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# FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

Electricity production from solar and wind in Germany in 2011

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# Agenda

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- Facts solar and wind energy
- Annual energies
- Monthly energies
- Weekly energies
- Daily energies
- Annual power curves
- Monthly power curves
- Diurnal power courses
- Exemplary weekly power curves
- Exemplary daily power curves

# Fakten zur Stromerzeugung aus Solar und Wind 2011

- The gross electricity generation in 2011 was 612 TWh, the gross electricity consumption was 605 TWh.
- Due to the strong growth of the renewables, an export surplus of 3.8 TWh was achieved.
- Wind turbines produced 48.9 TWh in 2011 (37.8 TWh in 2010).
- Their production increased by 29% compared to 2010.
- Wind energy produced 8.1% of the gross electricity generation.
- Photovoltaic (PV) plants produced 19.3 TWh in 2011 (11.7 TWh in 2010).
- The production increased by 65% compared to 2010.
- Solar energy produced 3.2% of the gross electricity generation.
- Hydro power produced 18.1 TWh in 2011 and ranges now behind PV for the first time. The share of the gross electricity generation was 3.0%.

Data source: BMWi Energiedaten, Date: 15.01.2012

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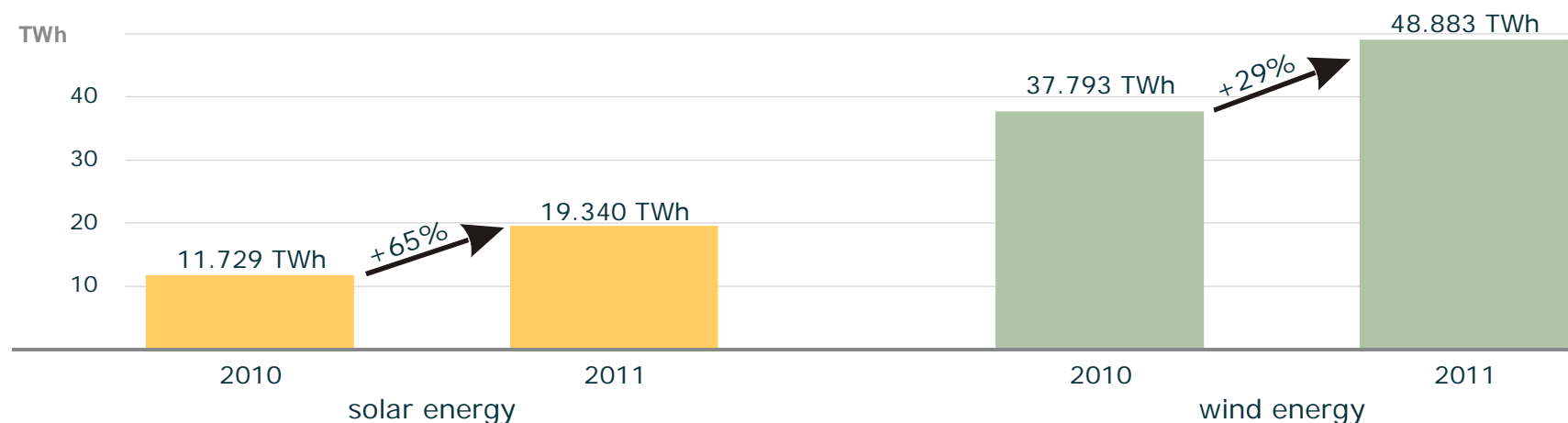
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# Annual production solar and wind

## Annual production solar und wind

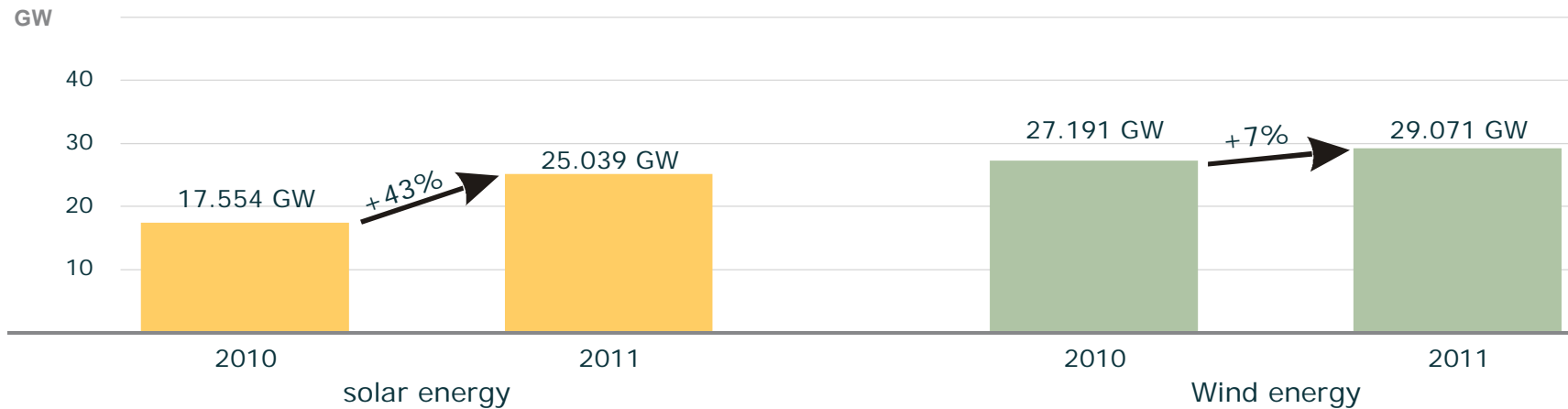


- Solar power plants produced 65% more electricity in 2011 compared to 2010. They reached a share of 3.2% of the gross electricity production.
- Wind turbines increased their production by 29% compared to 2010. They reached a share of 8.1% of the gross electricity production.

Graph: B. Burger, Fraunhofer ISE; Data source: BMWi Energiedaten, Revision: 25.01.2012

# Installed solar and wind power

## Installed solar and wind power



- The installed solar power increased by 7.5 GW from 17.5 GW in 2010 to 25.0 GW in 2011.
- The installed wind power increased by 1.9 GW from 27.2 GW to 29.1 GW.

Graph: B. Burger, Fraunhofer ISE; Data source: BMU: Renewable energies 2011, Revision: 02/2012

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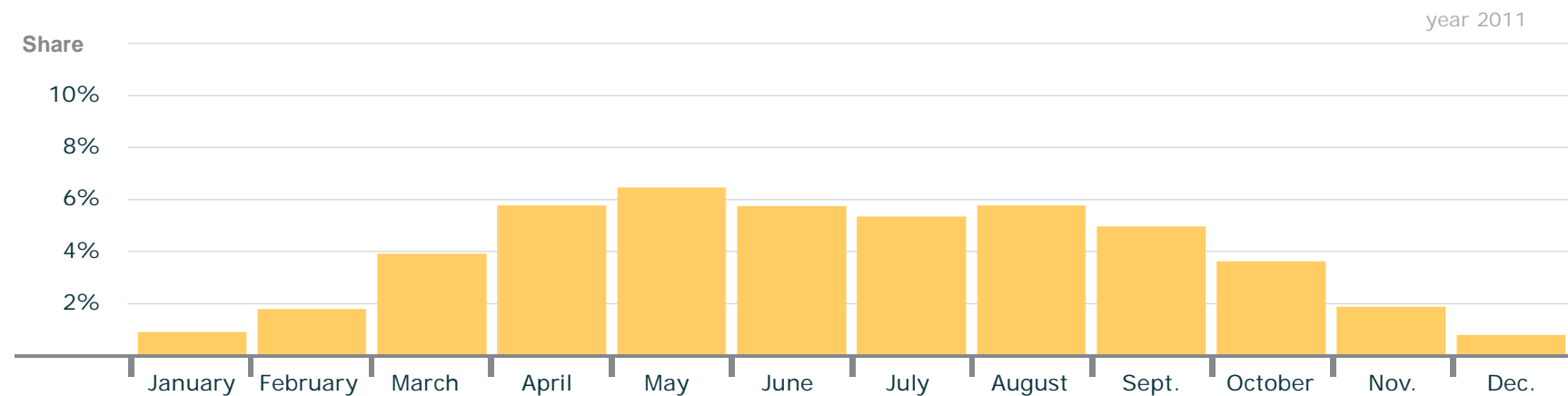
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# Monthly Production Solar

## Monthly Solar Energy Share of the Load



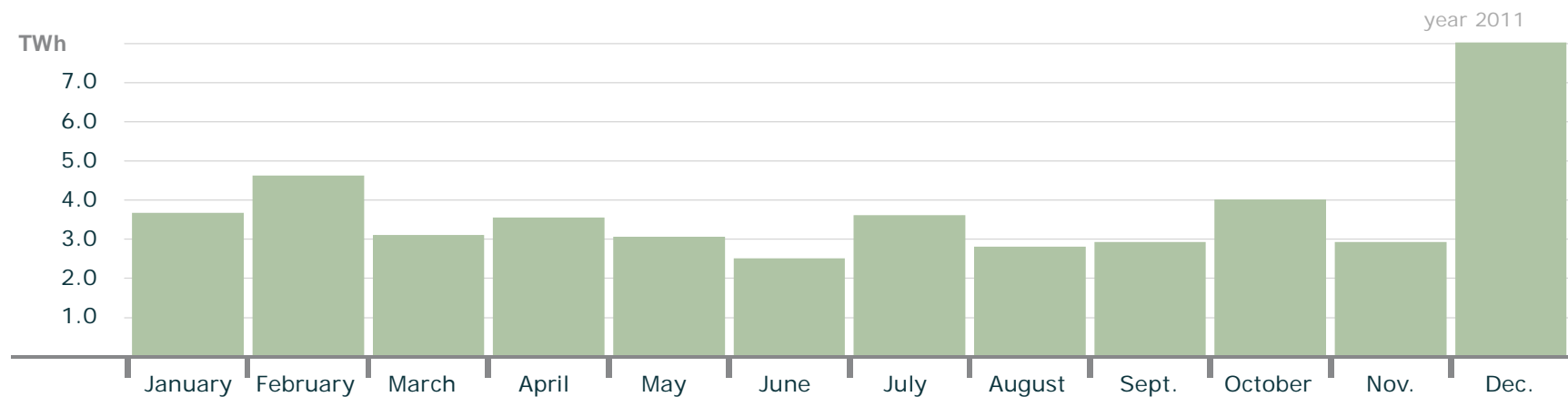
- The maximal monthly solar production was 2.6 TWh in May 2011
- The minimal monthly solar production was 0.31 TWh in December 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform



# Monthly Production Wind

## Monthly Production Wind

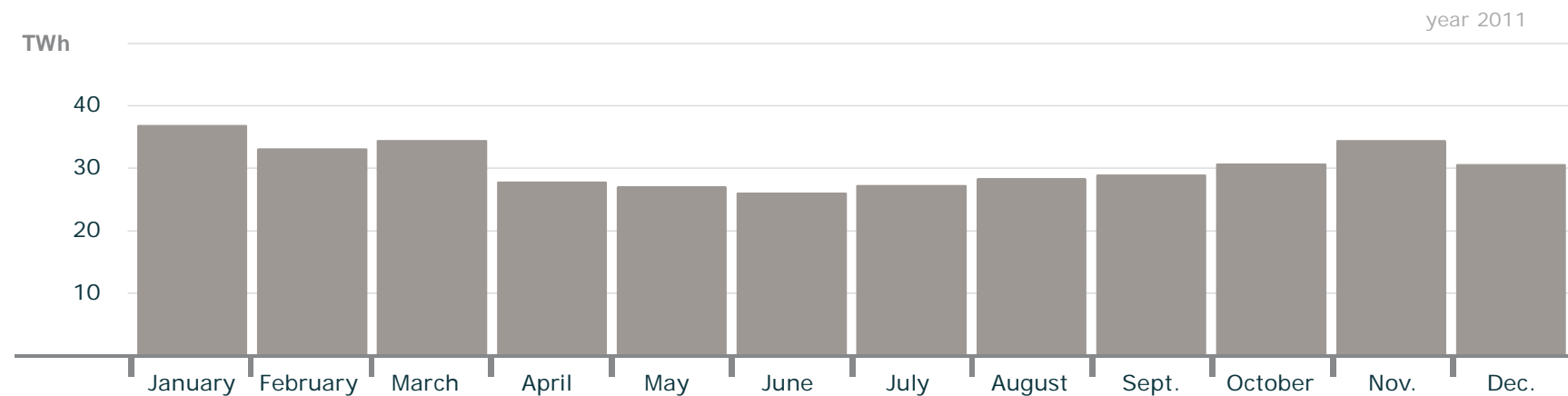


- The maximum production of wind turbines was 8 TWh in December 2011
- The minimum production was 2.5 TWh in June 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Monthly Production Conventional > 100 MW

