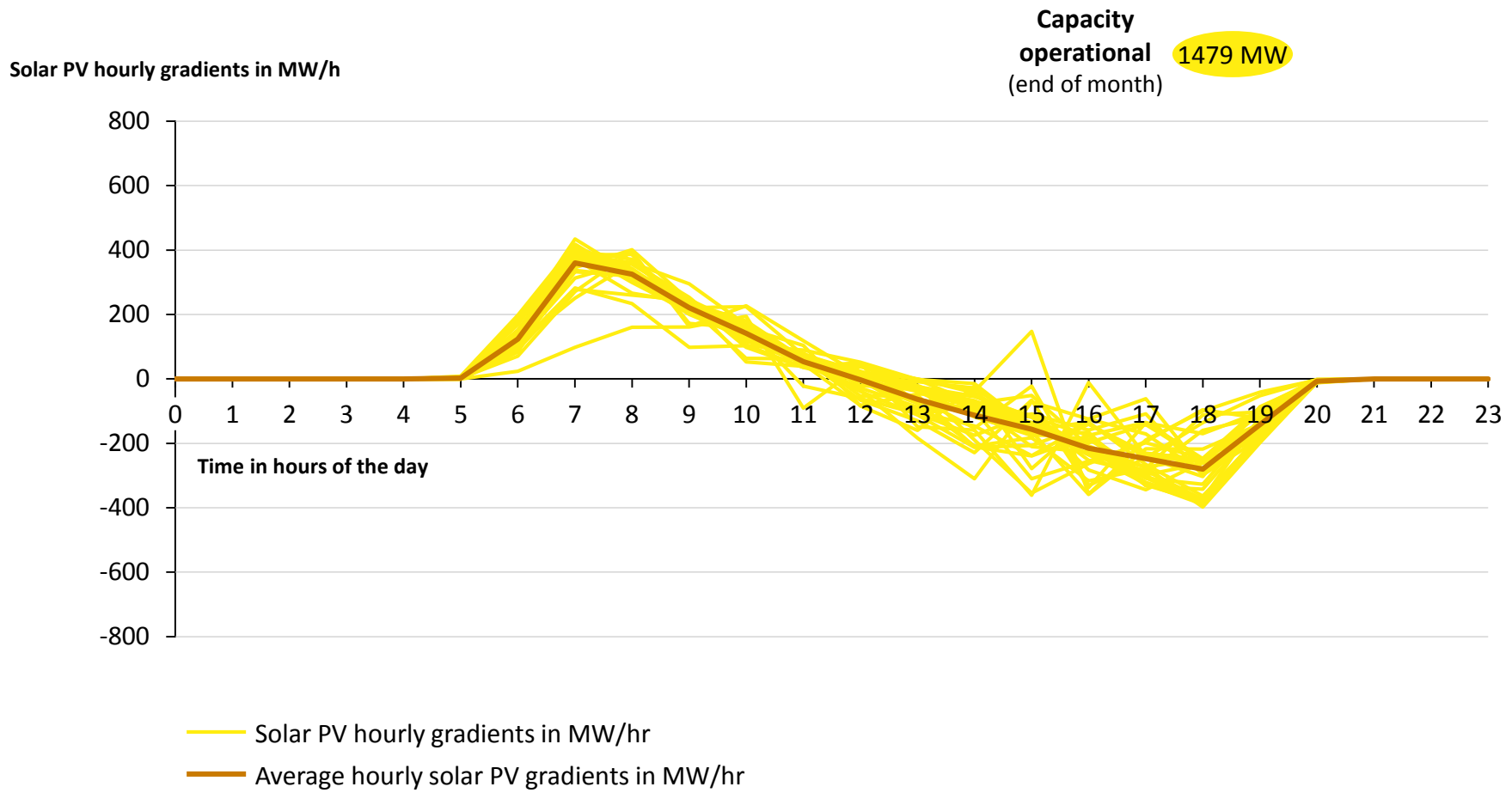


Jan - Dec 2018 wind, solar PV and CSP frequency distribution of 1-hour gradients

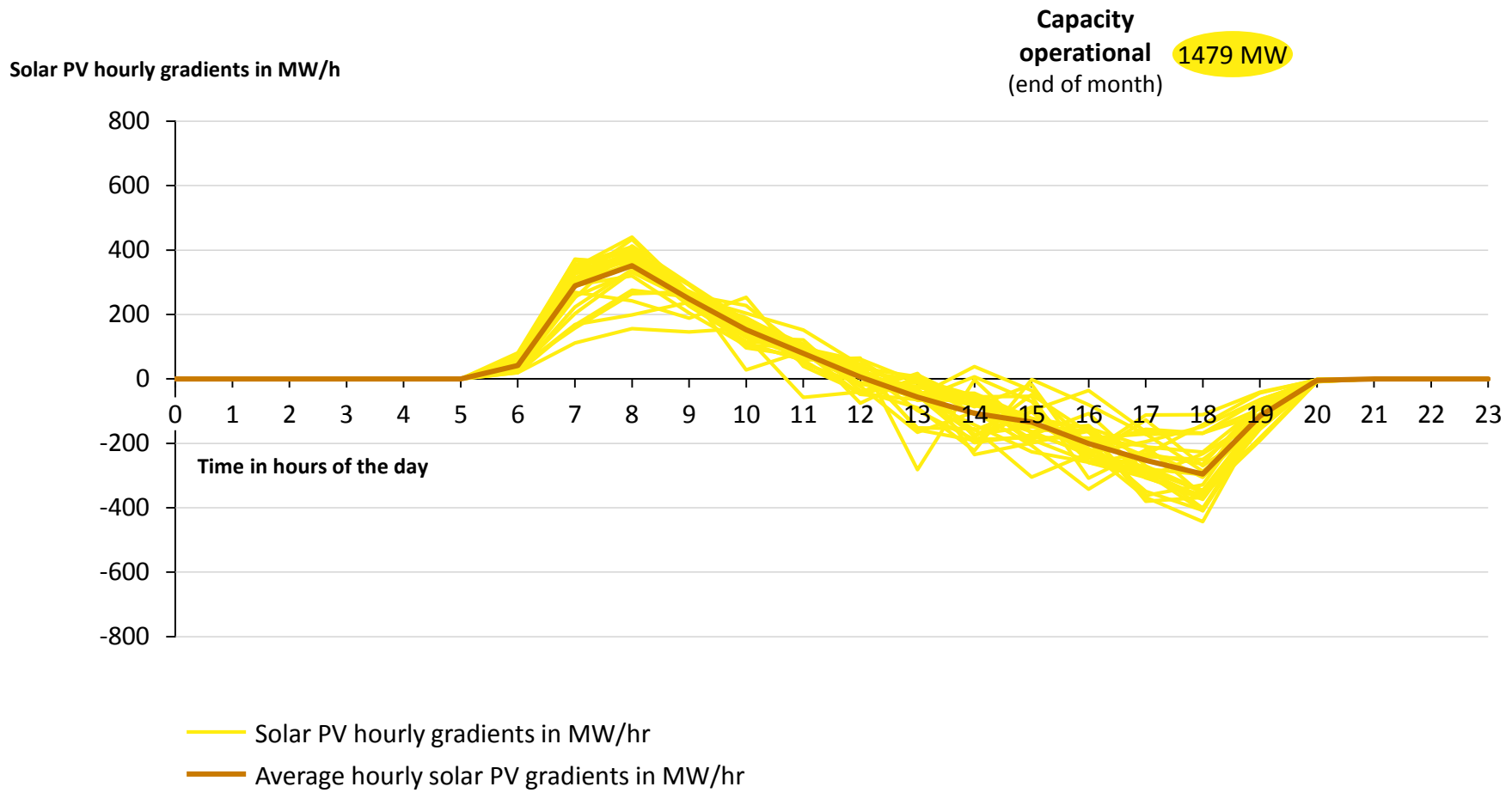
- Cumulative frequency distribution of 1-hour gradients for all hours from Jan – Dec 2018



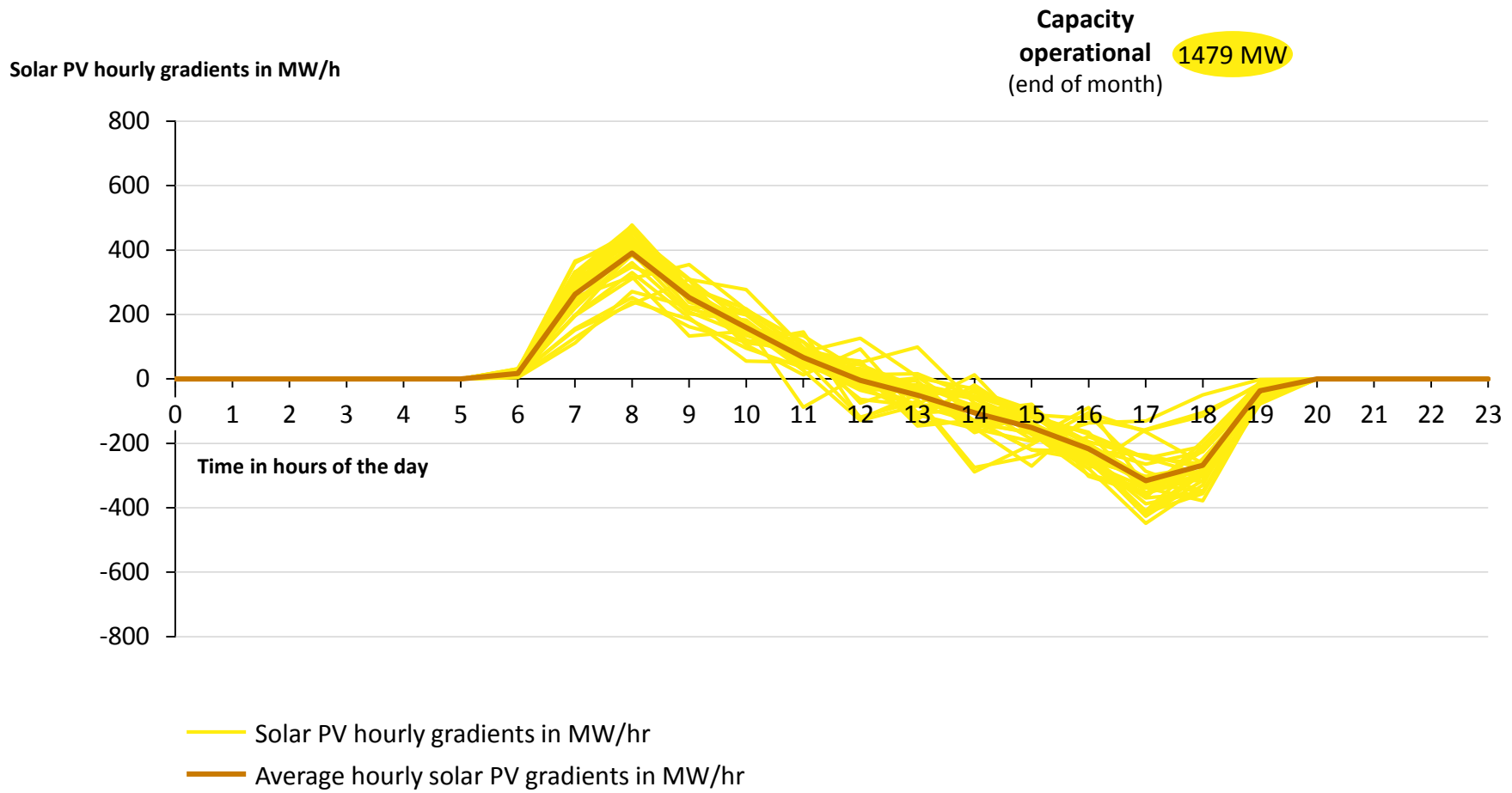
Solar PV 1-hour gradients in January 2018



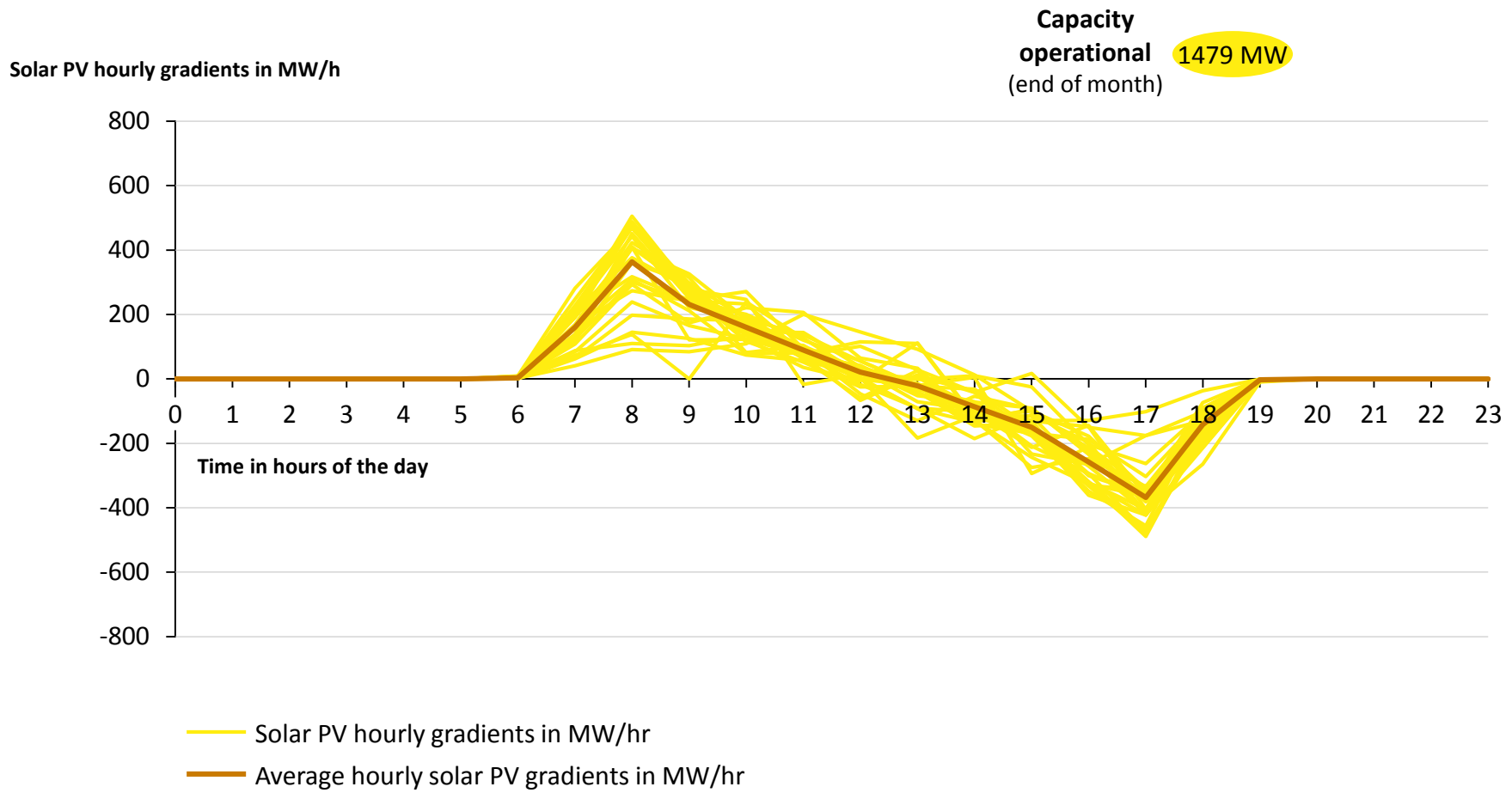
Solar PV 1-hour gradients in February 2018