## Monthly Production Conventional > 100 MW

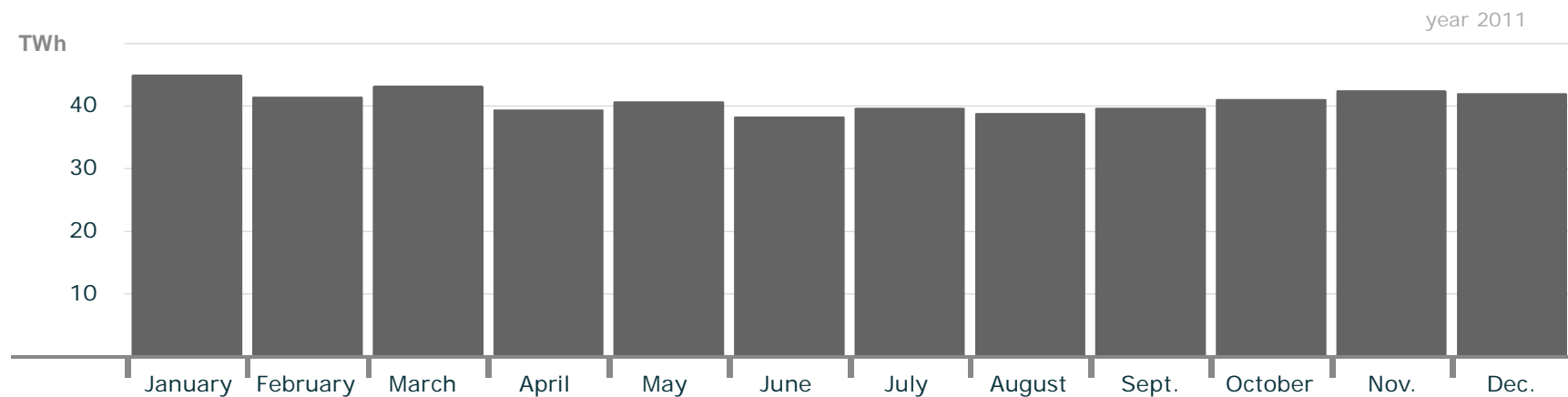


- The maximal electricity production of conventional sources was 36.8 TWh in January 2011
- The minimal production was 26 TWh in June 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Monthly Load Data

## Monthly Load

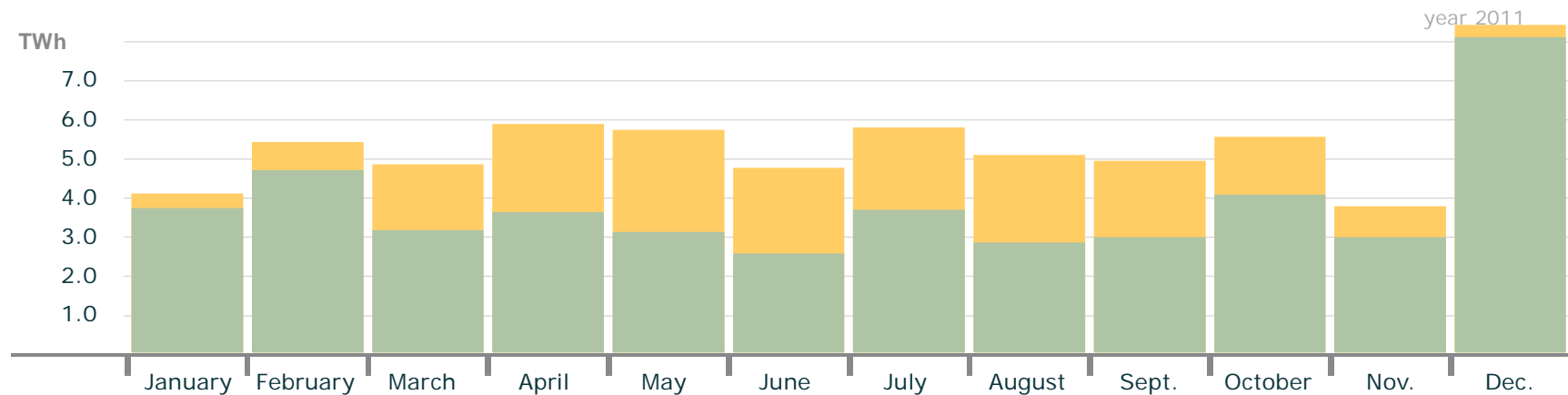


- The maximal monthly load was 44.8 TWh in January 2011
- The minimal monthly load was 38.2 TWh in June 2011

Graph: B. Burger, Fraunhofer ISE; data: ENTSO-E

# Monthly Production Solar and Wind

## Monthly Production Solar and Wind

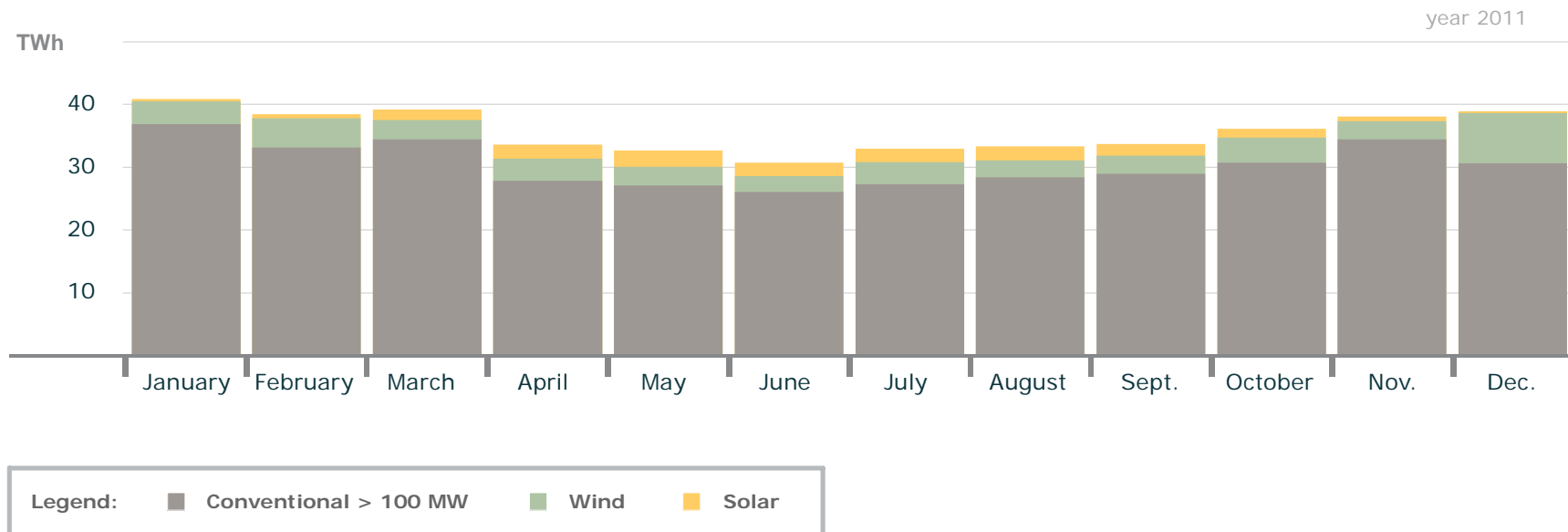


- Die maximal electricity production of solar and wind was 8.3 TWh in December 2011
- Die minimal production was 3.7 TWh in November 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Monthly Production Solar, Wind and Conventional

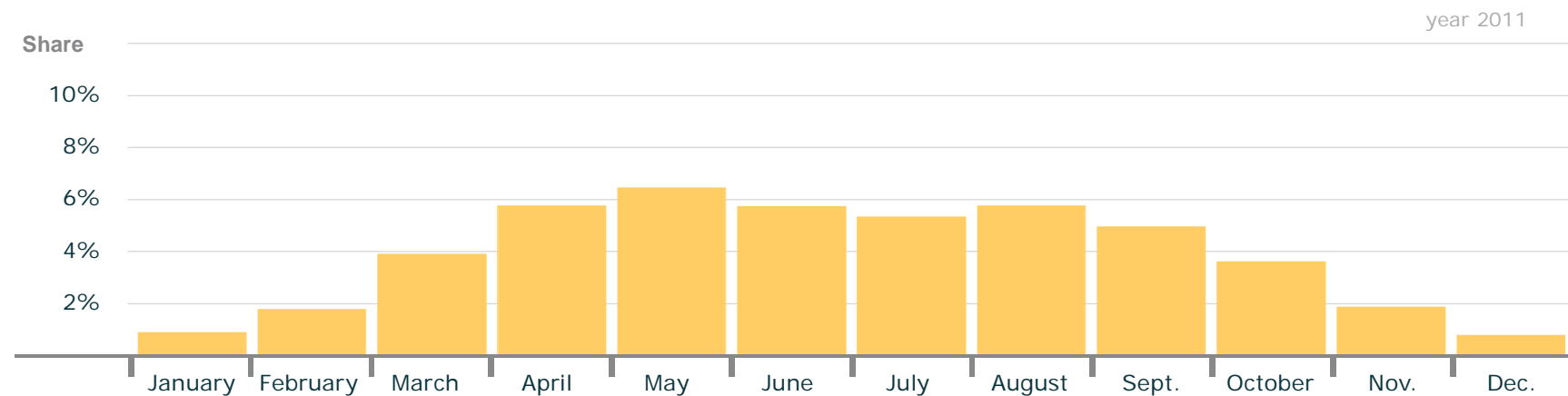
## Monthly Production Solar, Wind and Conventional



Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Monthly Solar Share of the Load

## Monthly Solar Share of the Load

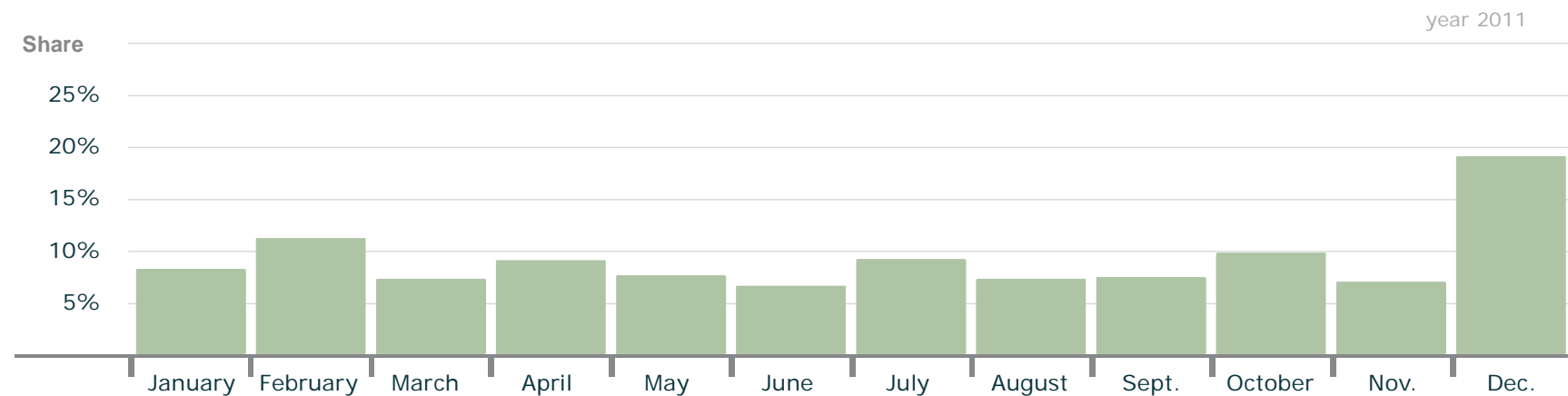


- The maximal monthly solar energy share of the load was 6.4% and was reached in May 2011
- The minimal monthly solar energy share of the load was 0.74% and was reached in December 2011

Graph: B. Burger, Fraunhofer ISE; solar data: EEX Transparency Platform; load data: ENTSO-E

# Monthly Wind Share of the Load

## Monthly Wind Share of the Load

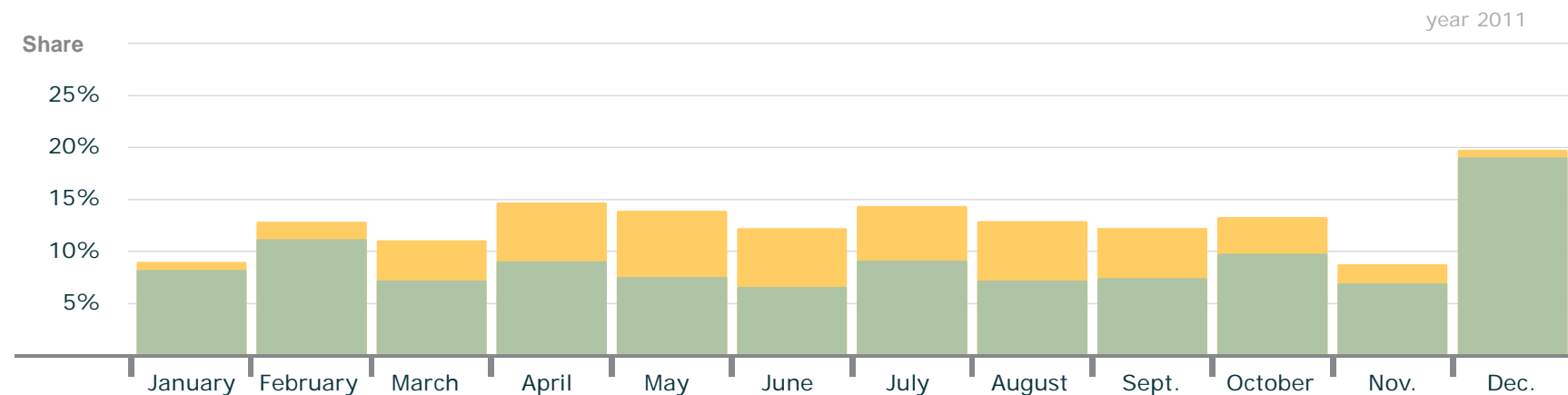


- The maximal monthly wind energy share of the load was 19% and was reached in December 2011
- The minimal monthly wind energy share of the load was 6,5% and was reached in June 2011

Graph: B. Burger, Fraunhofer ISE; wind data: EEX Transparency Platform; load data: ENTSO-E

# Monthly Share of Solar and Wind of the Load

## Monthly Share of Solar and Wind of the Load



- The maximal sum of solar and wind energy share of the load was 19.8% in December 2011
- The minimal sum of solar and wind energy share was 8,7% in November 2011

Graph: B. Burger, Fraunhofer ISE; solar and wind data: EEX Transparency Platform; load data: ENTSO-E



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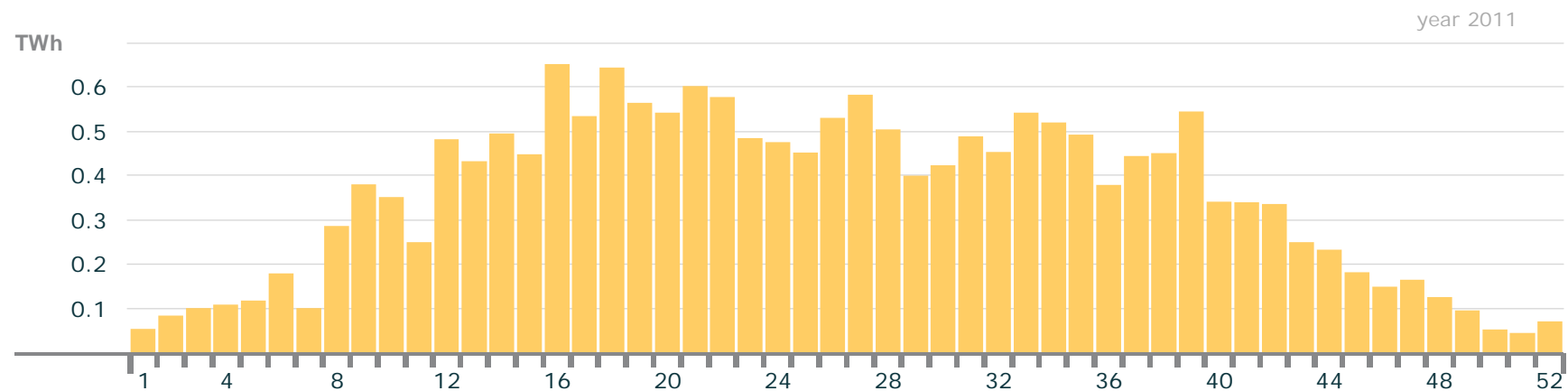
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# Weekly Production Solar

## Weekly Production Solar

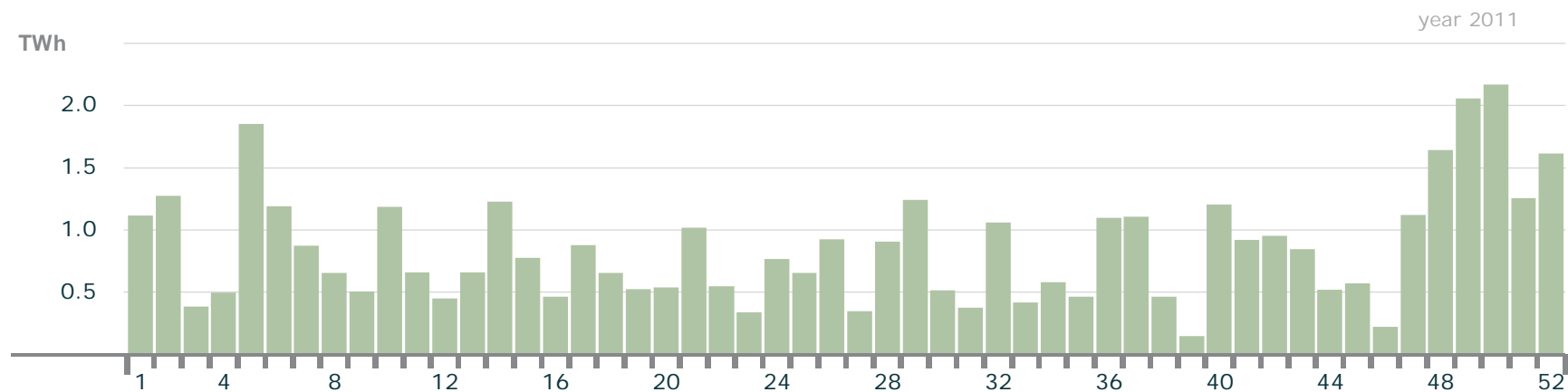


- The maximal weekly solar electricity production was 0.65 TWh in calendar week 16 from 18<sup>th</sup> to 24<sup>th</sup> of April 2011
- The minimal weekly production was 0.05 TWh in Calendar week 51 from 19<sup>th</sup> to 25<sup>th</sup> of December 2011

Graph: B. Burger, Fraunhofer ISE; solar data: EEX Transparency Platform

# Weekly Production Wind

## Weekly Production Wind

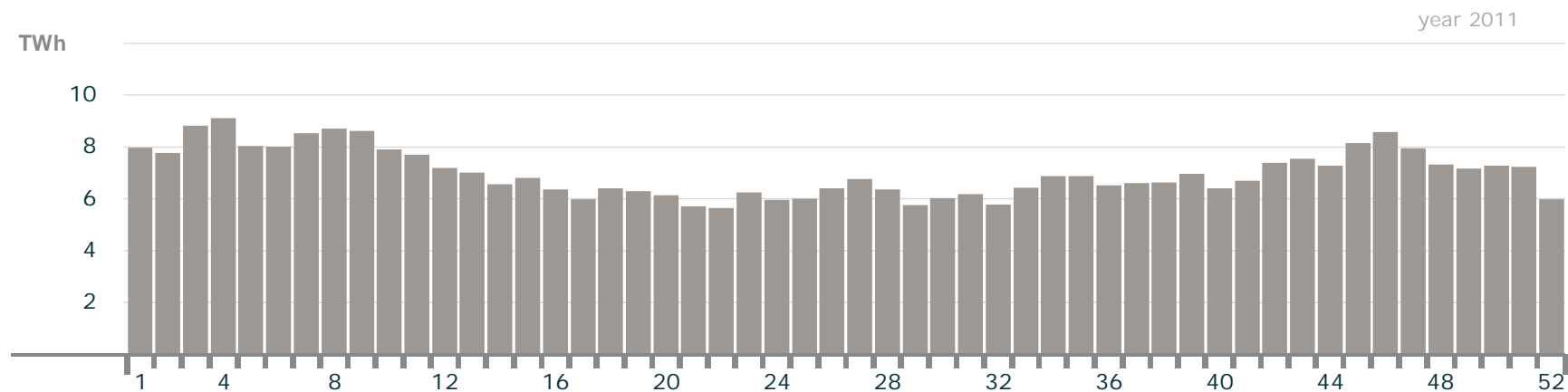


- The maximal weekly wind electricity production was 2.2 TWh in calendar week 50 from 12<sup>th</sup> to 18<sup>th</sup> December 2011
- The minimal weekly production was 0.14 TWh in calendar week 39 from 26<sup>th</sup> of September to 2<sup>nd</sup> of October 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Weekly Production Conventional > 100 MW

## Weekly Production Conventional > 100 MW

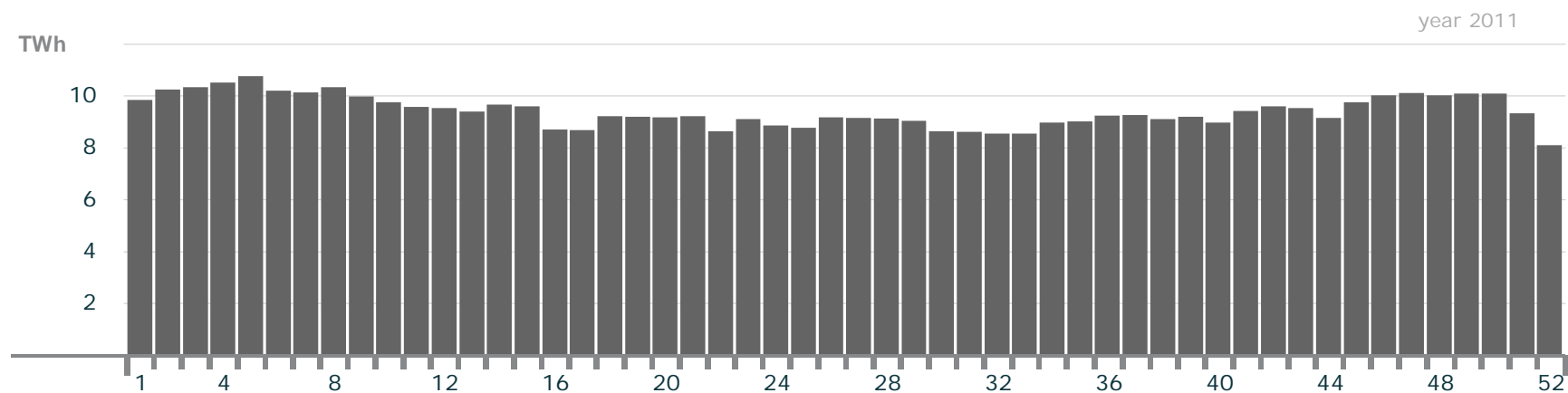


- The maximal weekly electricity production from conventional sources was 9.1 TWh in calendar week 4 from 24<sup>th</sup> to 30<sup>th</sup> of January 2011
- The minimal weekly production was 5.6 TWh in calendar week 22 from 30<sup>th</sup> of May to 05<sup>th</sup> of June 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Weekly Load