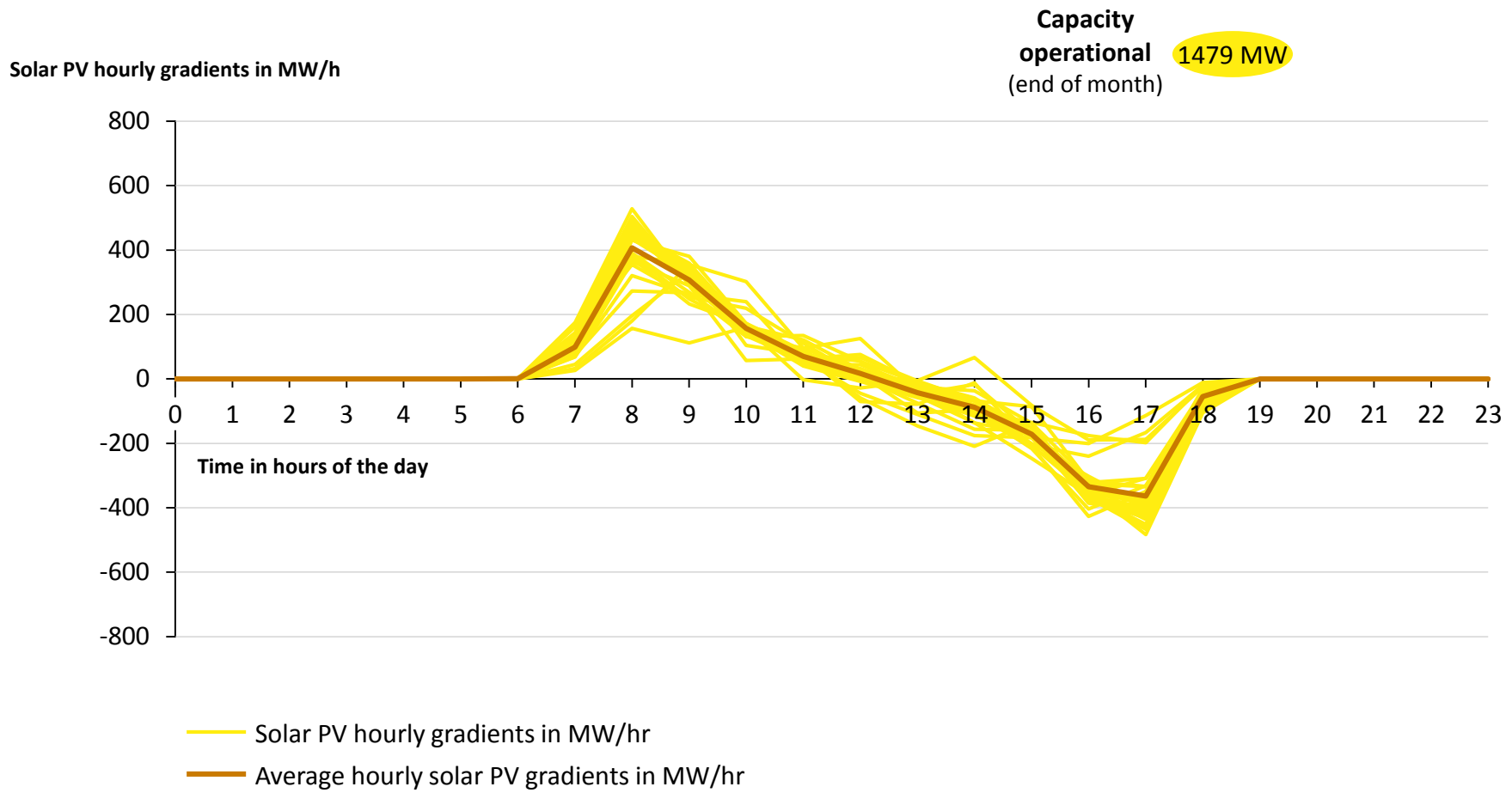
Solar PV 1-hour gradients in March 2018



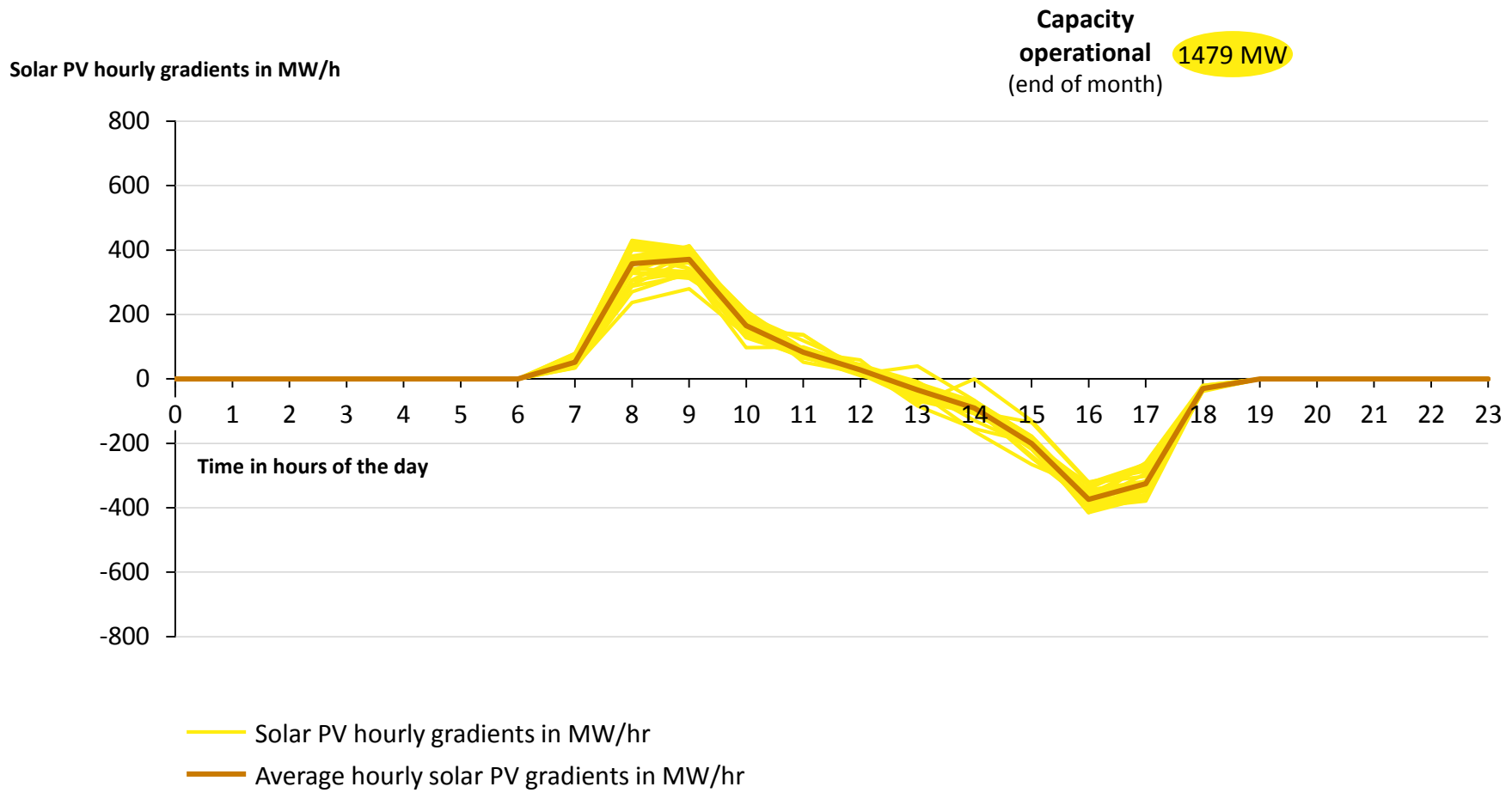
Solar PV 1-hour gradients in April 2018



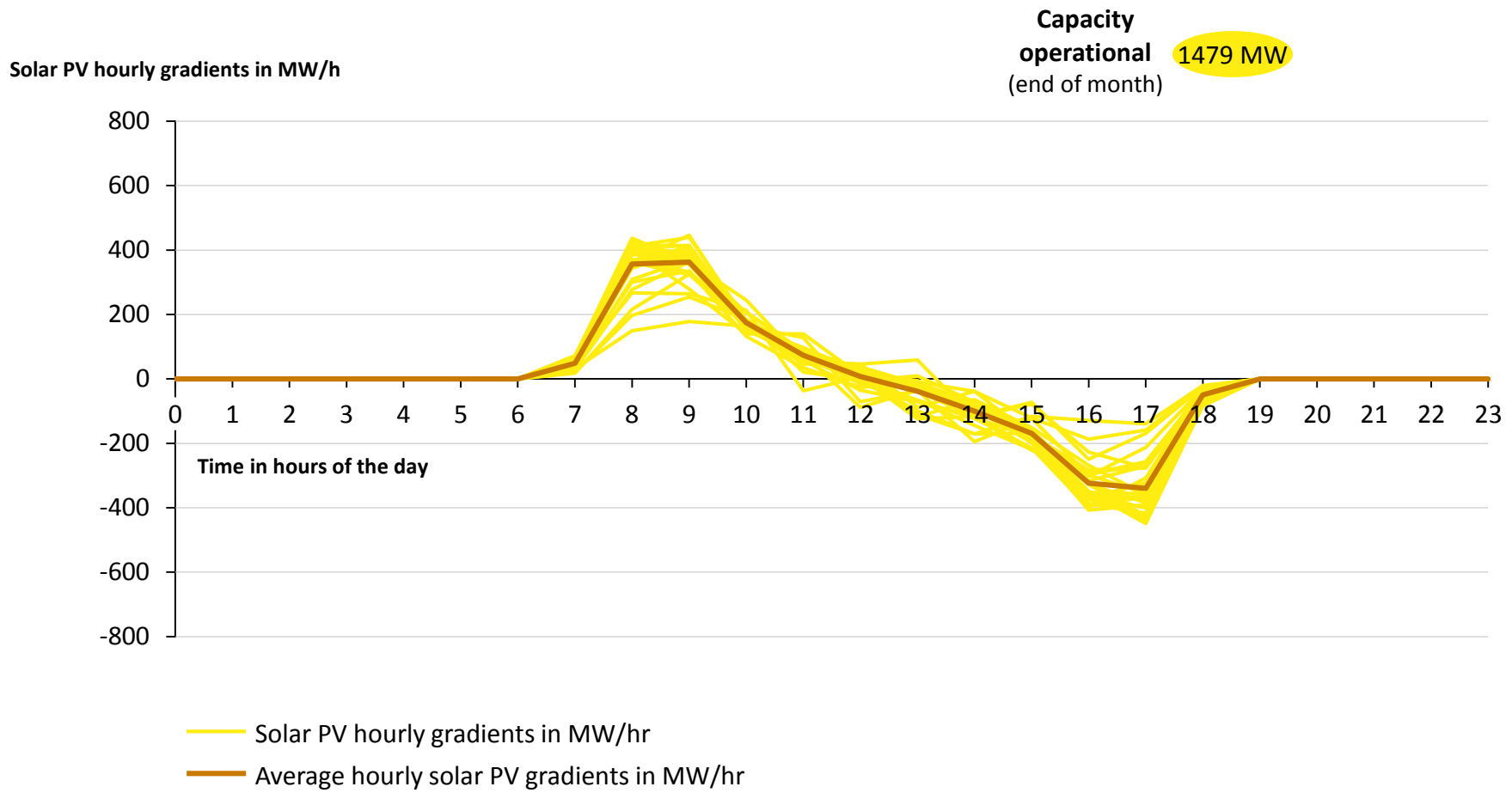
Solar PV 1-hour gradients in May 2018



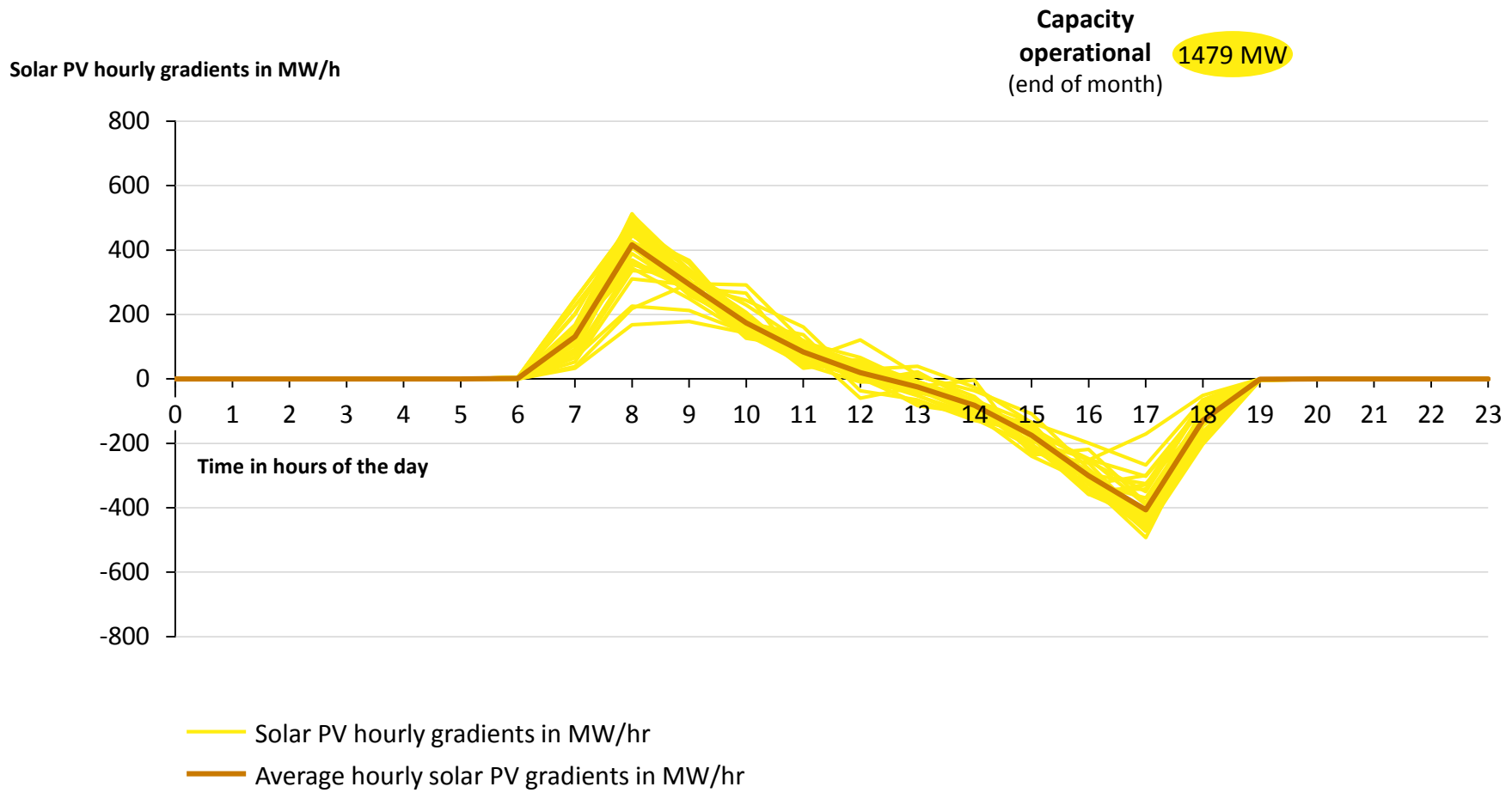
Solar PV 1-hour gradients in June 2018



Solar PV 1-hour gradients in July 2018



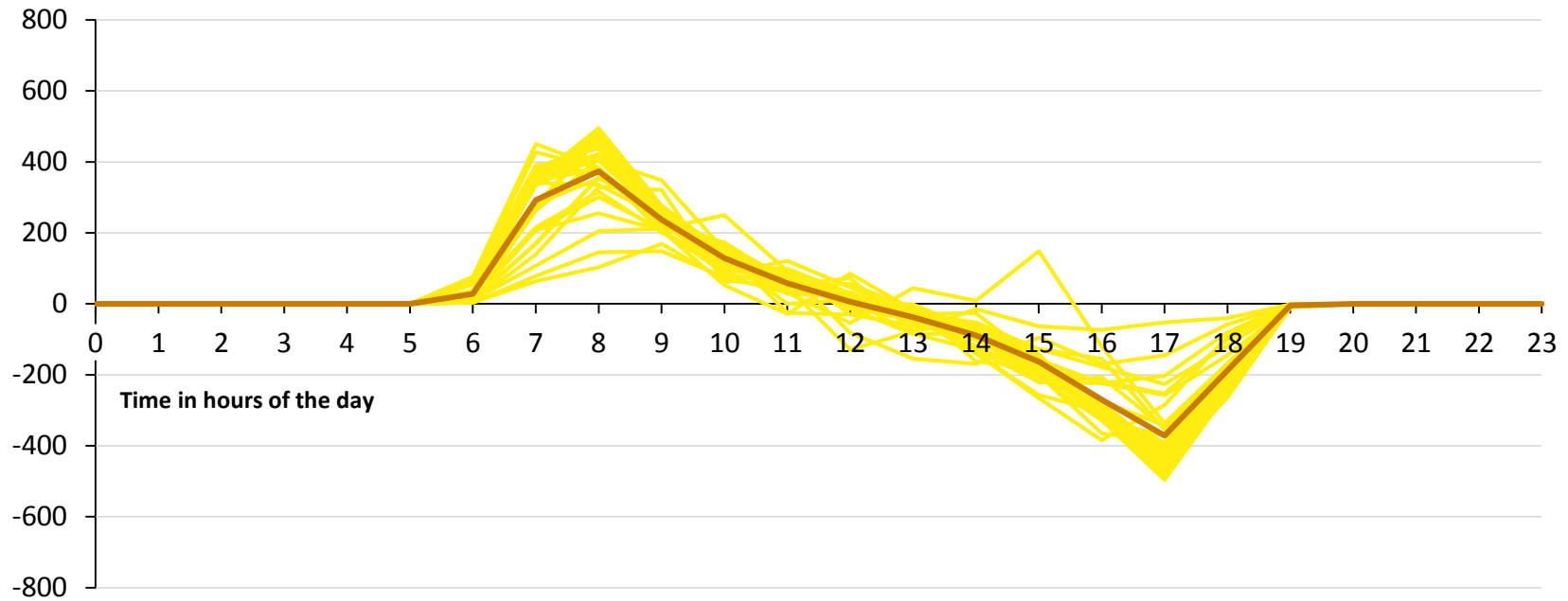
Solar PV 1-hour gradients in August 2018