## Weekly Load

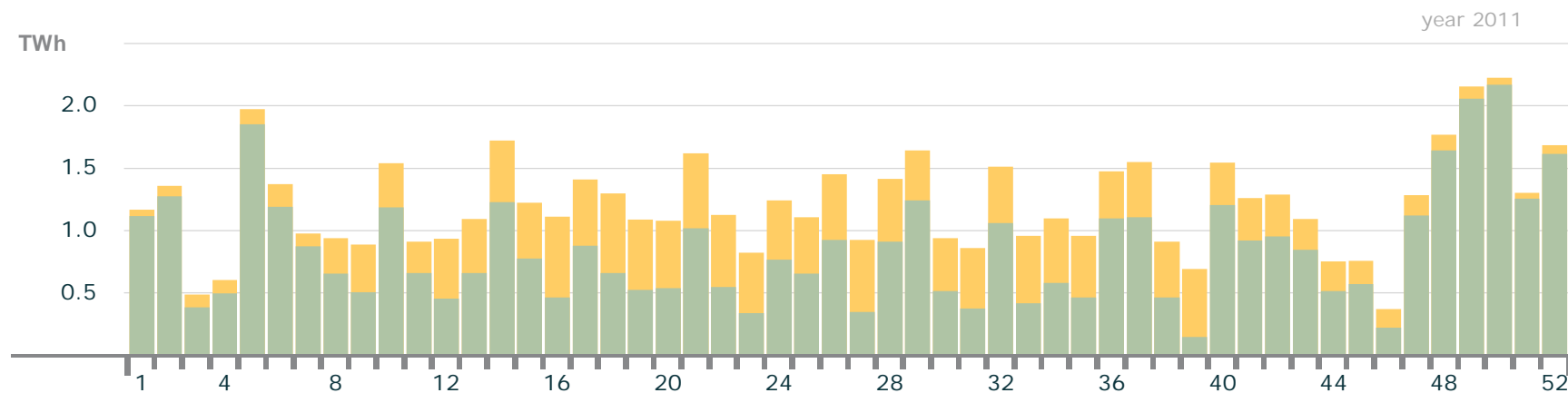


- The maximal weekly load was 10.8 TWh in calendar week 5 from 31<sup>st</sup> of January to 06<sup>th</sup> of February 2011
- The minimal weekly load was 8.1 TWh in calendar week 52 from 26<sup>th</sup> of December 2011 to 01<sup>st</sup> of January 2012

Grafik: B. Burger, Fraunhofer ISE; Daten: ENTSO-E

# Weekly Production Solar and Wind

## Weekly Production Solar and Wind

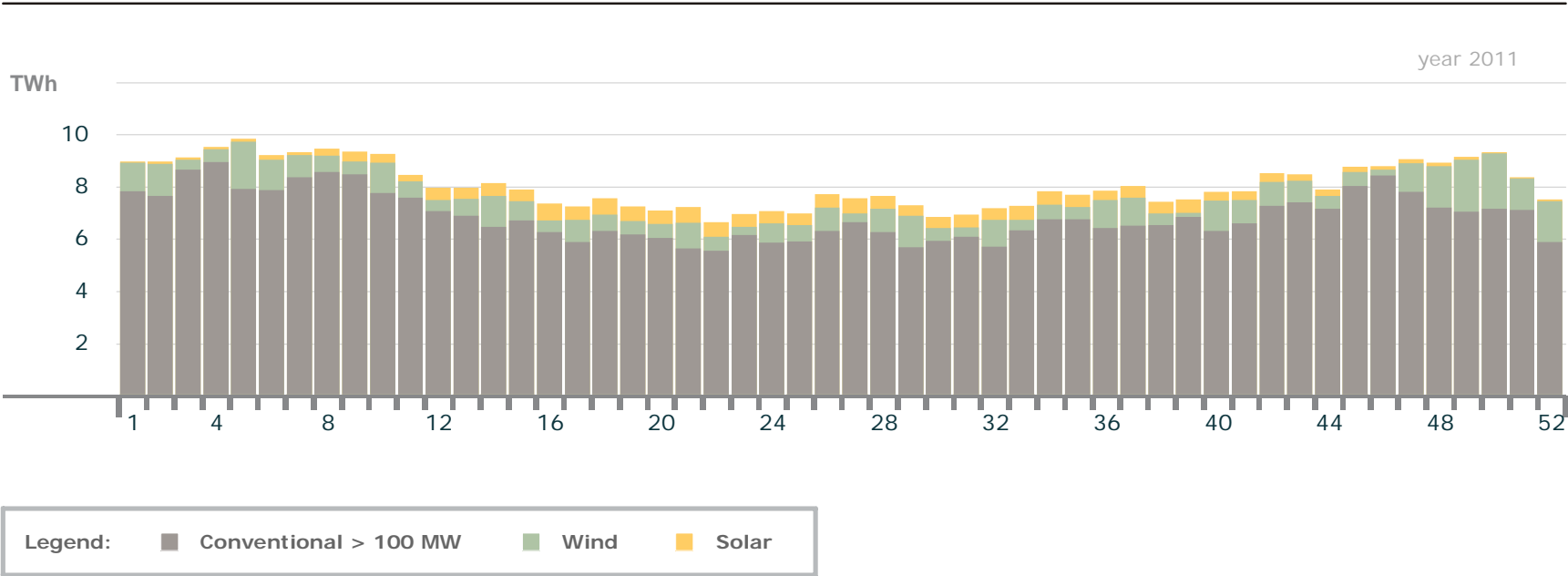


- The maximal weekly sum of solar and wind production was 2.2 TWh in calendar week 50 from 12<sup>th</sup> to 18<sup>th</sup> of December 2011
- The minimal weekly sum of solar and wind production was 0.37 TWh in calendar week 46 from 14<sup>th</sup> to 20<sup>th</sup> of November 2011

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Weekly Production Solar, Wind und Conventional

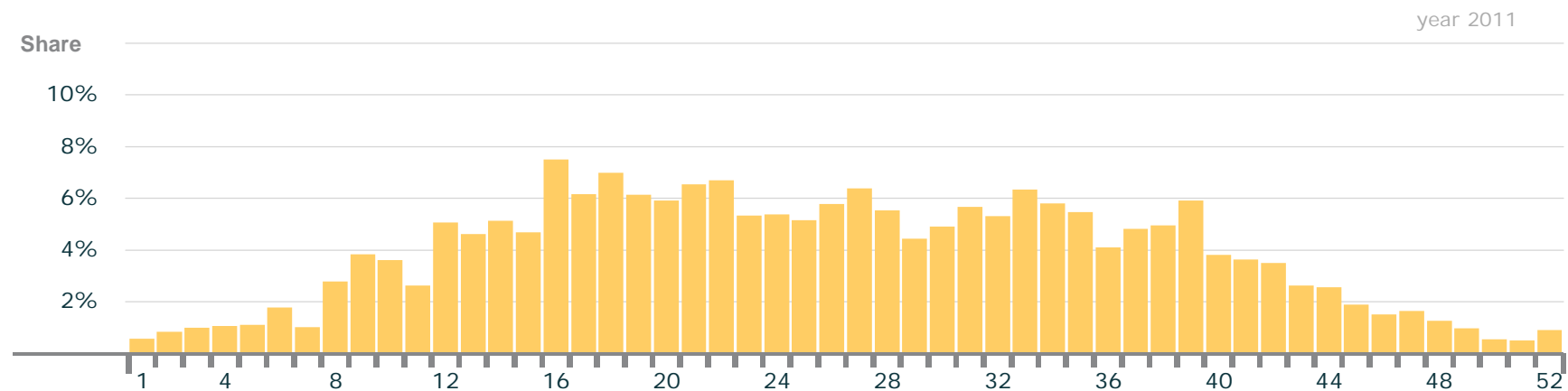
Weekly Production Solar, Wind and Conventional > 100 MW



Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Weekly Solar Energy Share of the Load

## Weekly Solar Energy Share of the Load



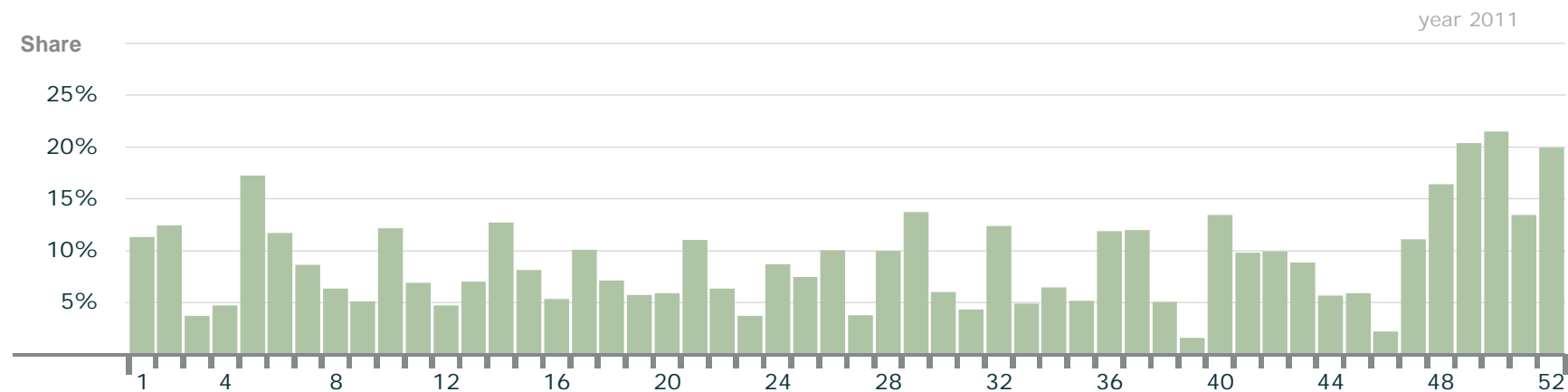
- The maximal weekly solar energy share of the load was 7.5% in calendar week 16 from 18<sup>th</sup> to 24<sup>th</sup> of April 2011
- The minimal weekly solar energy share of the load was 0.5% in calendar week 51 from 19<sup>th</sup> to 25<sup>th</sup> of December 2011

Graph: B. Burger, Fraunhofer ISE; solar data: EEX Transparency Platform



# Weekly Wind Energy Share of the Load

## Weekly Wind Energy Share of the Load

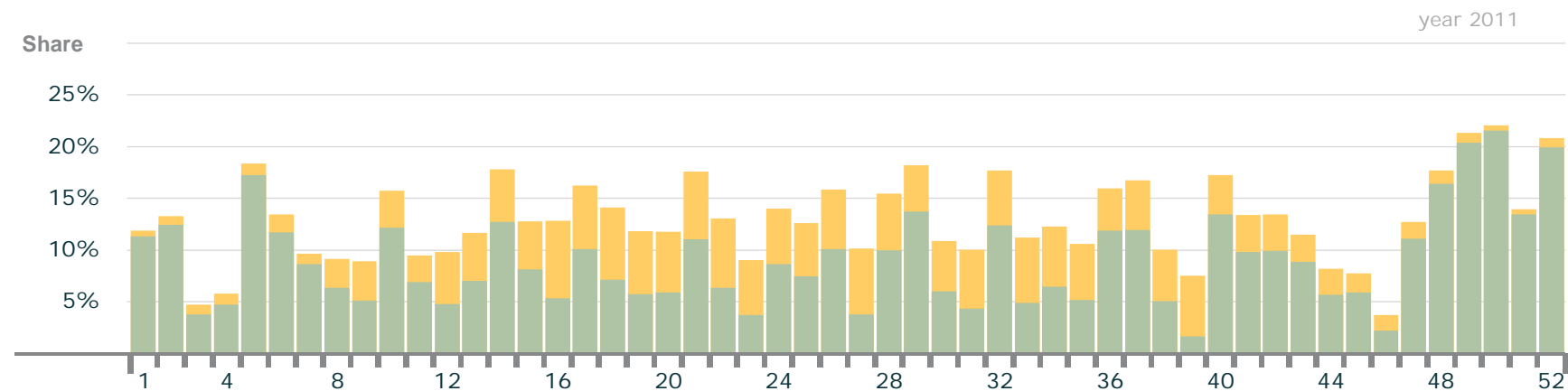


- The maximal weekly wind energy share of the load was 21.5% in calendar week 50 from 12<sup>th</sup> to 18<sup>th</sup> of December 2011
- The minimal weekly wind energy share of the load was 1.6% in calendar week 39 from 26<sup>th</sup> of September to 2<sup>nd</sup> of October 2011