Solar PV 1-hour gradients in September 2018

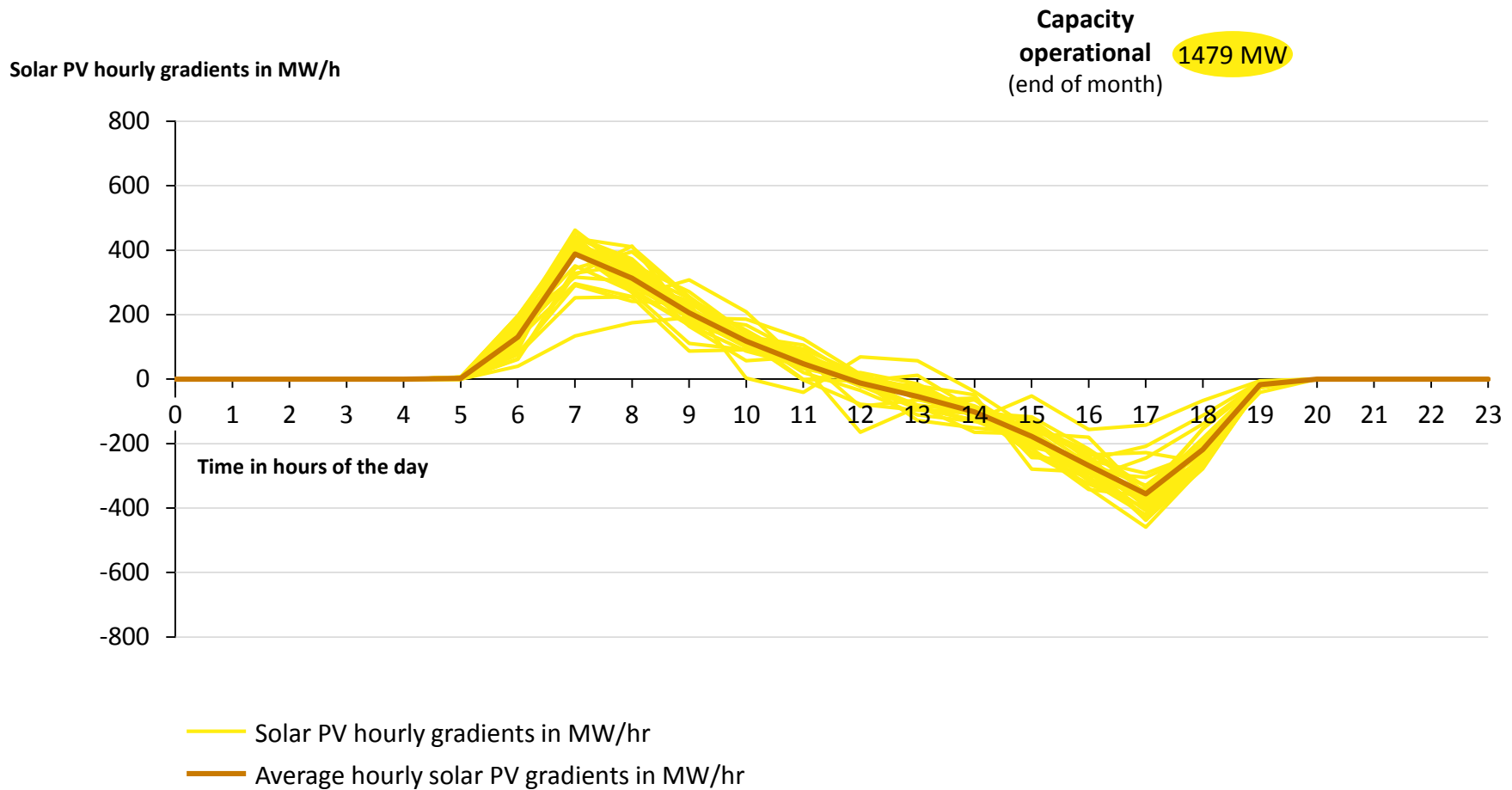
Solar PV hourly gradients in MW/h

Capacity operational (end of month) 1479 MW

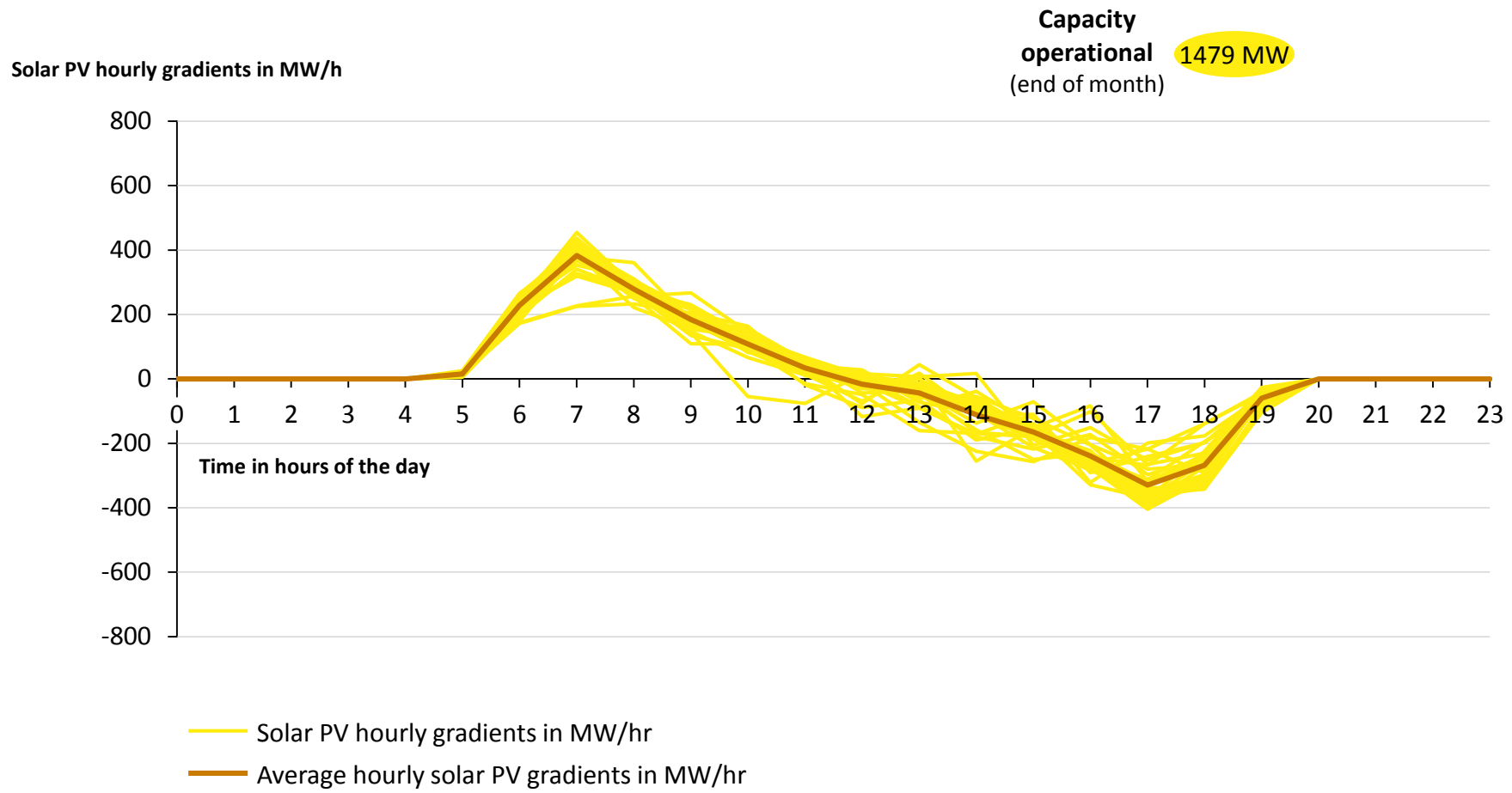


- Solar PV hourly gradients in MW/hr
- Average hourly solar PV gradients in MW/hr

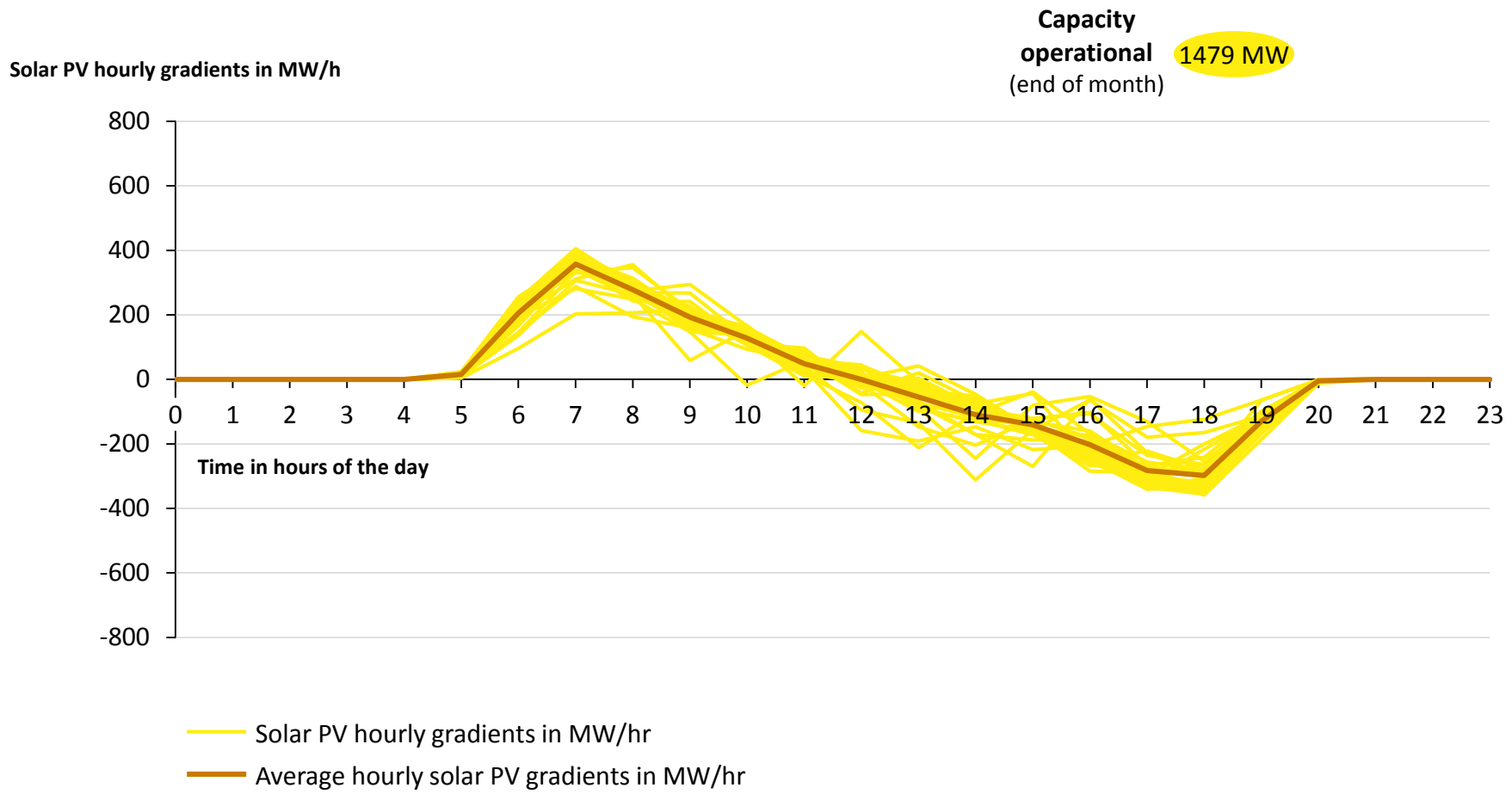
Solar PV 1-hour gradients in October 2018



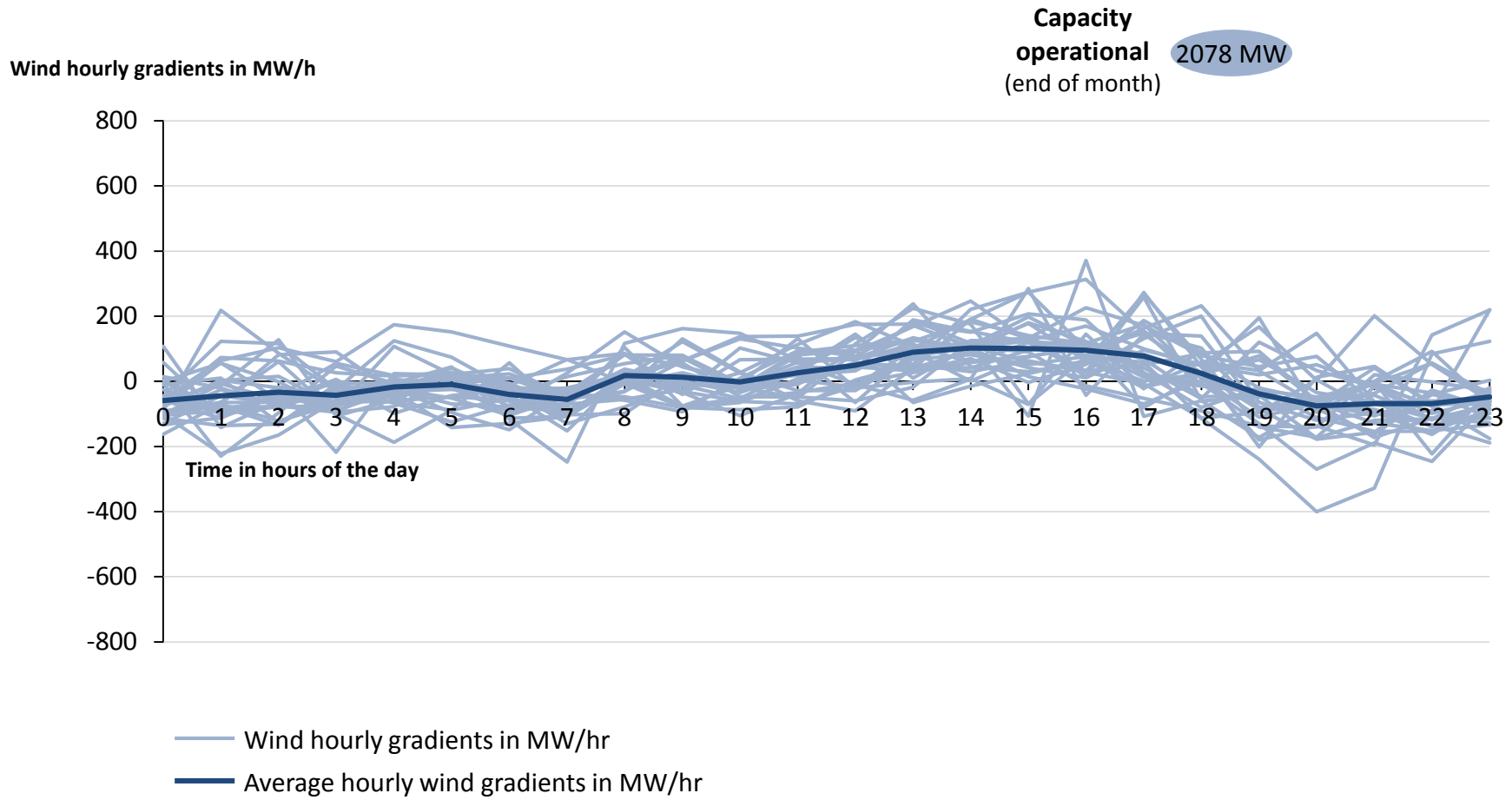
Solar PV 1-hour gradients in November 2018



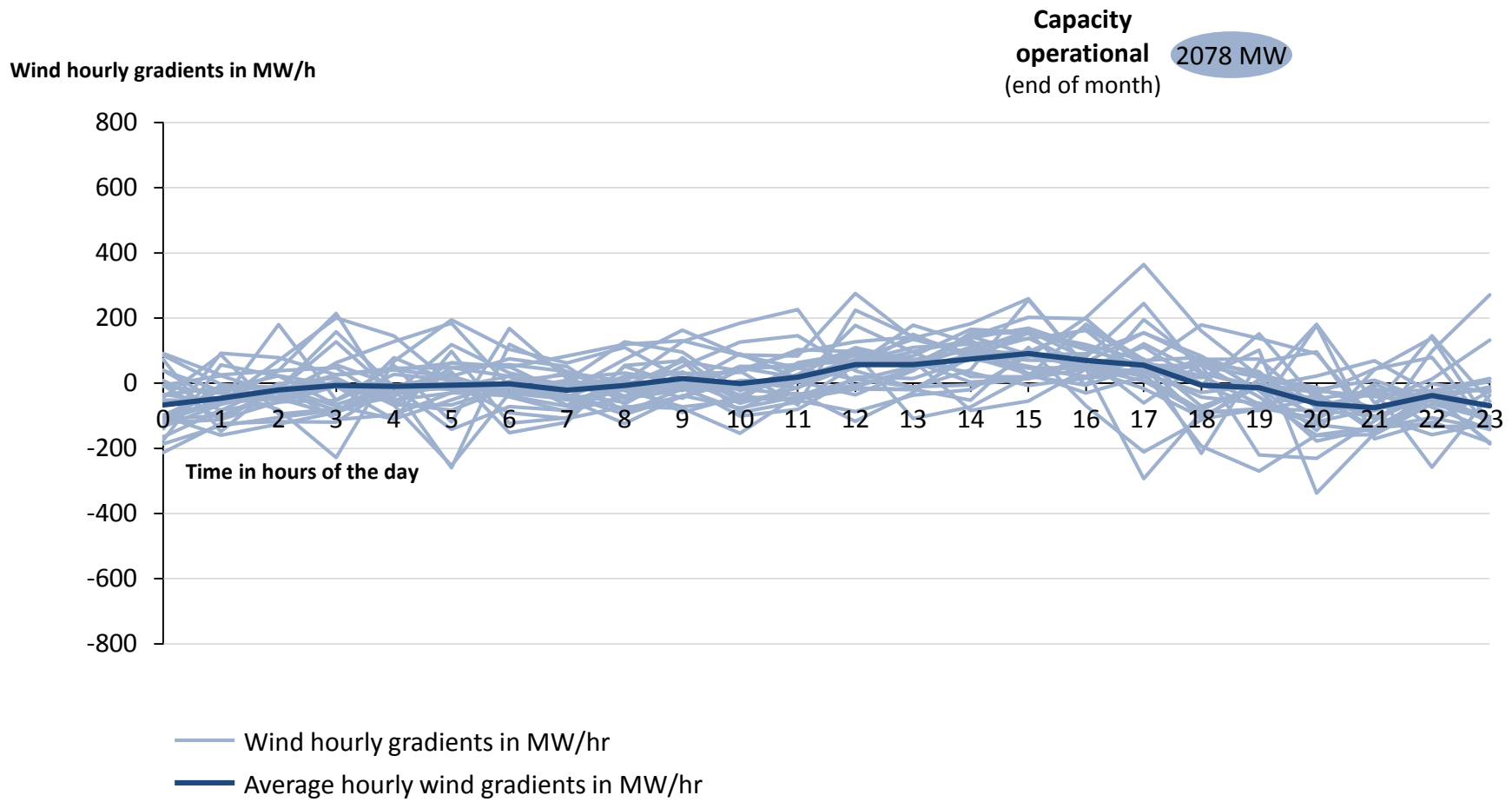
Solar PV 1-hour gradients in December 2018



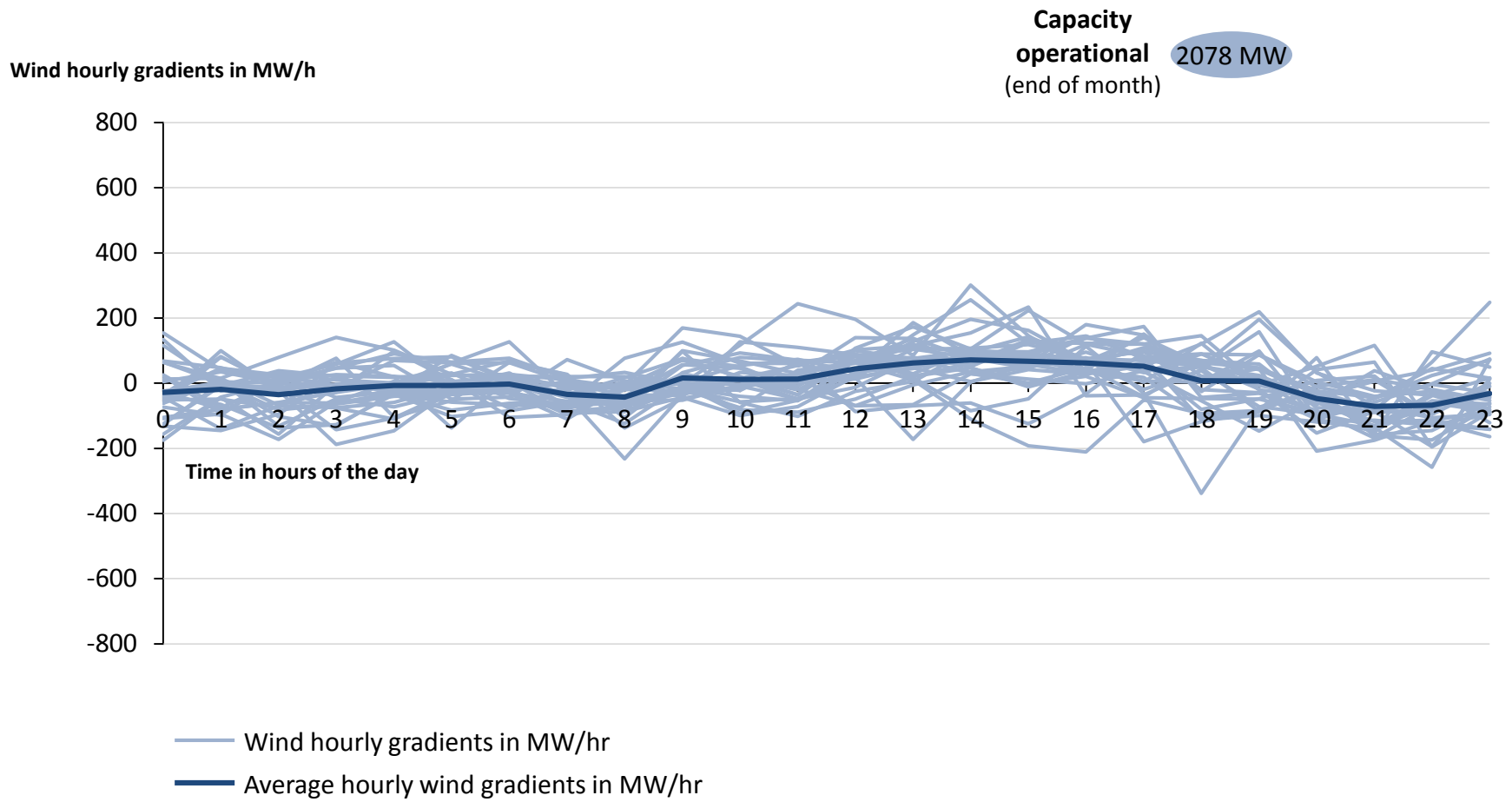
Wind 1-hour gradients in January 2018



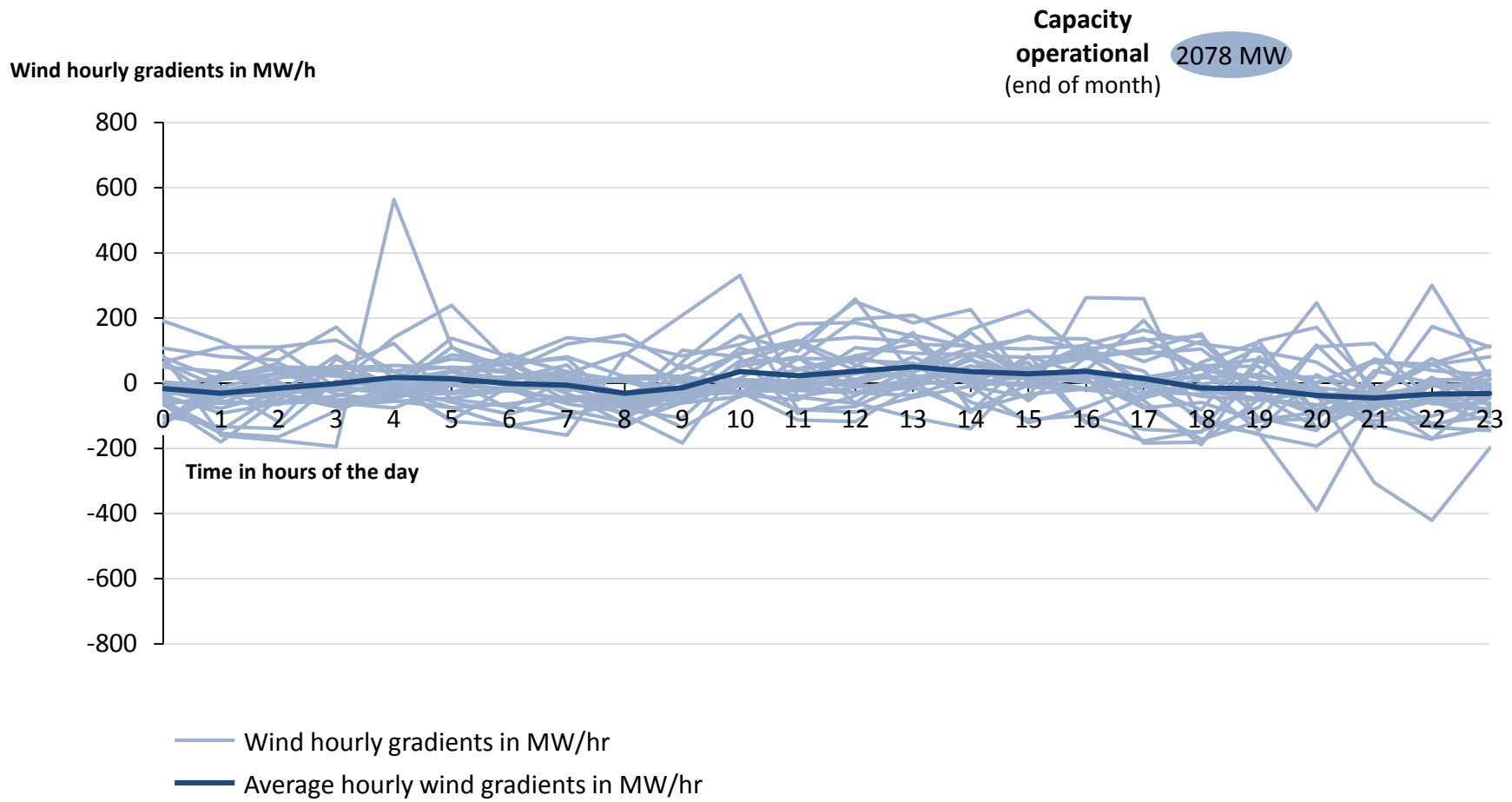
Wind 1-hour gradients in February 2018



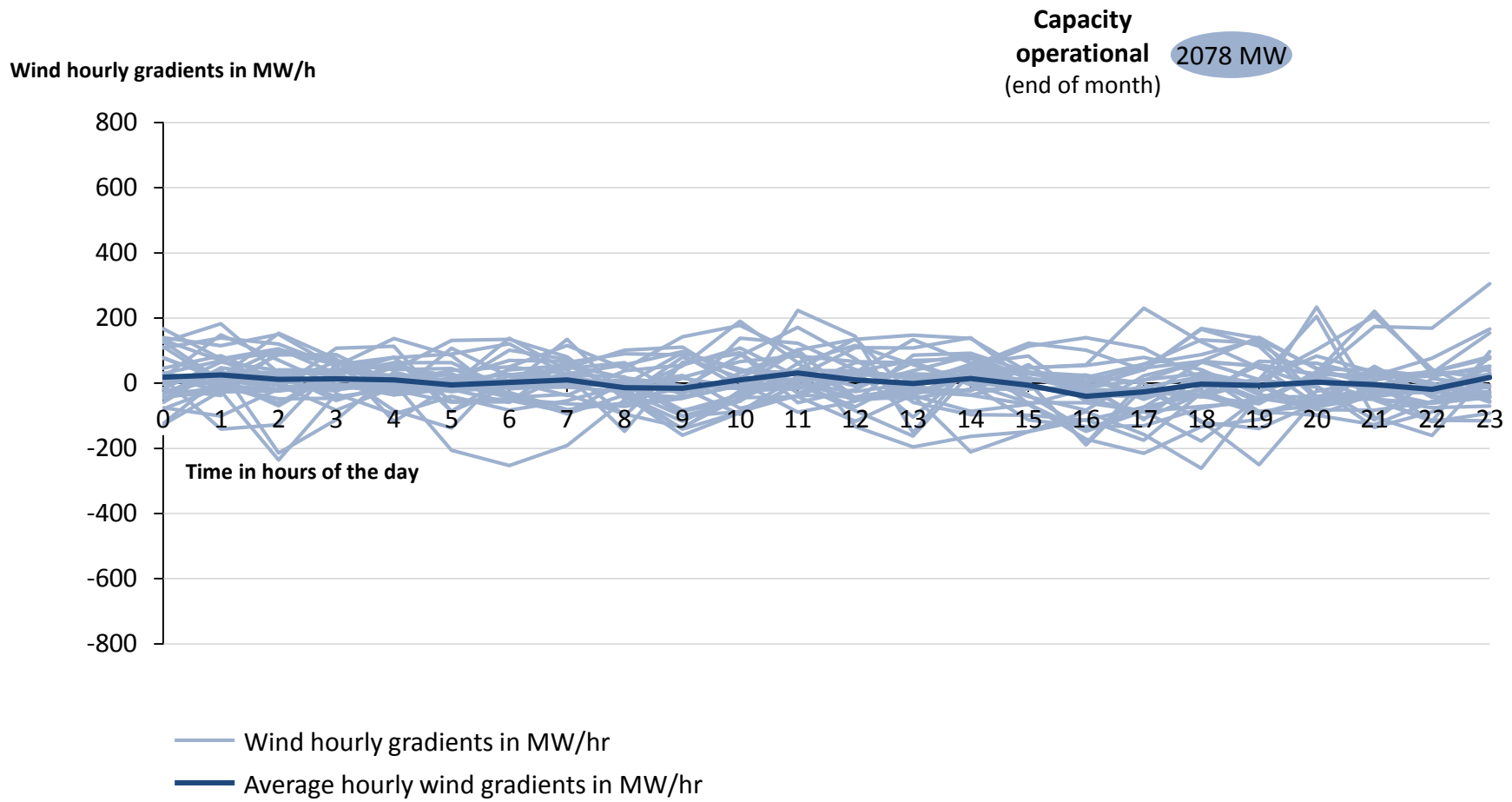
Wind 1-hour gradients in March 2018



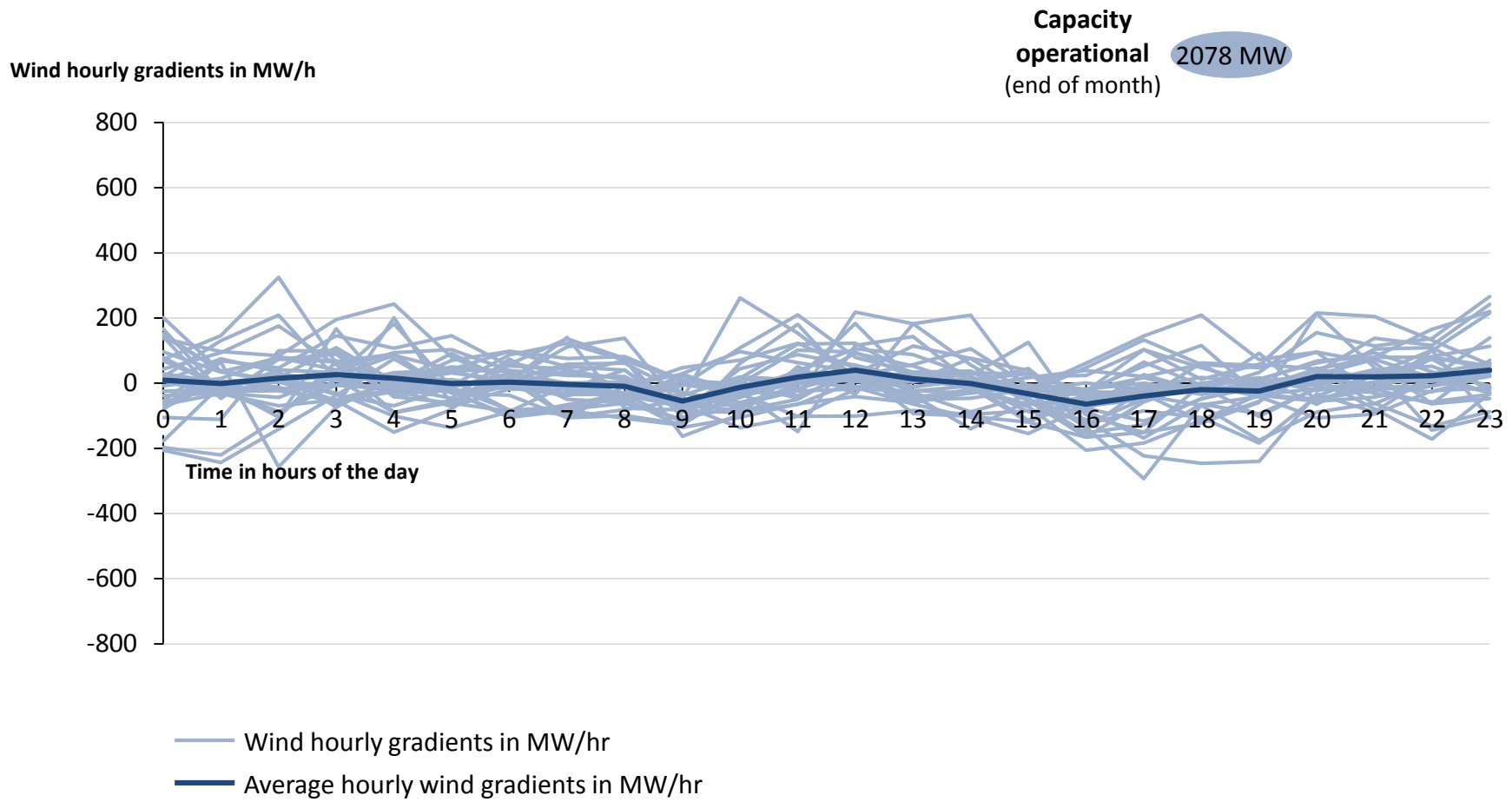
Wind 1-hour gradients in April 2018



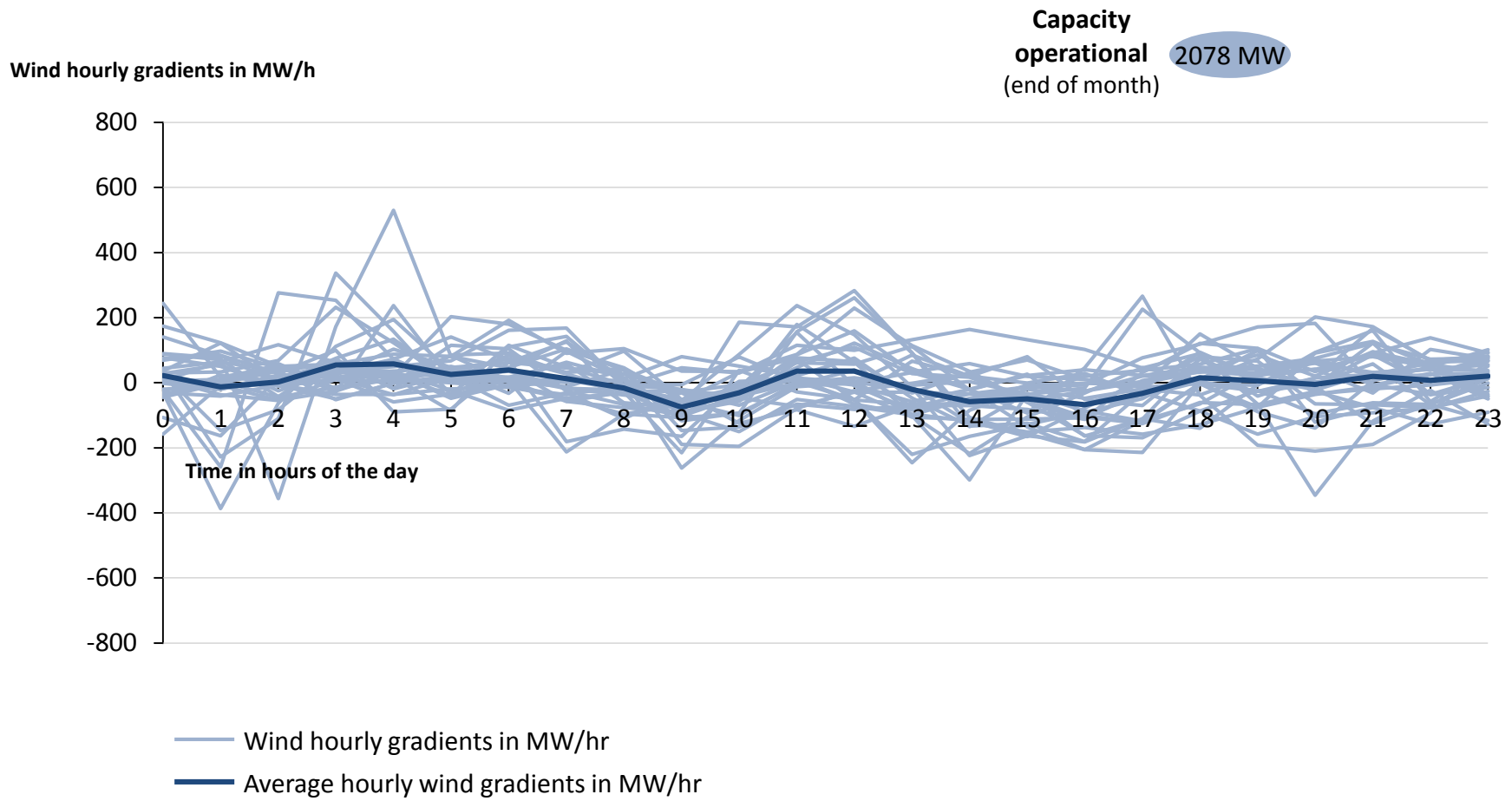
Wind 1-hour gradients in May 2018



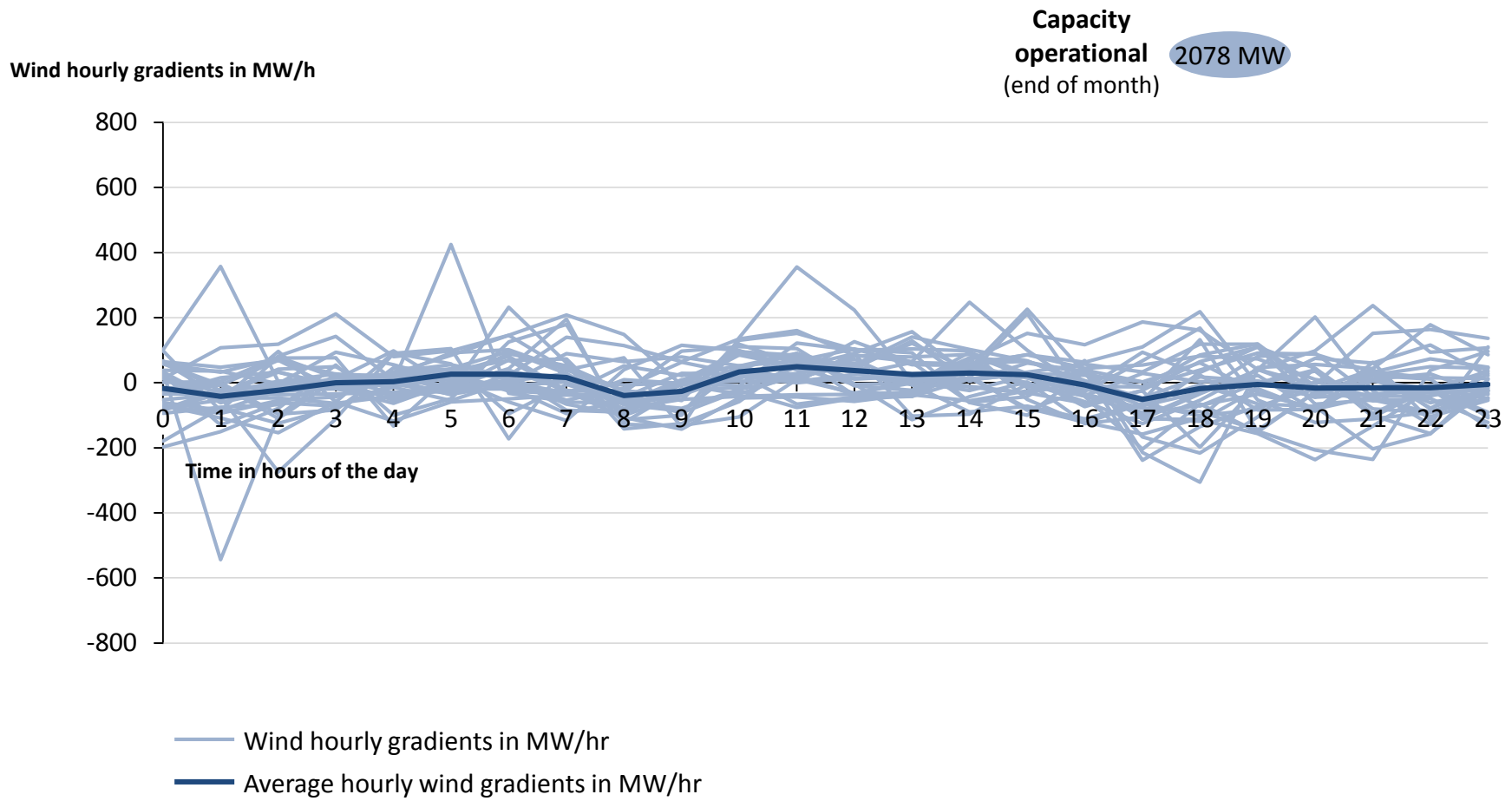
Wind 1-hour gradients in June 2018



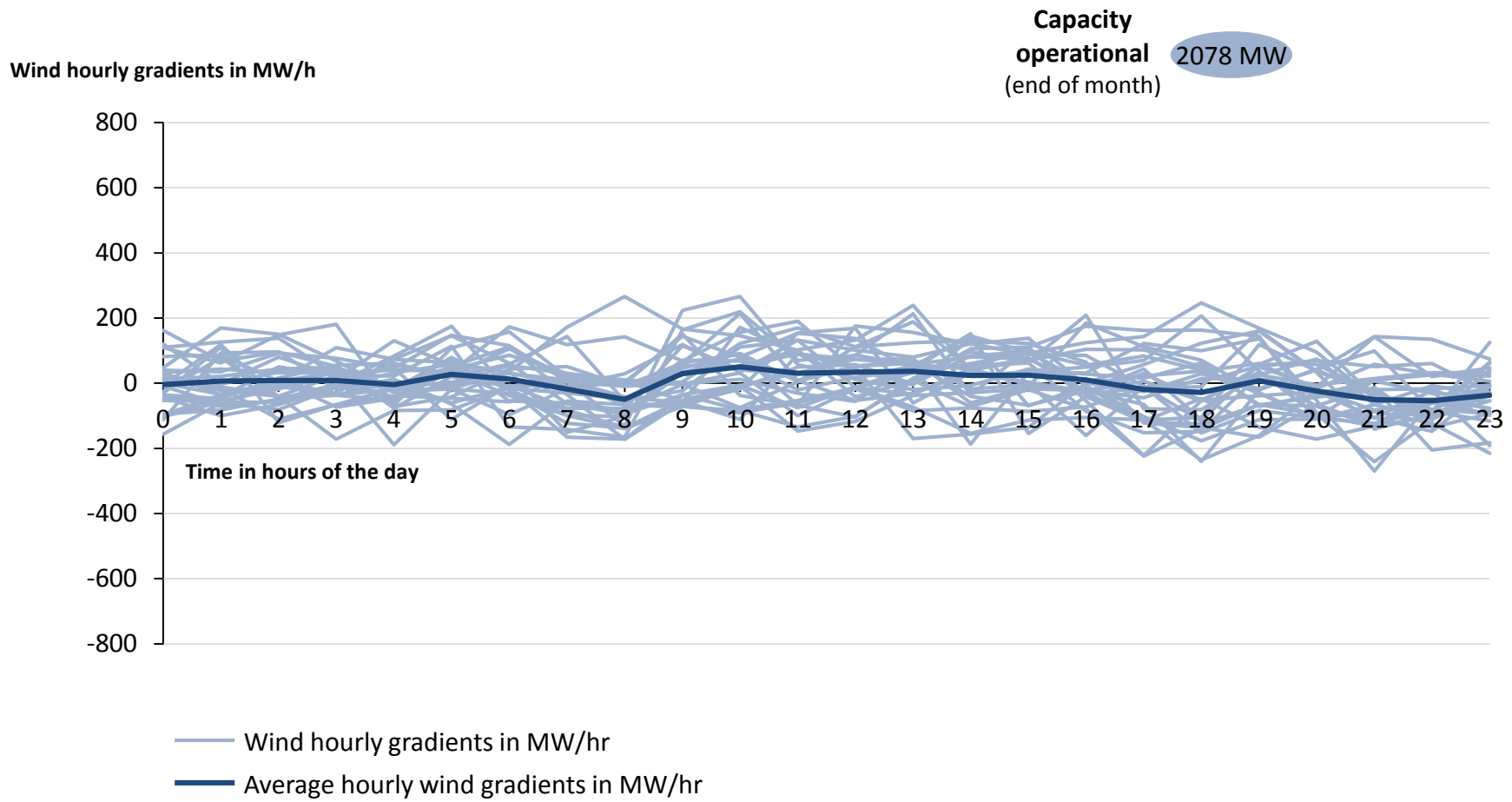
Wind 1-hour gradients in July 2018



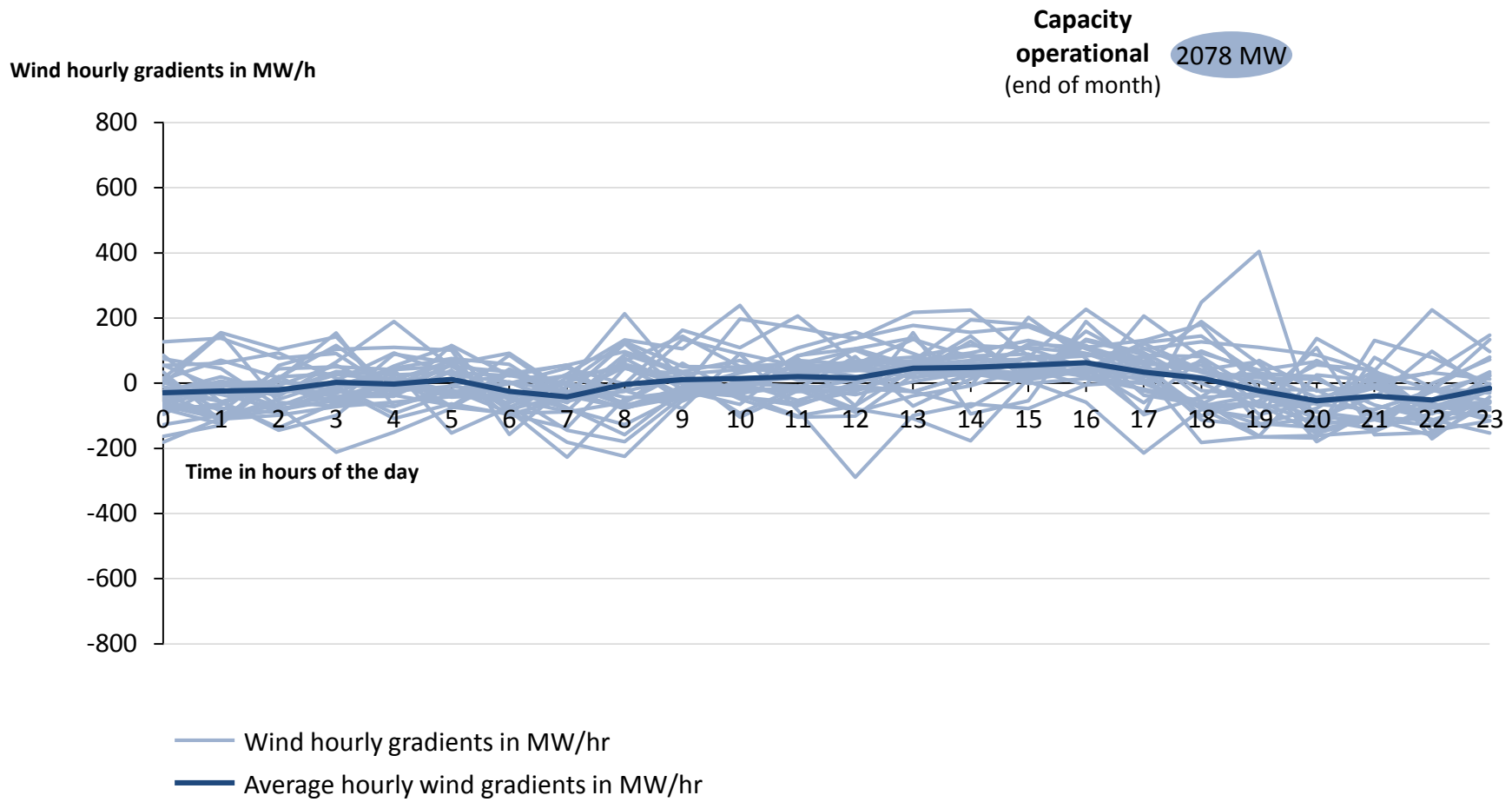
Wind 1-hour gradients in August 2018



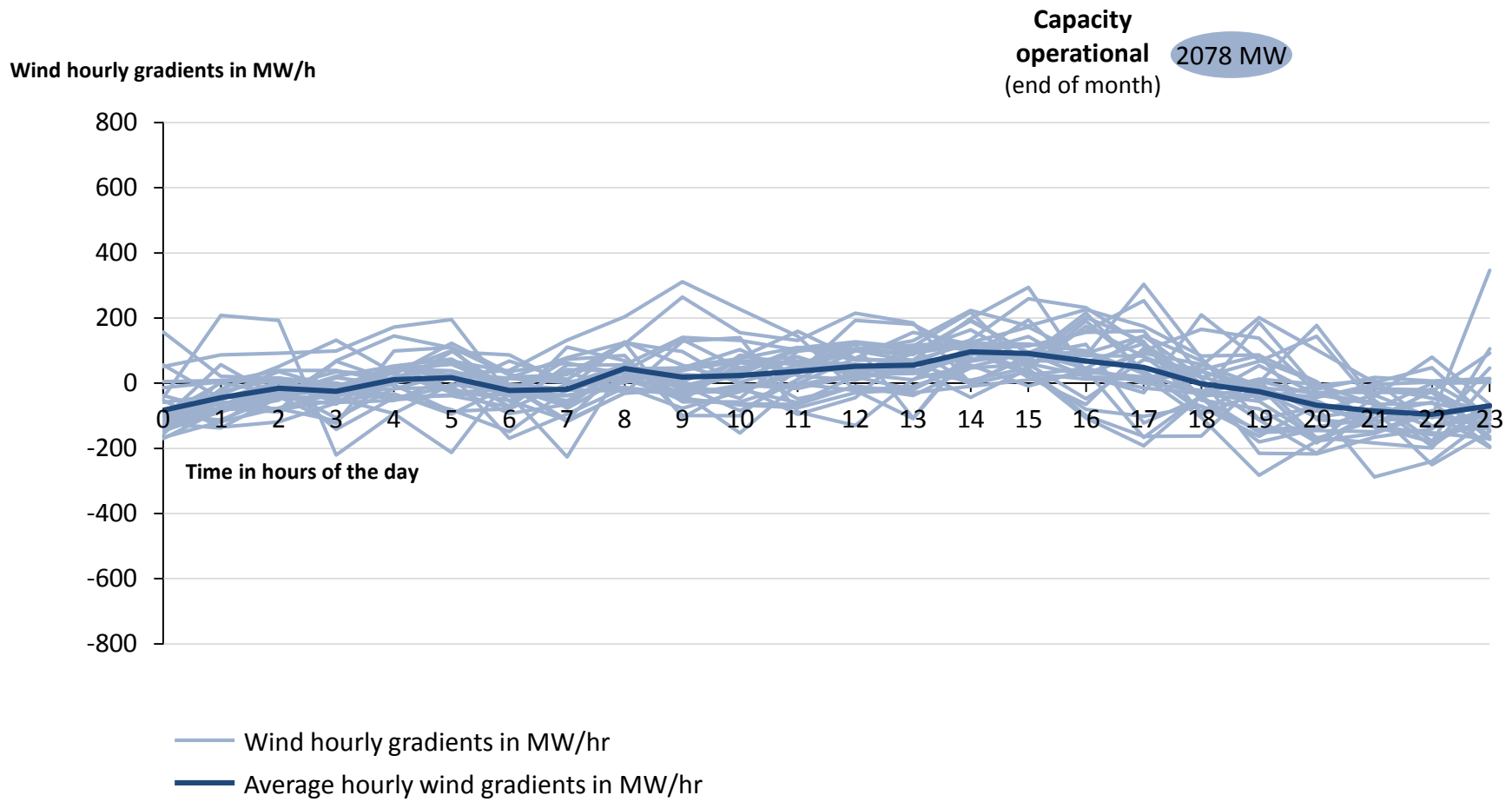
Wind 1-hour gradients in September 2018