Graph: B. Burger, Fraunhofer ISE; solar data: EEX Transparency Platform; load data: ENTSO-E

# Weekly Solar and Wind Energy Share of the Load

## Weekly Solar and Wind Energy Share of the Load



- The maximal sum of solar and wind energy share of the load was 22% in calendar week 50 from 12<sup>th</sup> to 18<sup>th</sup> of December 2011
- The minimal sum of solar and wind energy share of the load was 3.7% in calendar week 46 from 14<sup>th</sup> to 20<sup>th</sup> of November 2011

Graph: B. Burger, Fraunhofer ISE; solar and wind data: EEX Transparency Platform; load data: ENTSO-E

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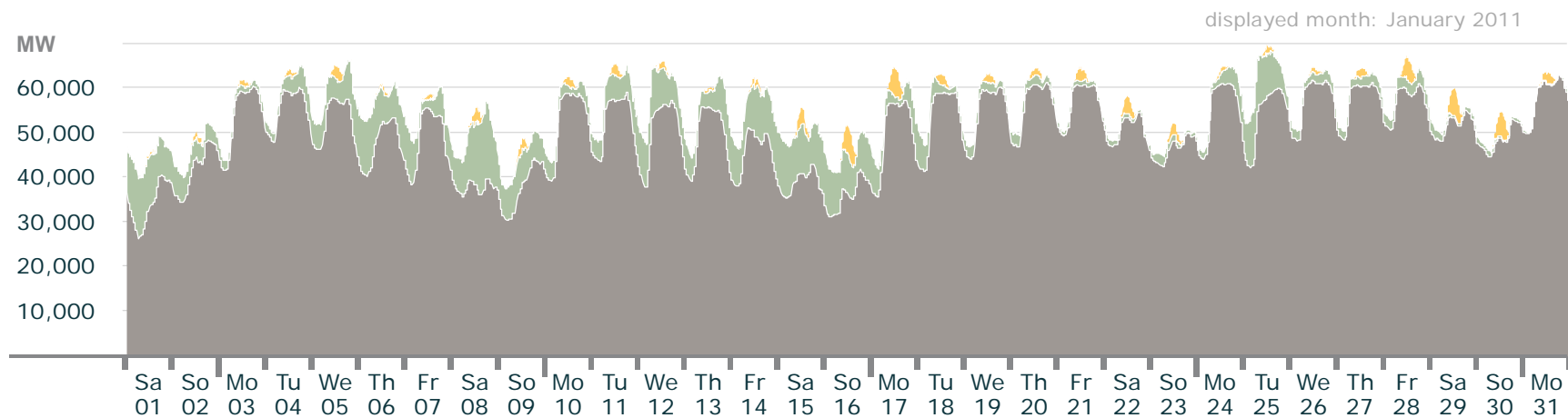
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# Electricity Production in Germany : January 2011

## Actual production



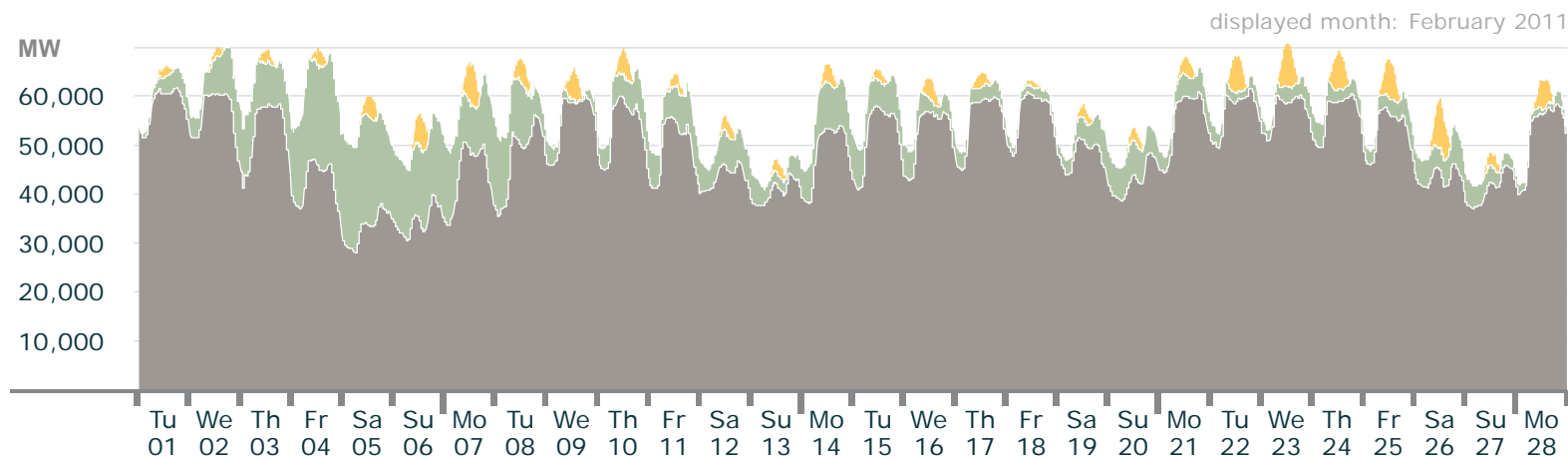
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 6.7 GW; 0.37 TWh
- Wind: max. 17.4 GW; 3.6 TWh
- Conventional: max. 62.7 GW; 36.8 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : February 2011

## Actual production



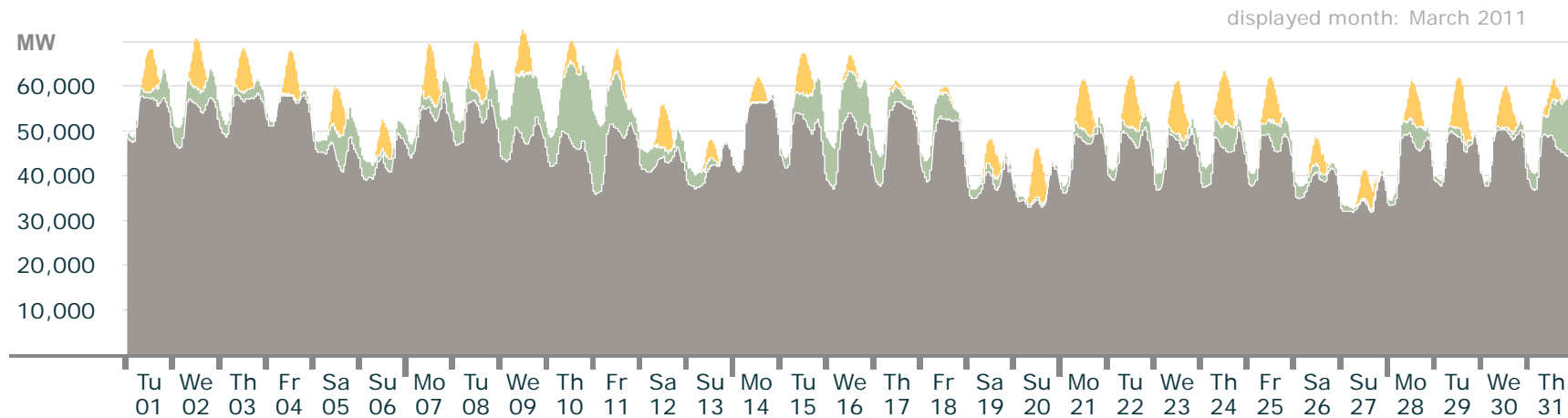
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 9.9 GW; 0.7 TWh
- Wind: max. 22.9 GW; 4.6 TWh
- Conventional: max. 61.7 GW; 33.1 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : March 2011

## Actual production



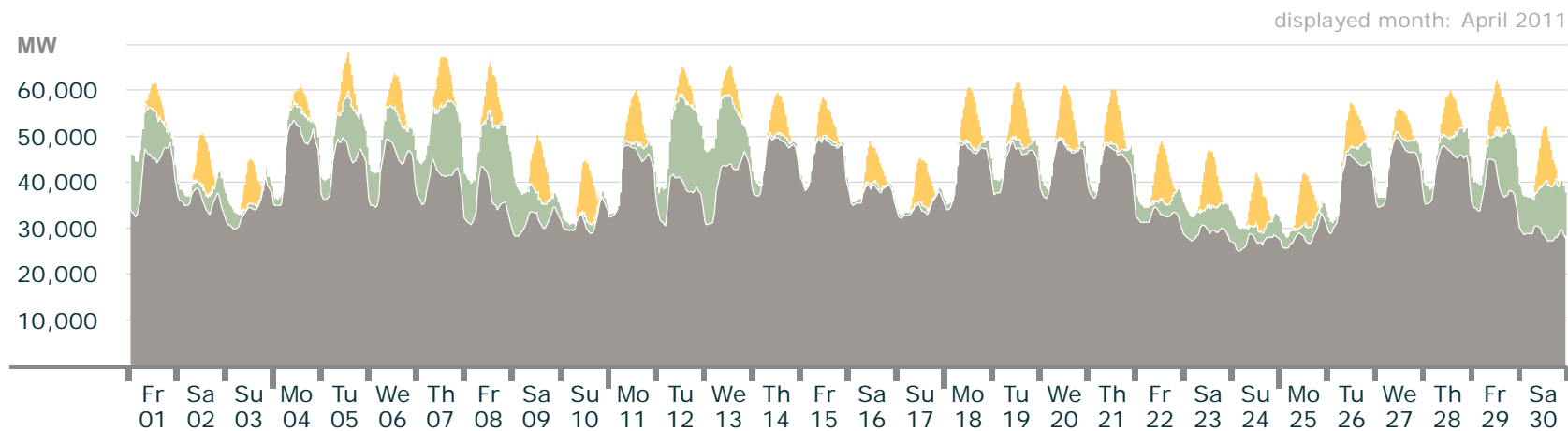
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12 GW; 1.7 TWh
- Wind: max. 18.9 GW; 3.1 TWh
- Conventional: max. 58.4 GW; 34.4 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: April 2011

## Actual production



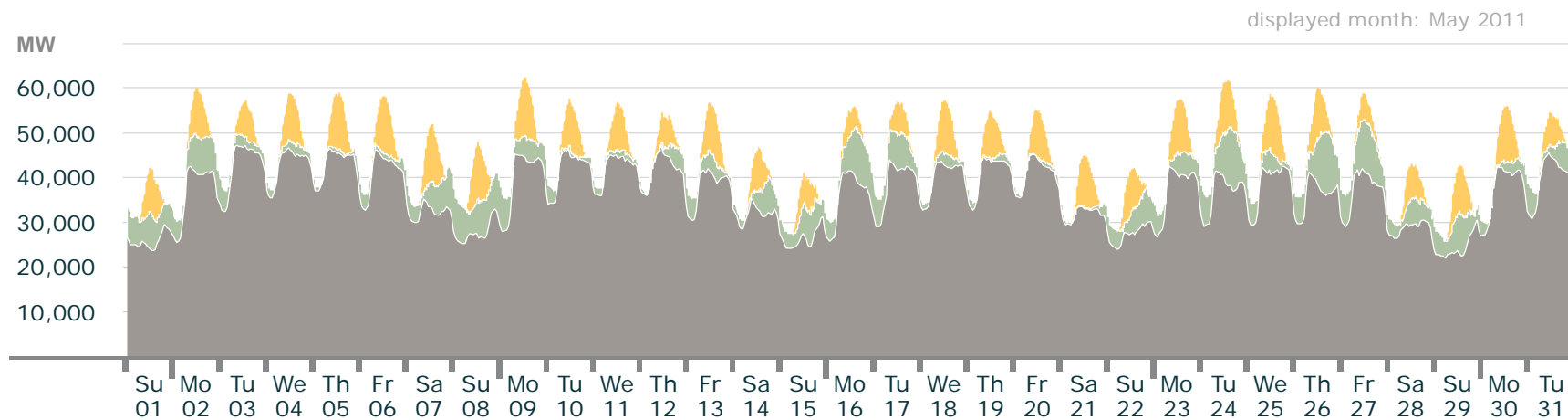
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12.8 GW; 2.2 TWh
- Wind: max. 19.2 GW; 3.5 TWh
- Conventional: max. 53.5 GW; 27.8 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: May 2011