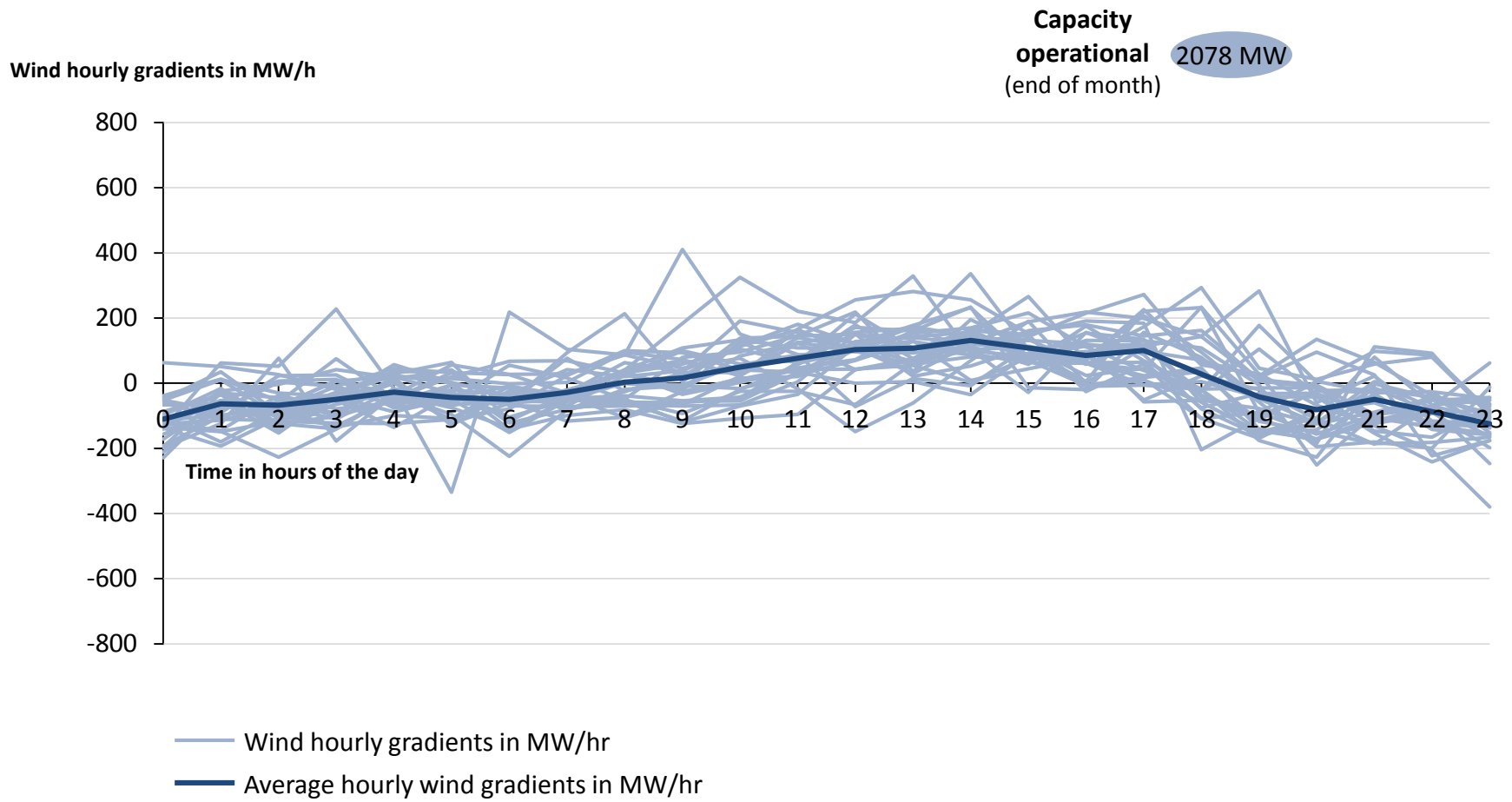
Wind 1-hour gradients in October 2018



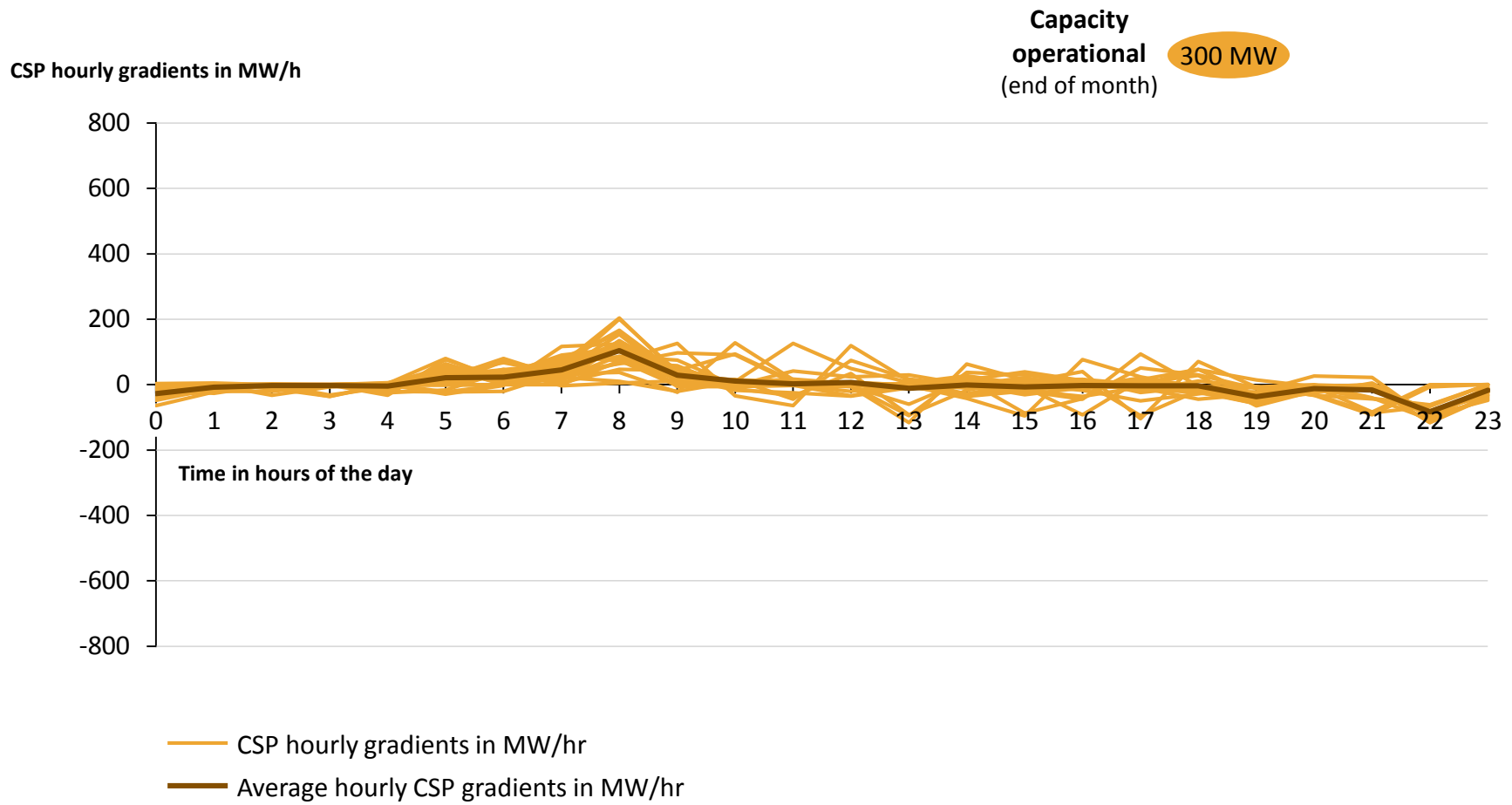
Wind 1-hour gradients in November 2018



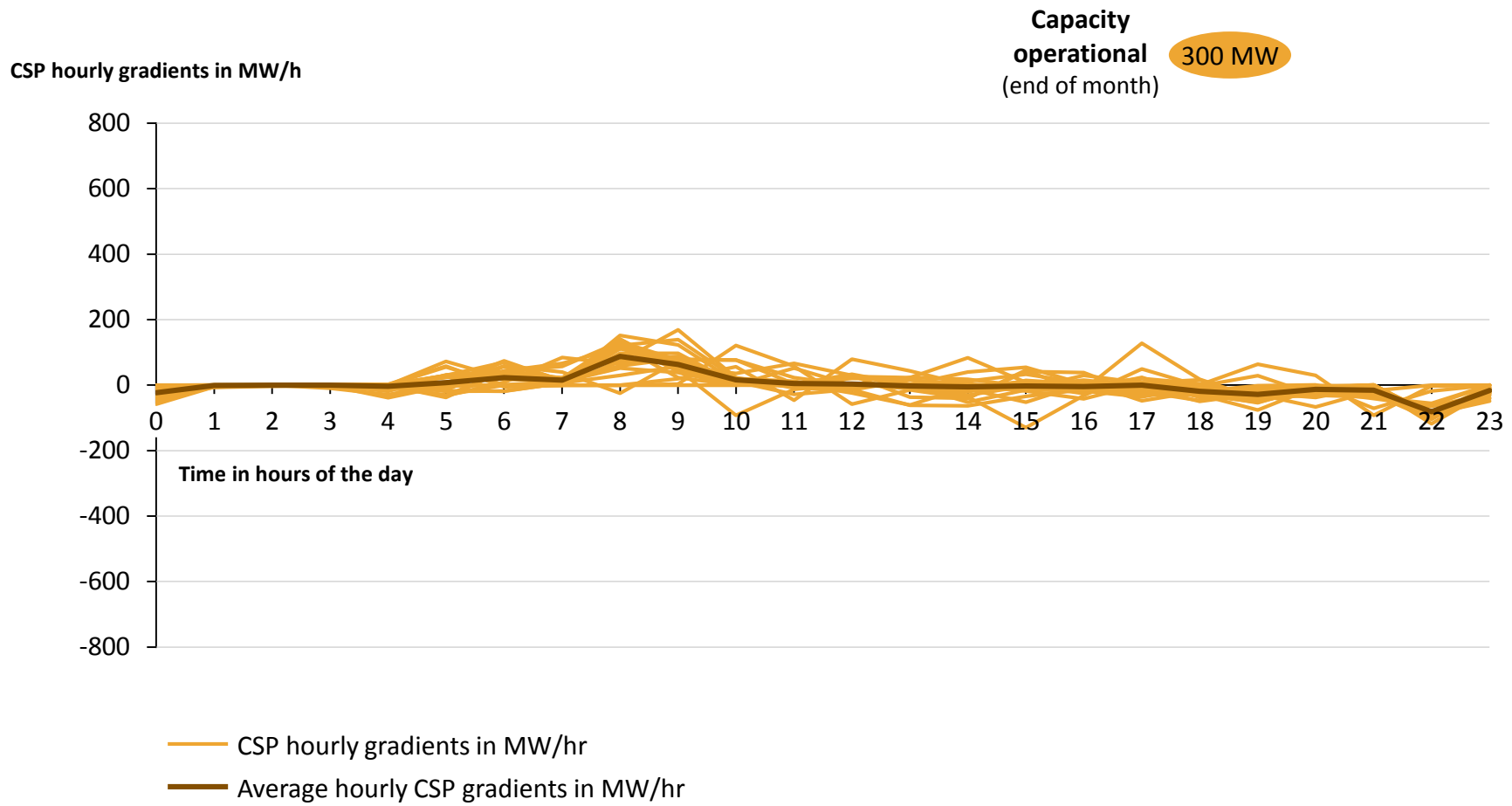
Wind 1-hour gradients in December 2018



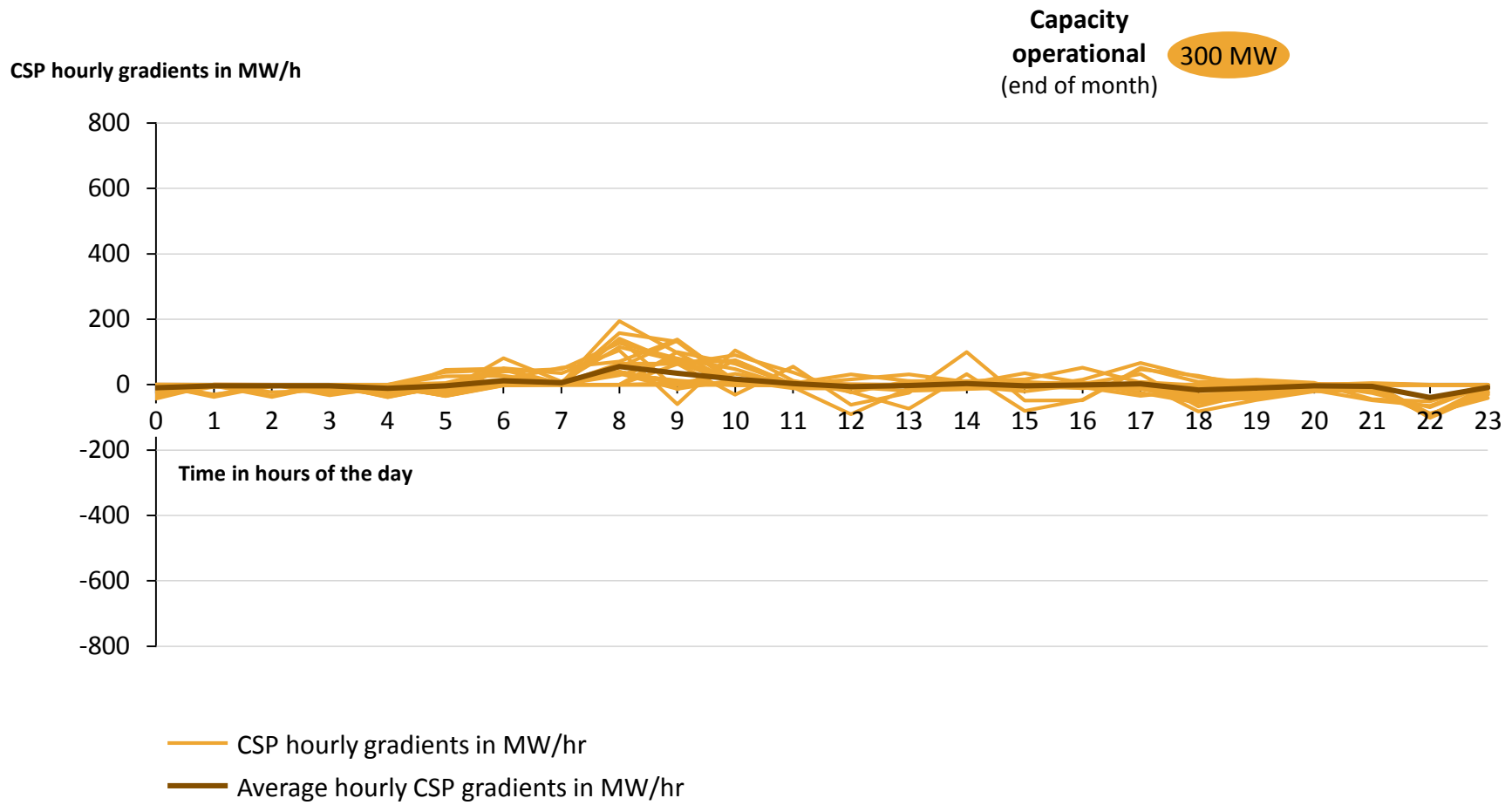
CSP 1-hour gradients in January 2018



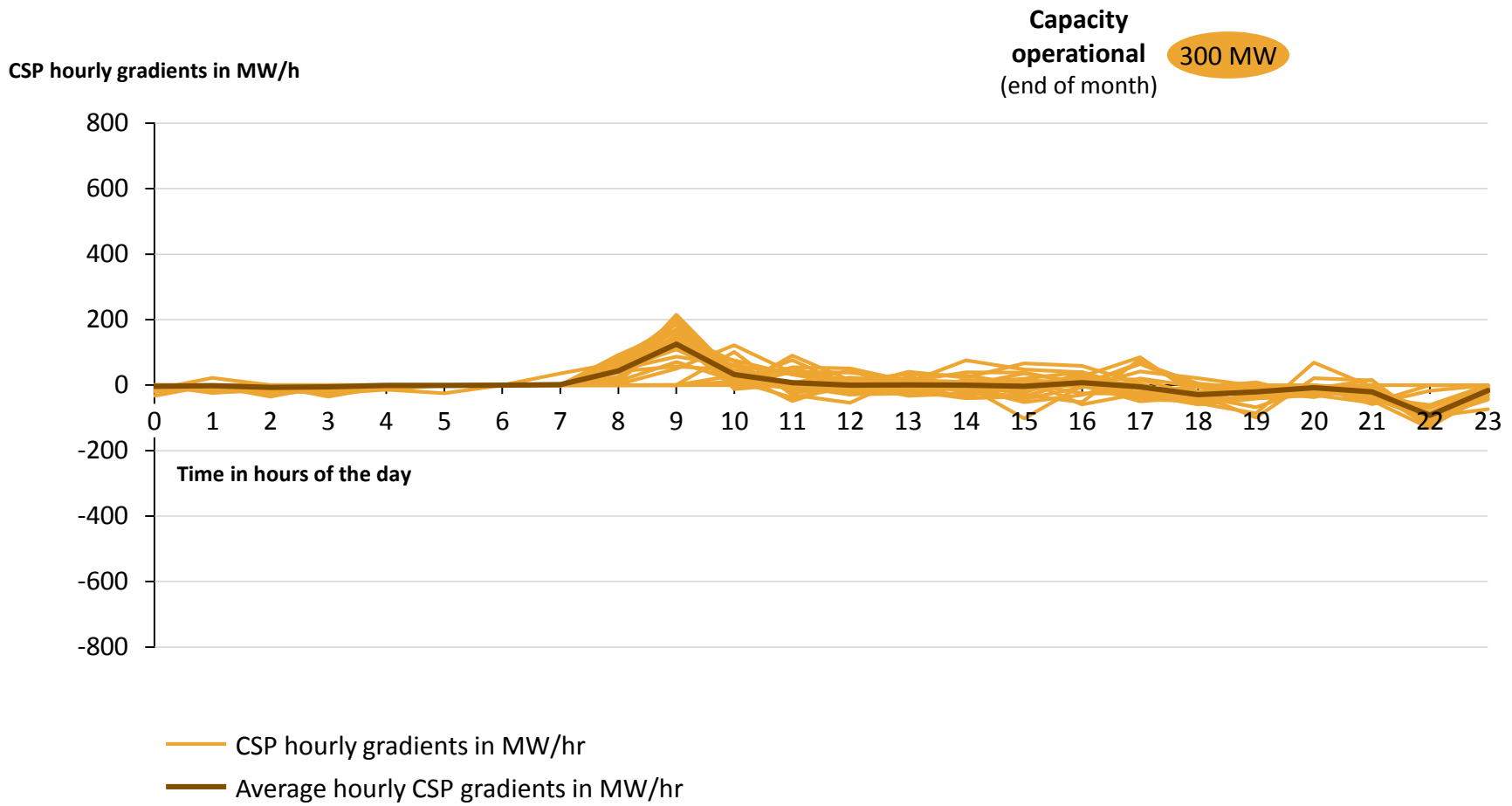
CSP 1-hour gradients in February 2018



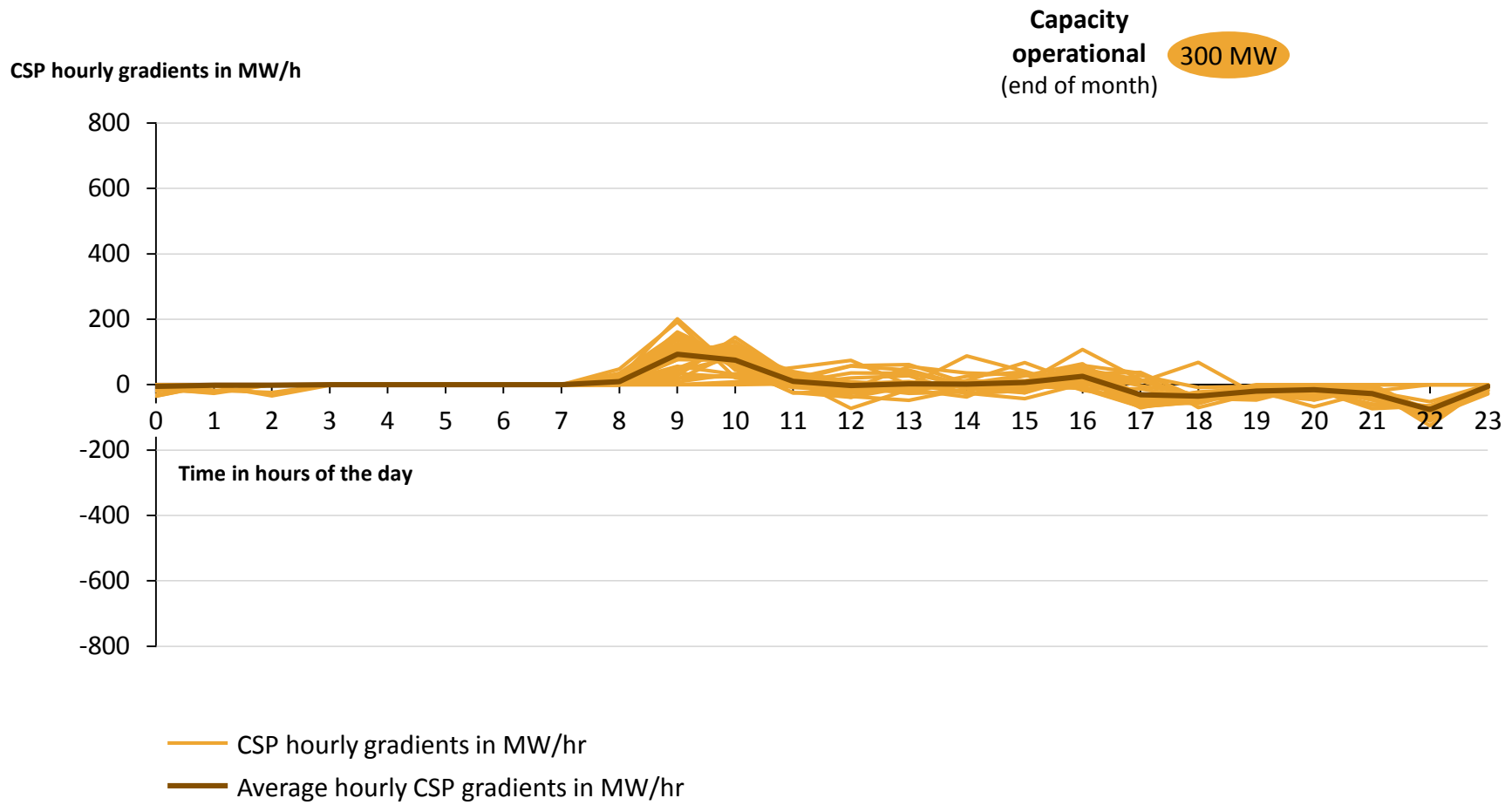
CSP 1-hour gradients in March 2018



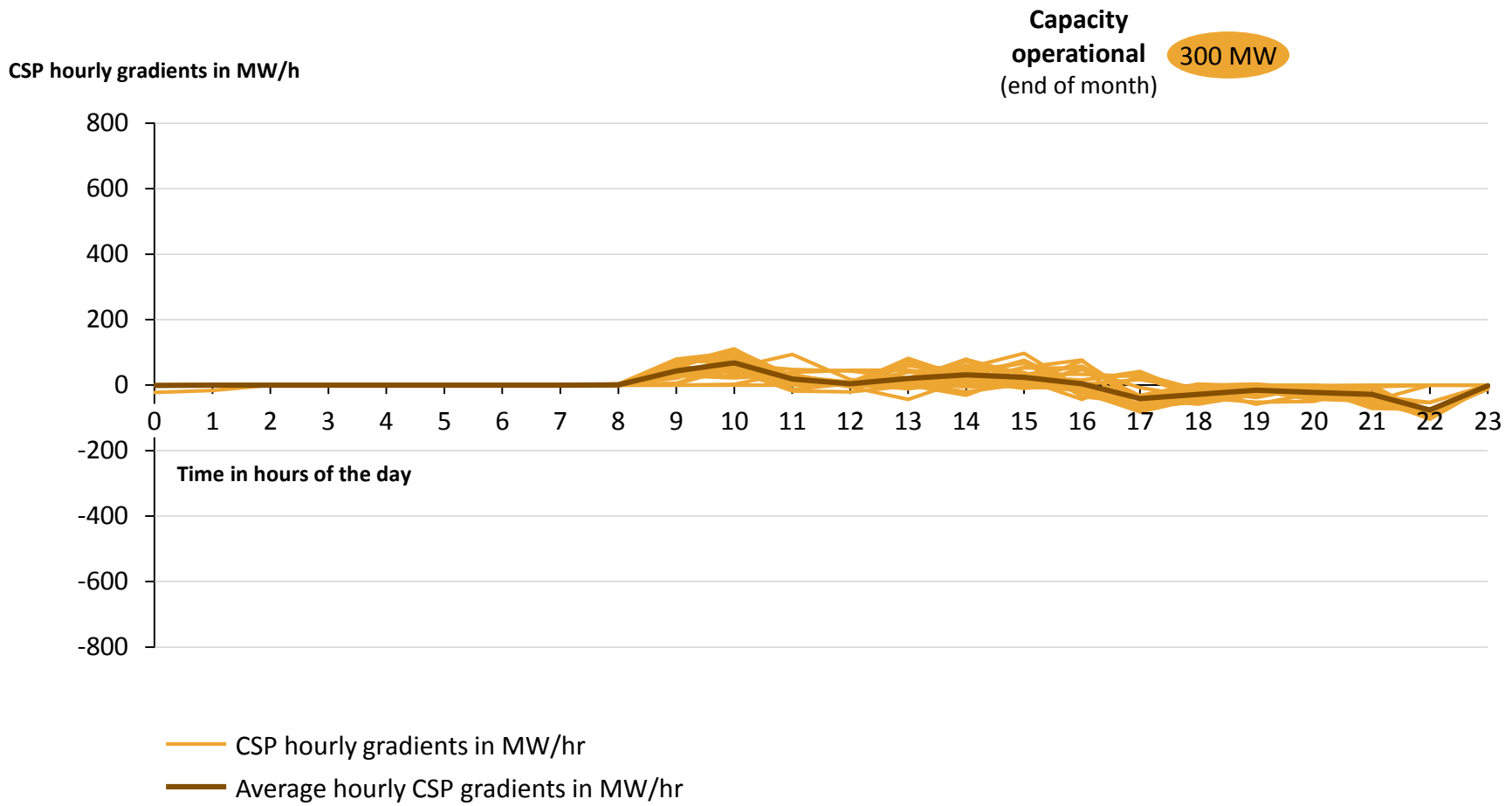
CSP 1-hour gradients in April 2018



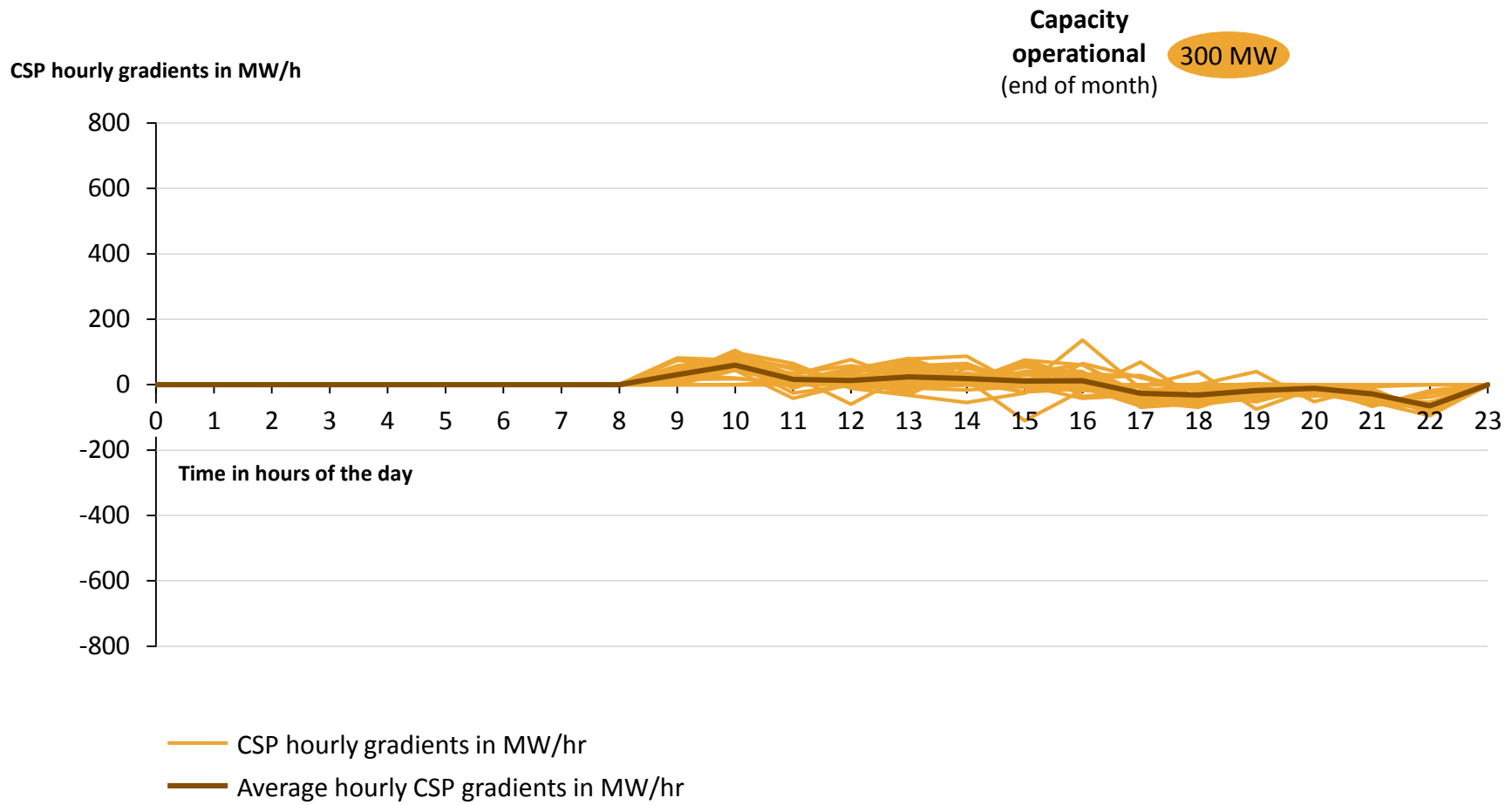
CSP 1-hour gradients in May 2018



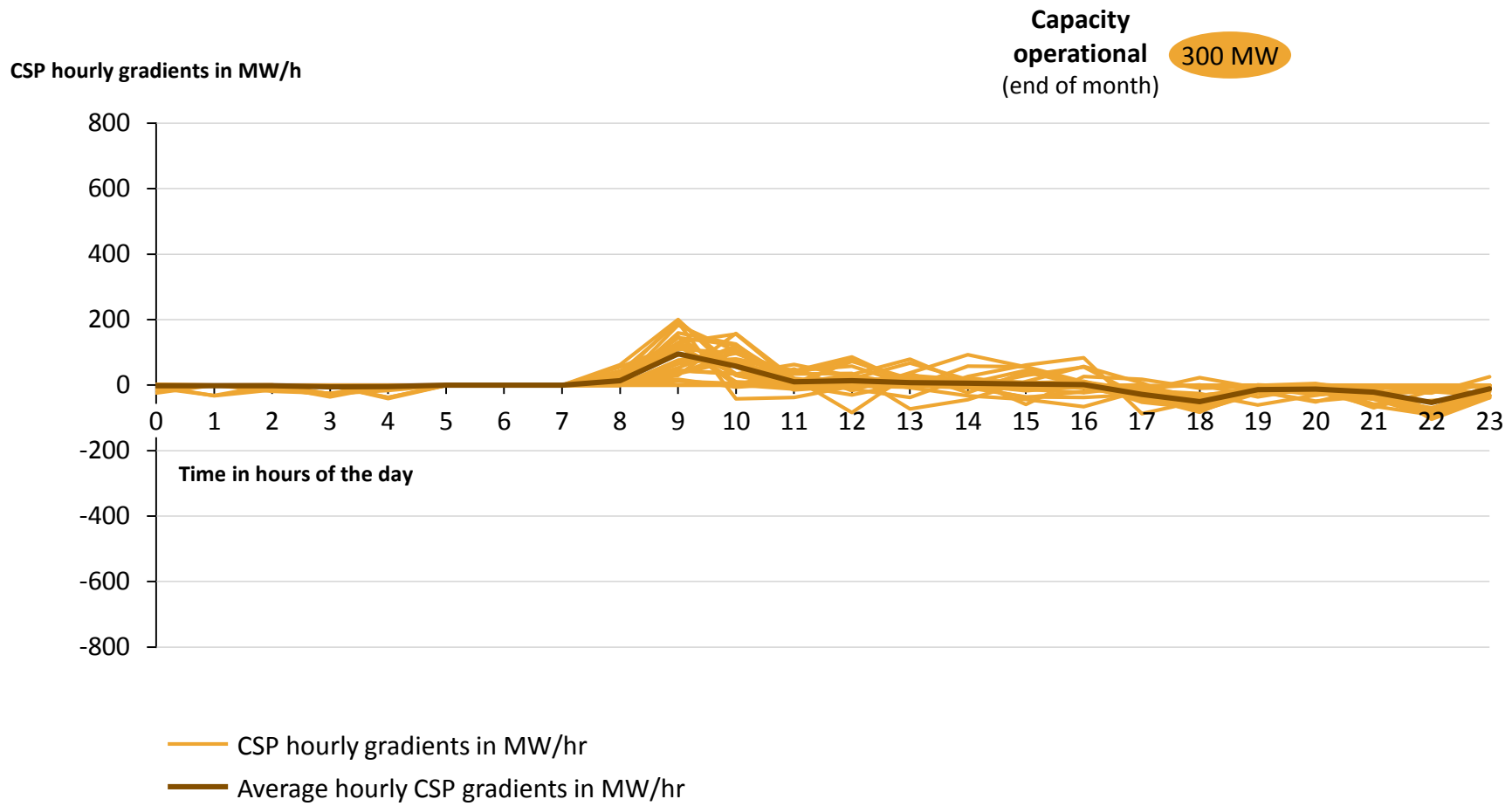
CSP 1-hour gradients in June 2018



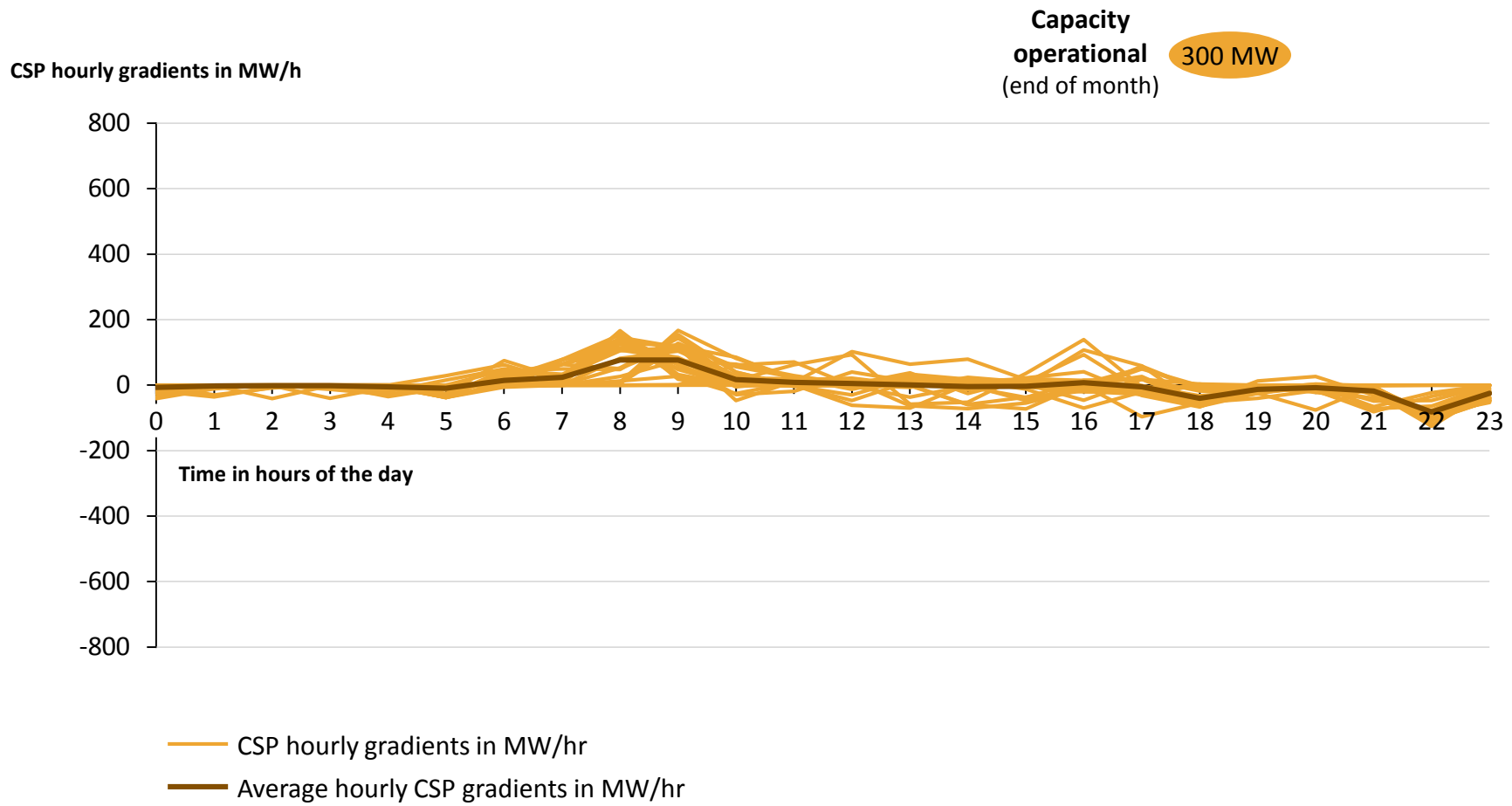
CSP 1-hour gradients in July 2018



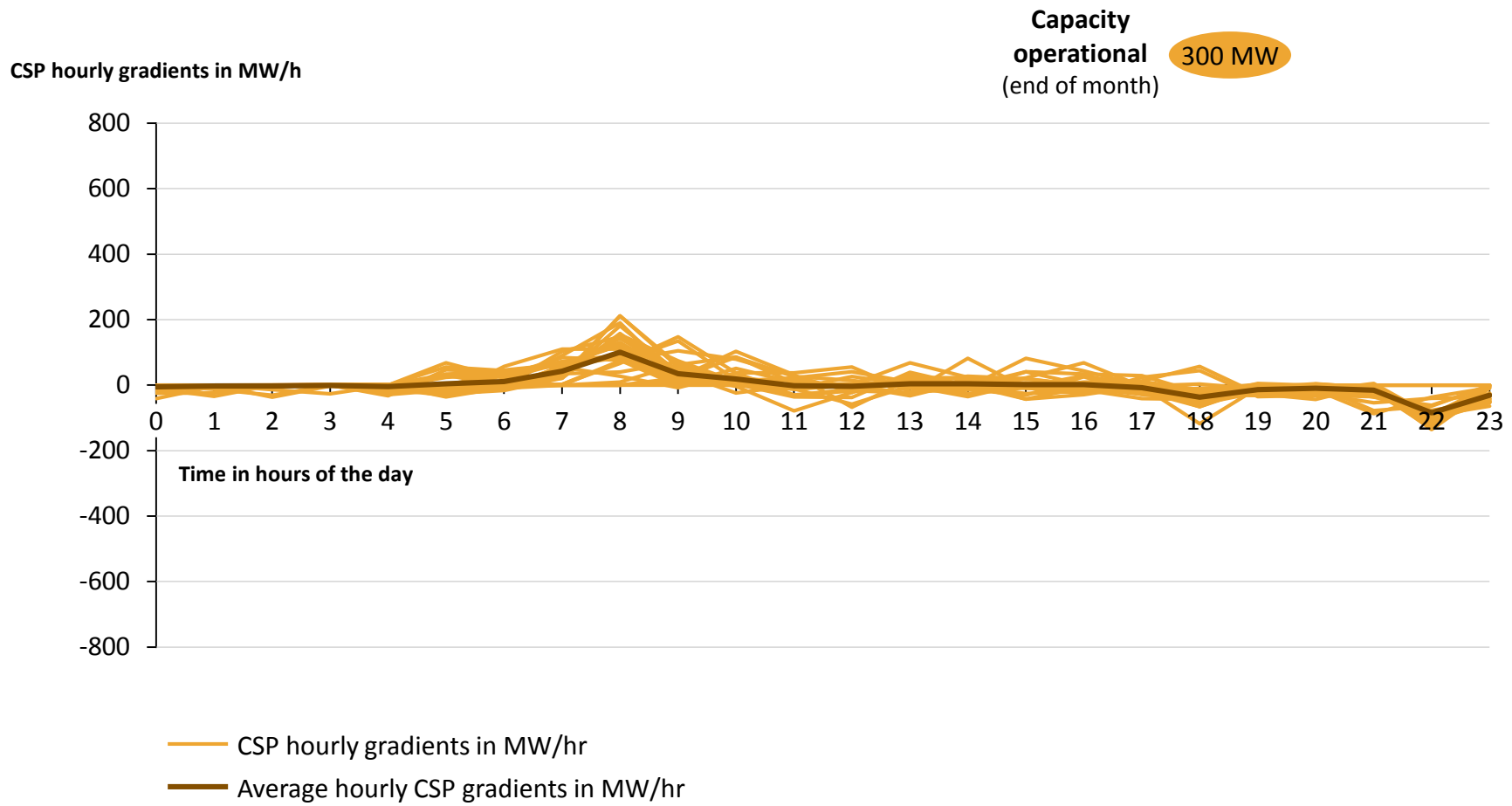
CSP 1-hour gradients in August 2018



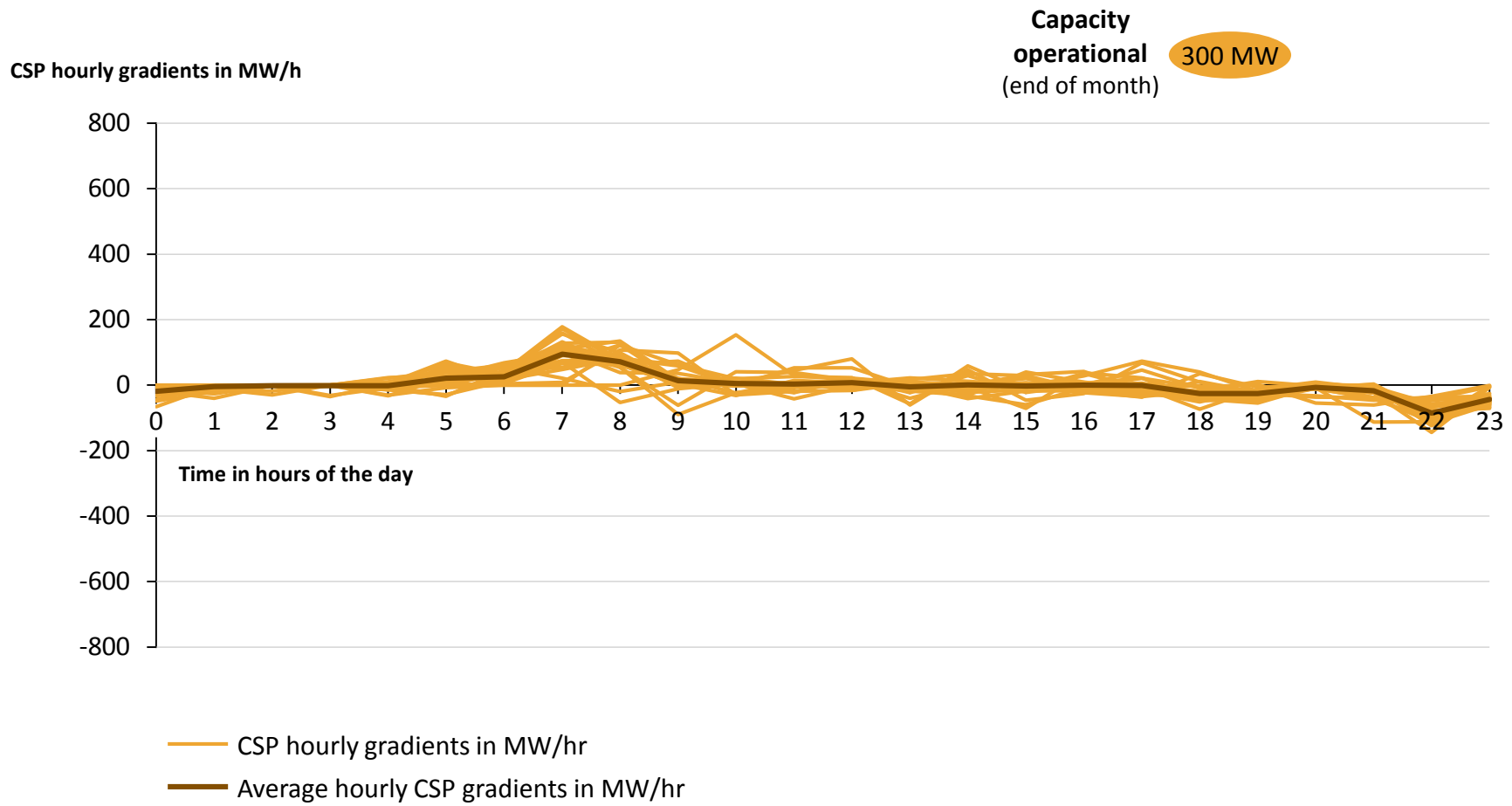
CSP 1-hour gradients in September 2018



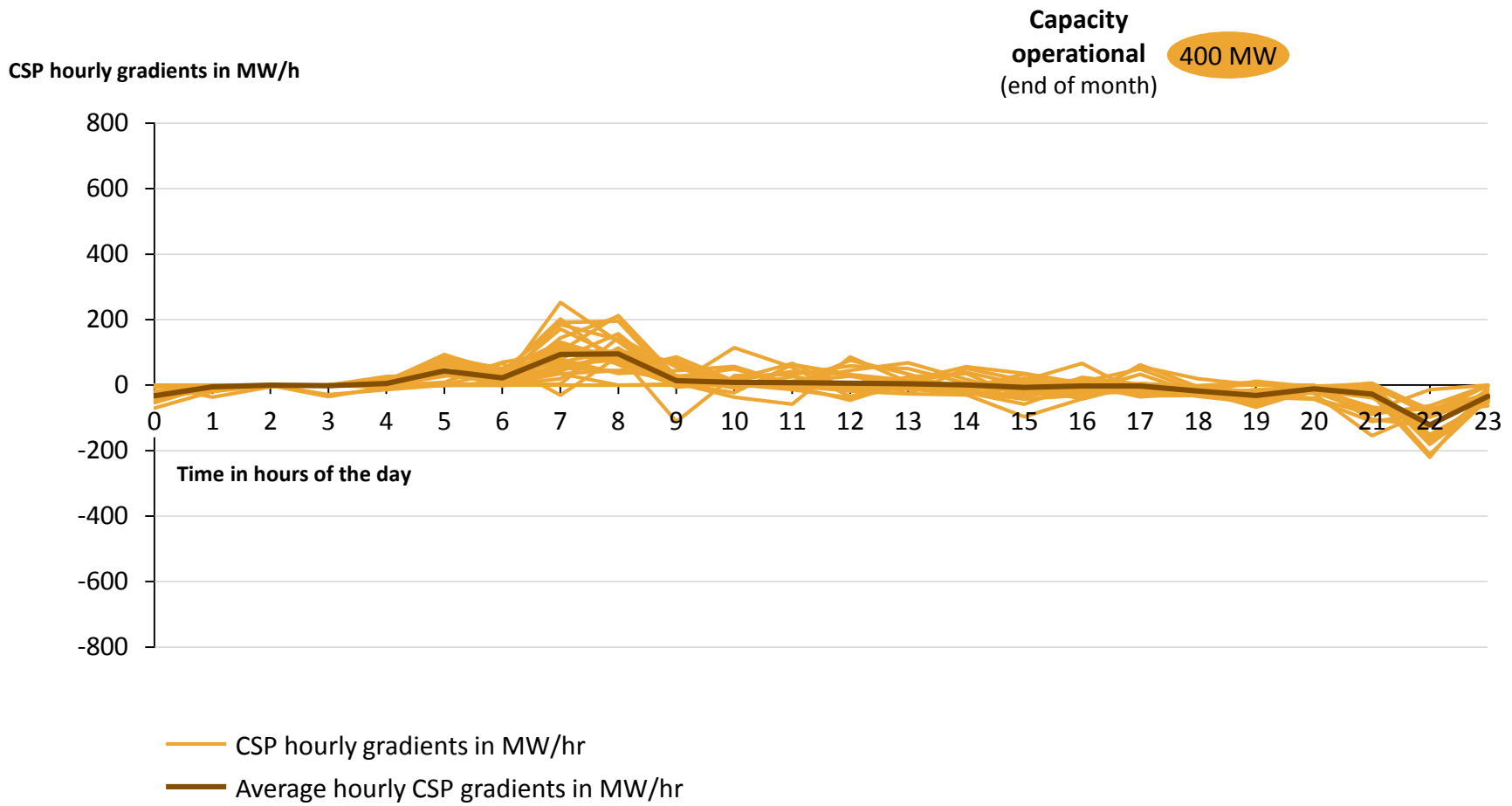
CSP 1-hour gradients in October 2018



CSP 1-hour gradients in November 2018



CSP 1-hour gradients in December 2018

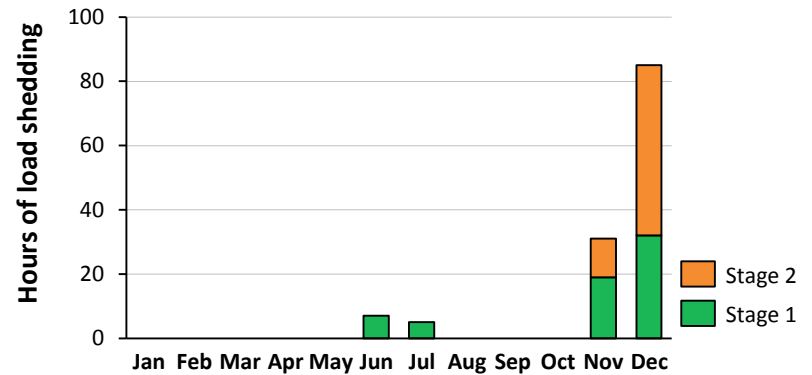


Agenda

- 1 Overview and status of REIPPPP
- 2 Overview actual electricity production data for 2018
- 3 Monthly electricity production
- 4 Weekly electricity production
- 5 Daily electricity production
- 6 Hourly electricity production
- 7 Actual load shedding in 2018

Load shedding in 2018 occurred on 12 days for ~128 hours