## Actual production



Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

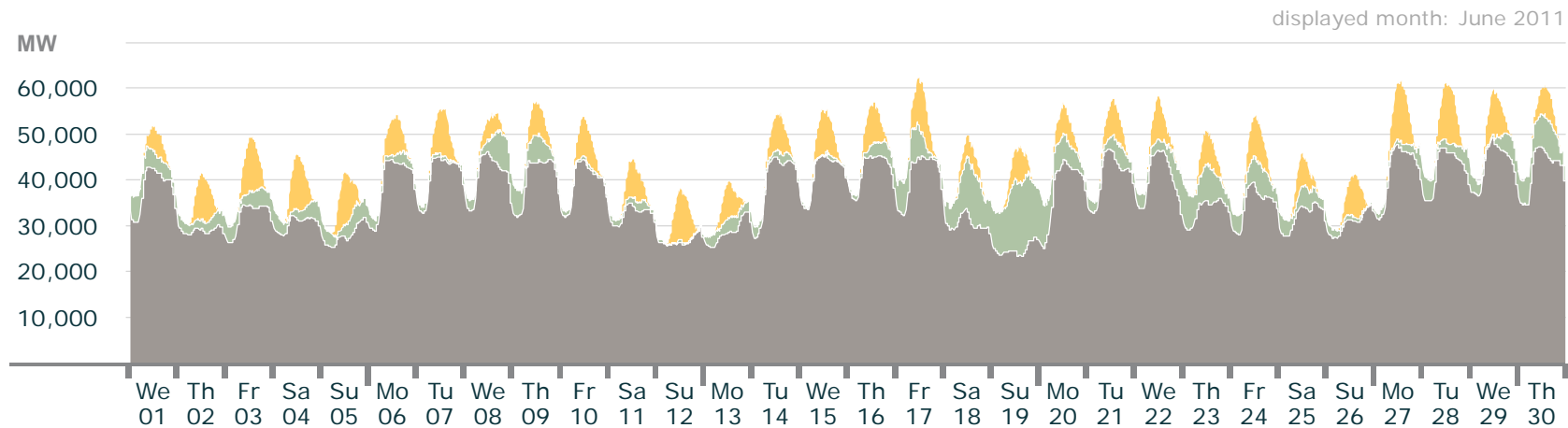
- Solar: max. 13.2 GW; 2.6 TWh
- Wind: max. 14.5 GW; 3.0 TWh
- Conventional: max. 47.2 GW; 27 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform



# Electricity Production in Germany: June 2011

## Actual production



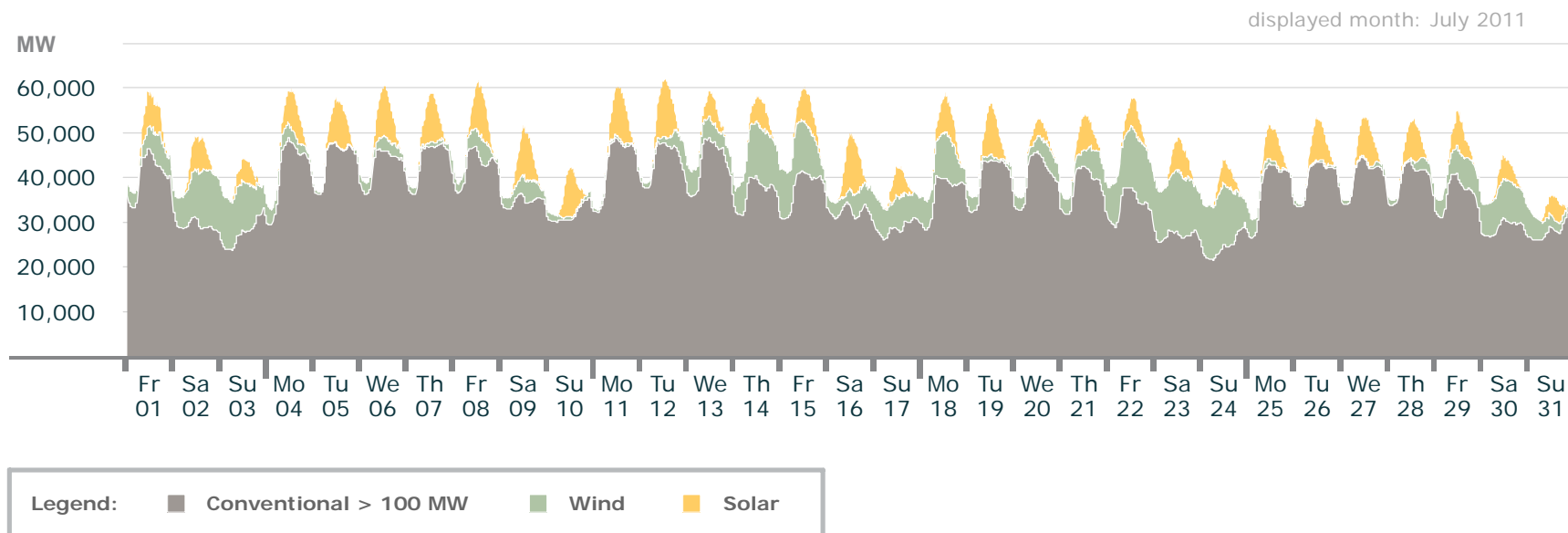
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 13 GW; 2.2 TWh
- Wind: max. 16.4 GW; 2.5 TWh
- Conventional: max. 49 GW; 26 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: July 2011

## Actual production

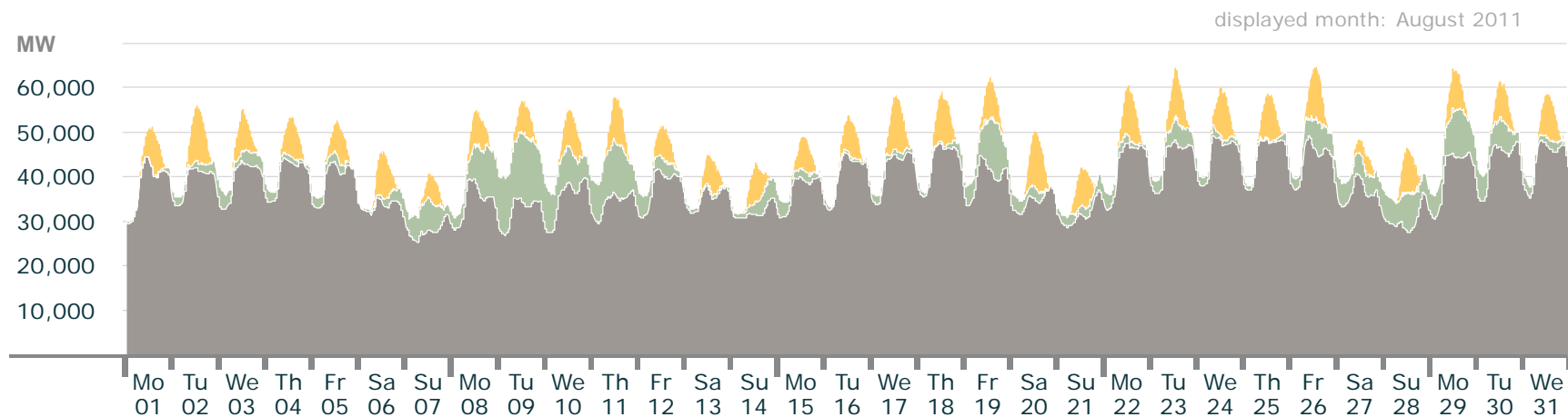


- Solar: max. 12.8 GW; 2.1 TWh
- Wind: max. 14.4 GW; 3.6 TWh
- Conventional: max. 48.9 GW; 27.2 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: August 2011

## Actual production



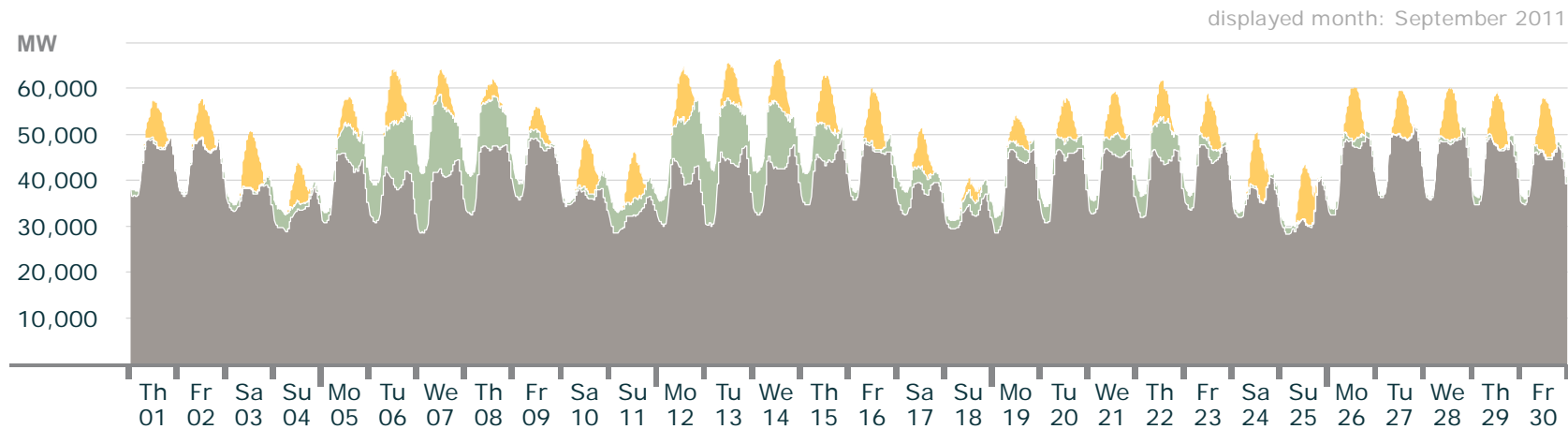
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12.7 GW; 2.2 TWh
- Wind: max. 15.9 GW; 2.8 TWh
- Conventional: max. 49.1 GW; 28.3 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: September 2011

## Actual production



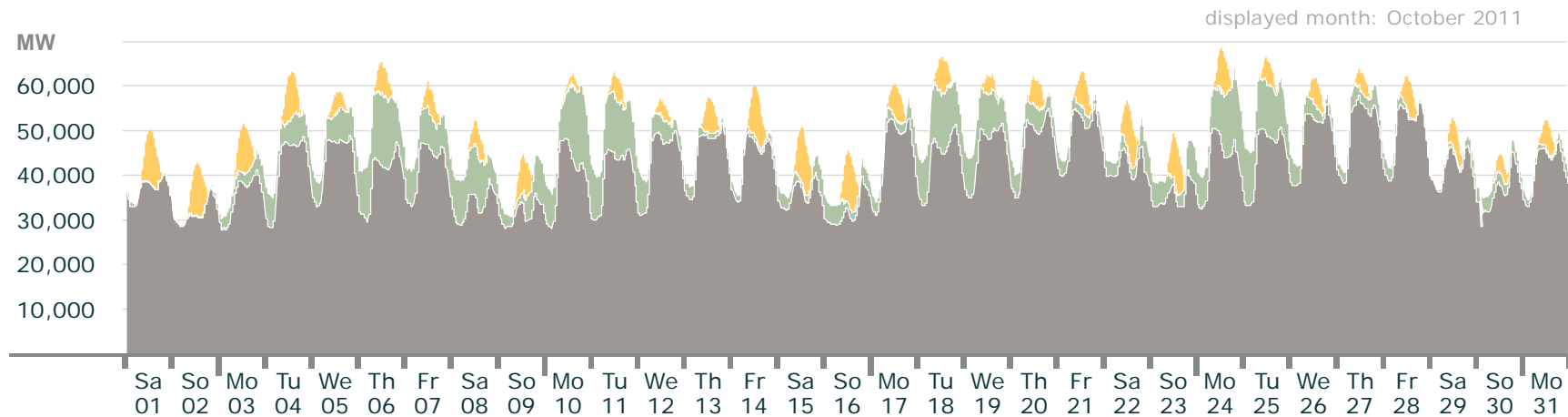
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12.4 GW; 1.9 TWh
- Wind: max. 16.3 GW; 2.9 TWh
- Conventional: max. 51.6 GW; 28.9 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: October 2011

## Actual production



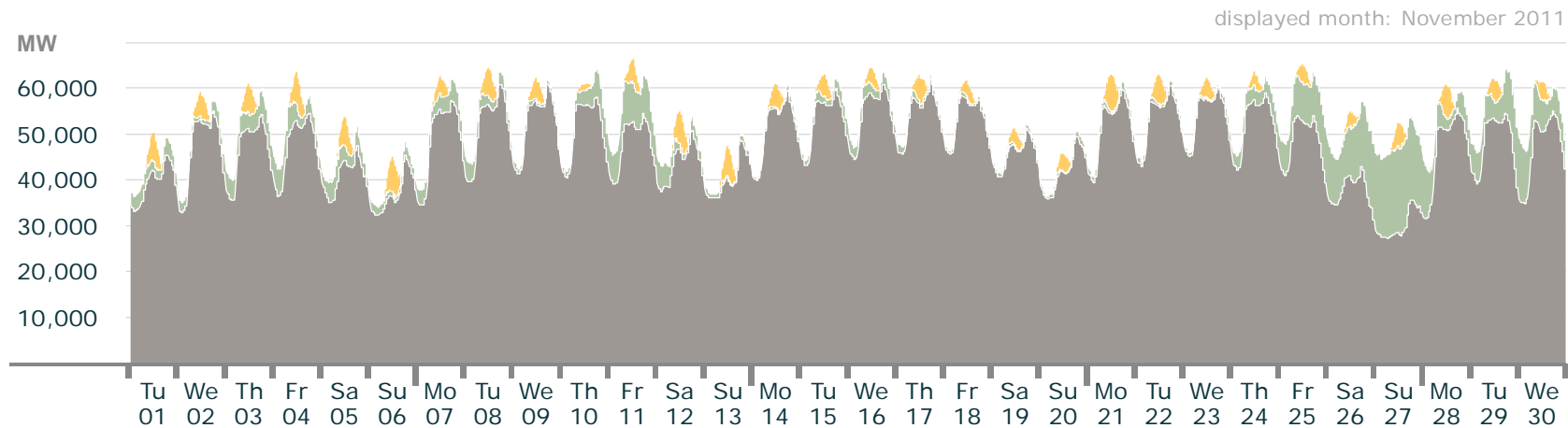
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12.6 GW; 1.5 TWh
- Wind: max. 18.1 GW; 4 TWh
- Conventional: max. 57.7 GW; 30.7 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: November 2011

## Actual production



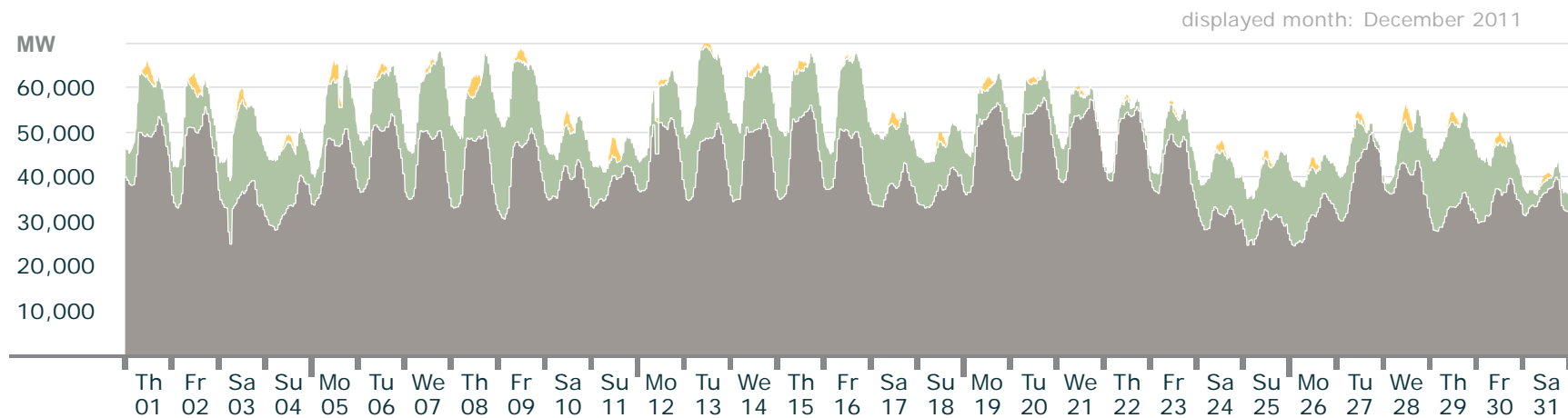
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 8.1 GW; 0.8 TWh
- Wind: max. 19.7 GW; 2.9 TWh
- Conventional: max. 62.6 GW; 34.4 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany: December 2011

## Actual production



Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 4.65 GW; 0.31 TWh
- Wind: max. 21.3 GW; 7.98 TWh
- Conventional: max. 57.8 GW; 30.6 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

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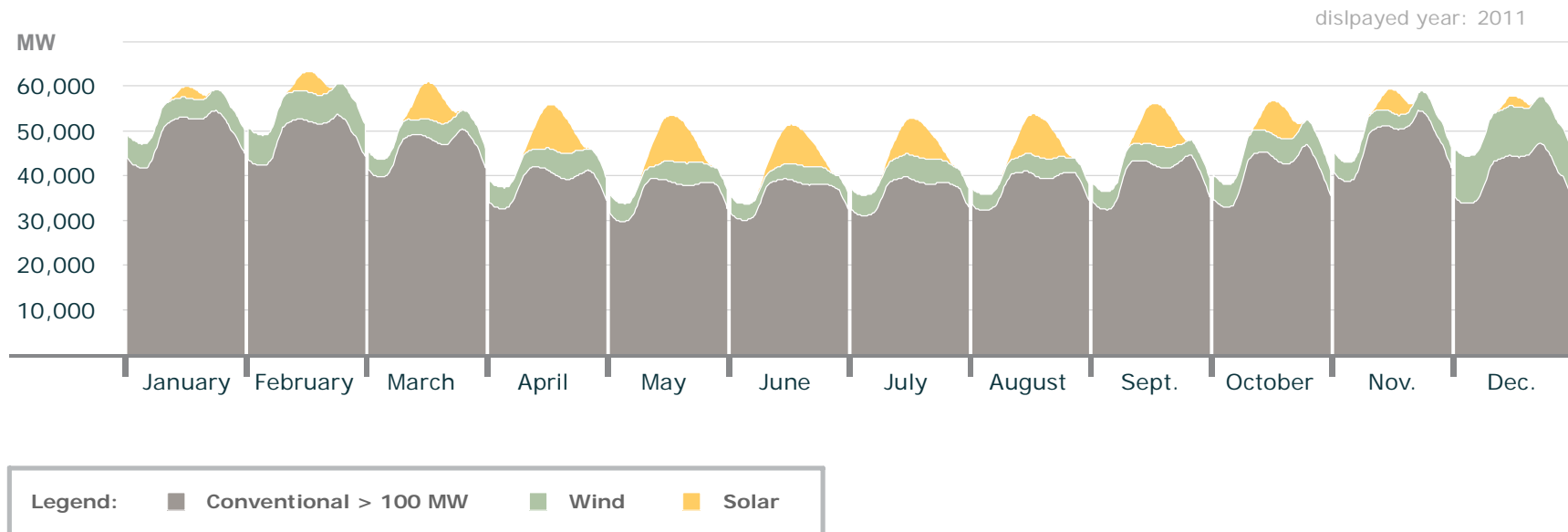
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# Diurnal courses 2011

## Diurnal courses



Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

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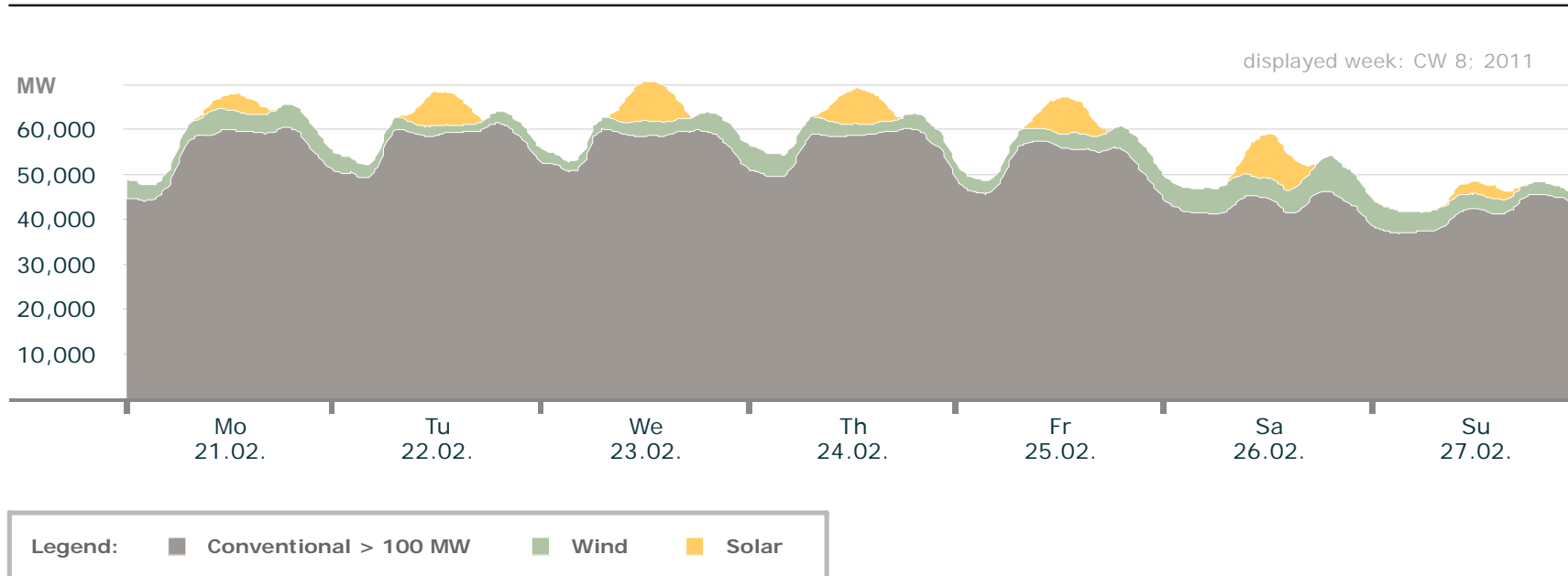
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# Electricity Production in Germany : Calendar Week 8