12 days, 128 hours of load shedding
Approx. 138 GWh of unserved energy

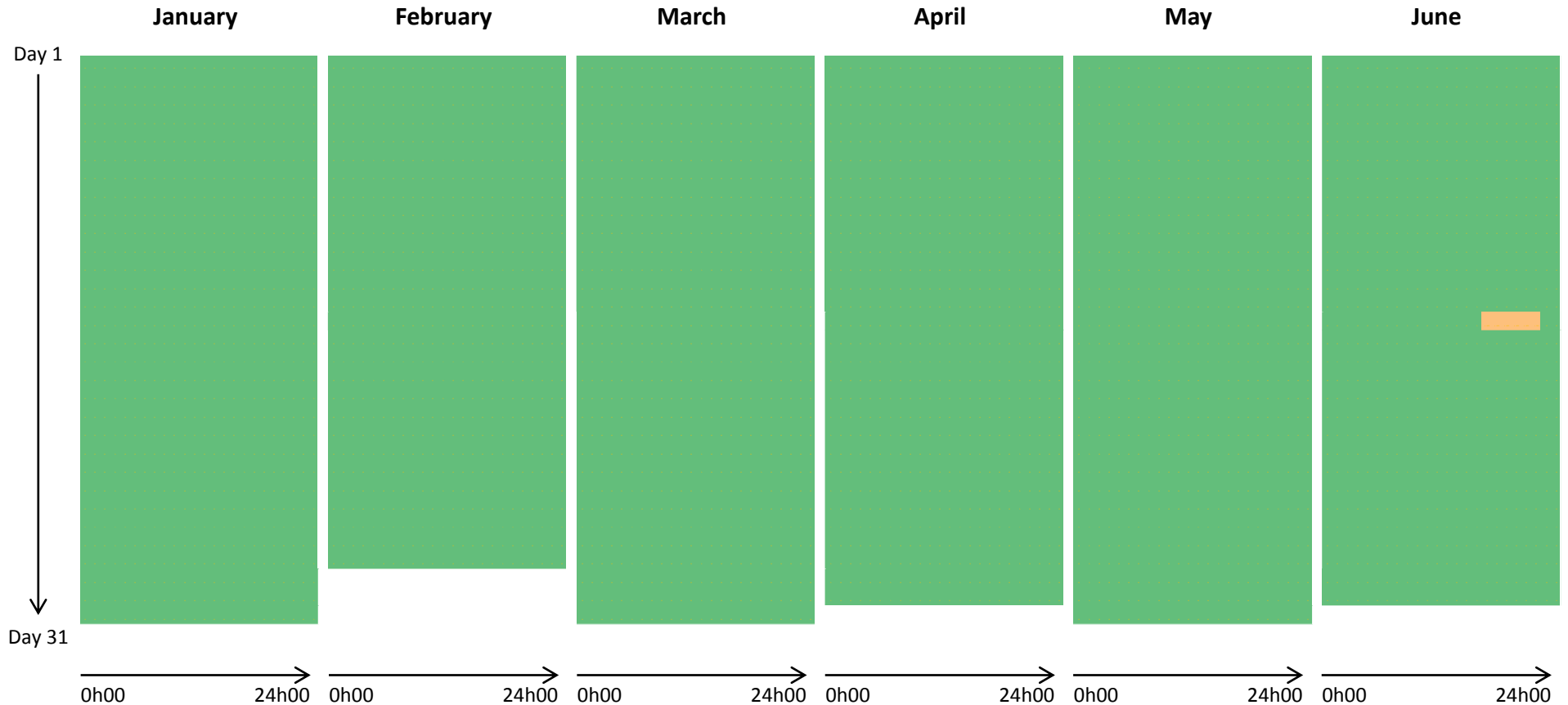


Total unserved energy due to load shedding for all hours per month Jan-Dec 2015 in GWh

	Hour of the day ==>																								Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	2	2	2	4	4	4	4	4	4	4	4	4	1	0	0	0	0
December	0	0	0	0	0	0	0	0	0	10	11	11	11	11	11	11	12	12	12	12	12	11	2	0	0	0

Notes: Load shedding assumed to have taken place for the full hours in which it was implemented, in reality 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
 Sources: Eskom Twitter account; CSIR Energy Centre analysis

Hourly distribution of actual load shedding January to June 2018

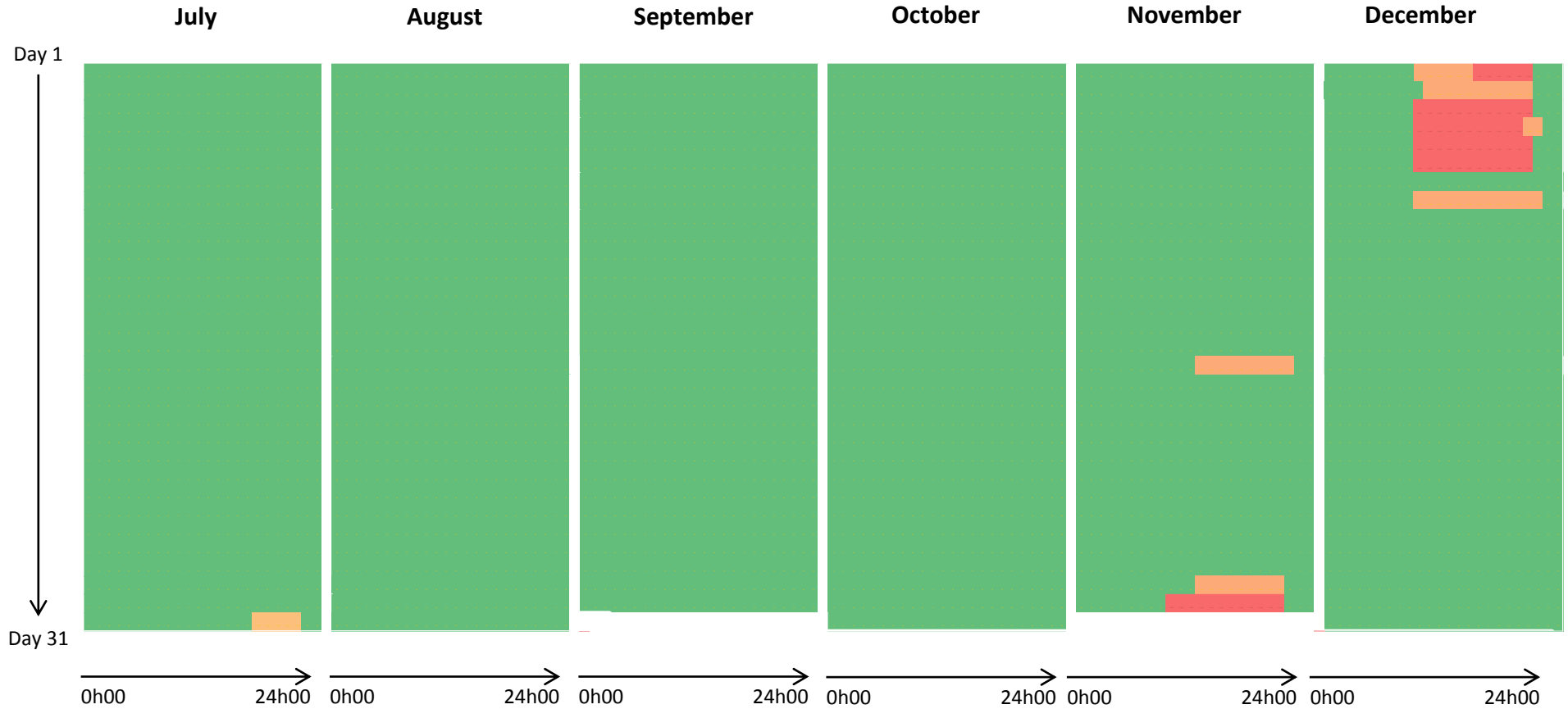


■ No load shedding
 ■ Stage 1 load shedding
 ■ Stage 2 load shedding
 ■ Stage 3 load shedding

Notes: Load shedding assumed to have taken place for the full hours in which it was implemented, in reality 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

Sources: Eskom Twitter account; CSIR Energy Centre analysis

Hourly distribution of actual load shedding July to December 2018



■ No load shedding
 ■ Stage 1 load shedding
 ■ Stage 2 load shedding
 ■ Stage 3 load shedding

Notes: Load shedding assumed to have taken place for the full hours in which it was implemented, in reality 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
 Sources: Eskom Twitter account; CSIR Energy Centre analysis

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