## Actual production



■ Solar: max. 9.9 GW; 0.29 TWh

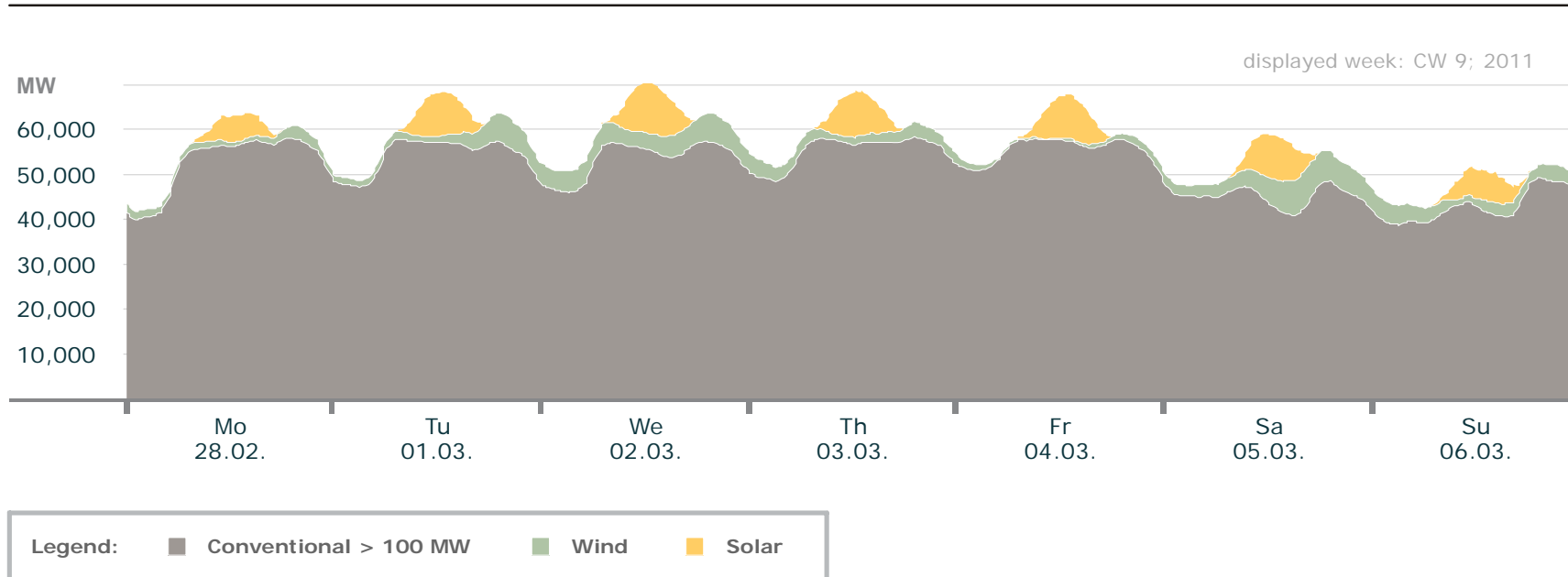
■ Wind: max. 8.3 GW; 0.65 TWh

■ Conventional: max. 61.5 GW; 8.7 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 9

## Actual production



■ Solar: max. 11.1 GW; 0.38 TWh

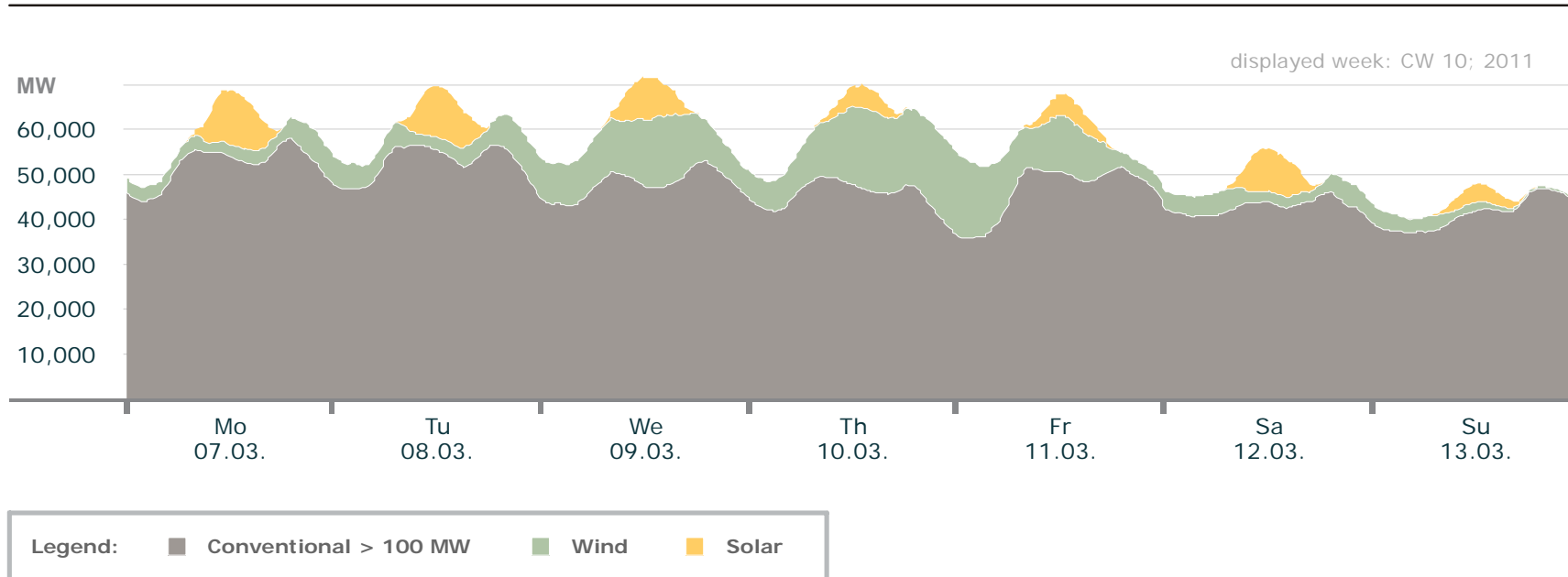
■ Wind: max. 8.2 GW; 0.5 TWh

■ Conventional: max. 58.4 GW; 8.6 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 10

## Actual production



■ Solar: max. 12.0 GW; 0.35 TWh

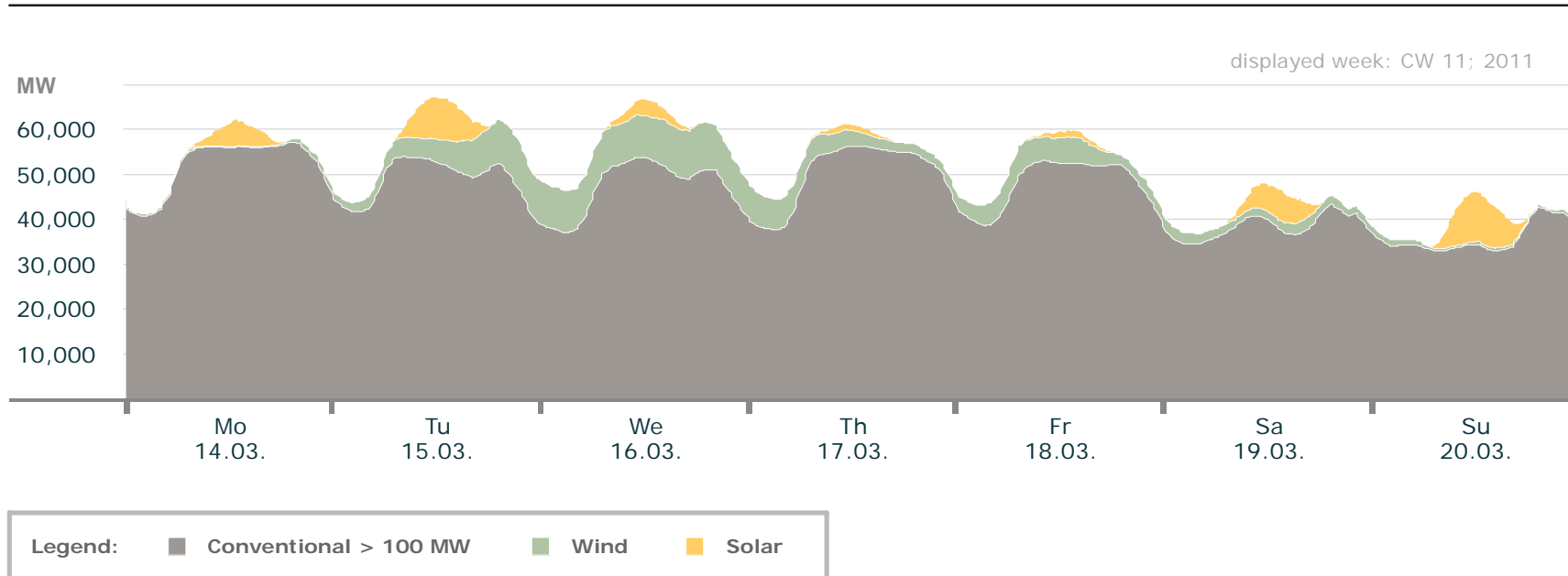
■ Wind: max. 18.9 GW; 1.2 TWh

■ Conventional: max. 58.2 GW; 7.9 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 11

## Actual production

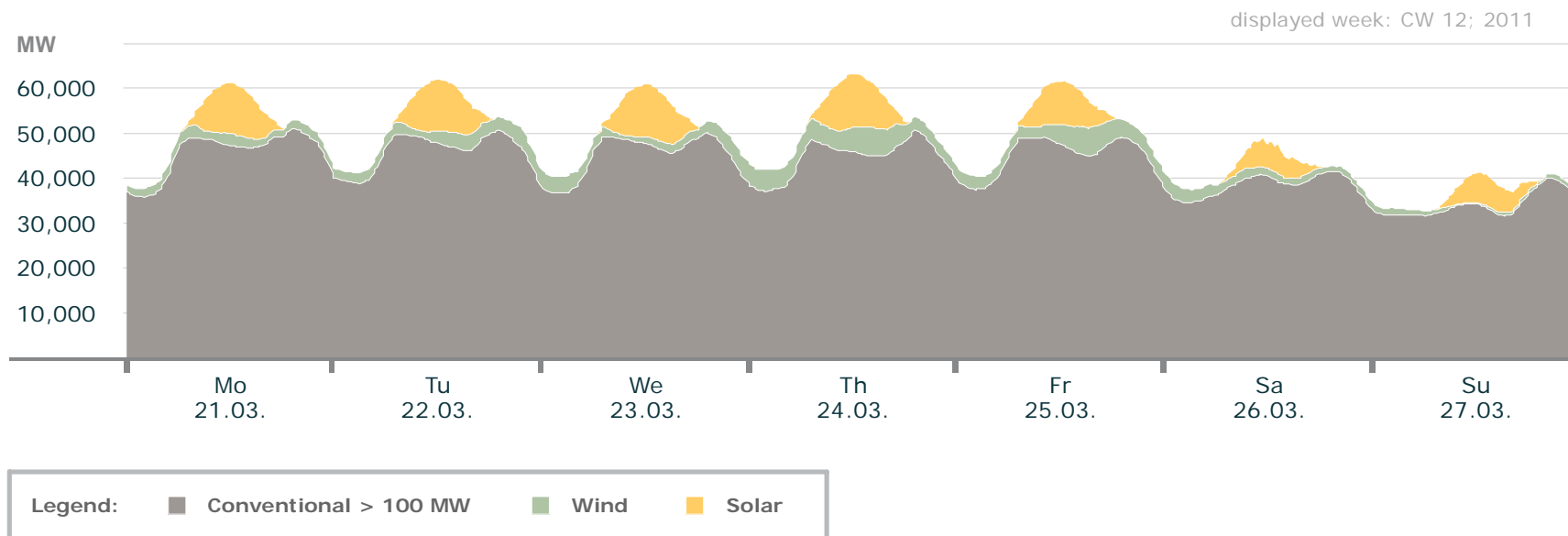


- Solar: max. 11.1 GW; 0.25 TWh
- Wind: max. 11.1 GW; 0.65 TWh
- Conventional: max. 57.3 GW; 7.7 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 12

## Actual production

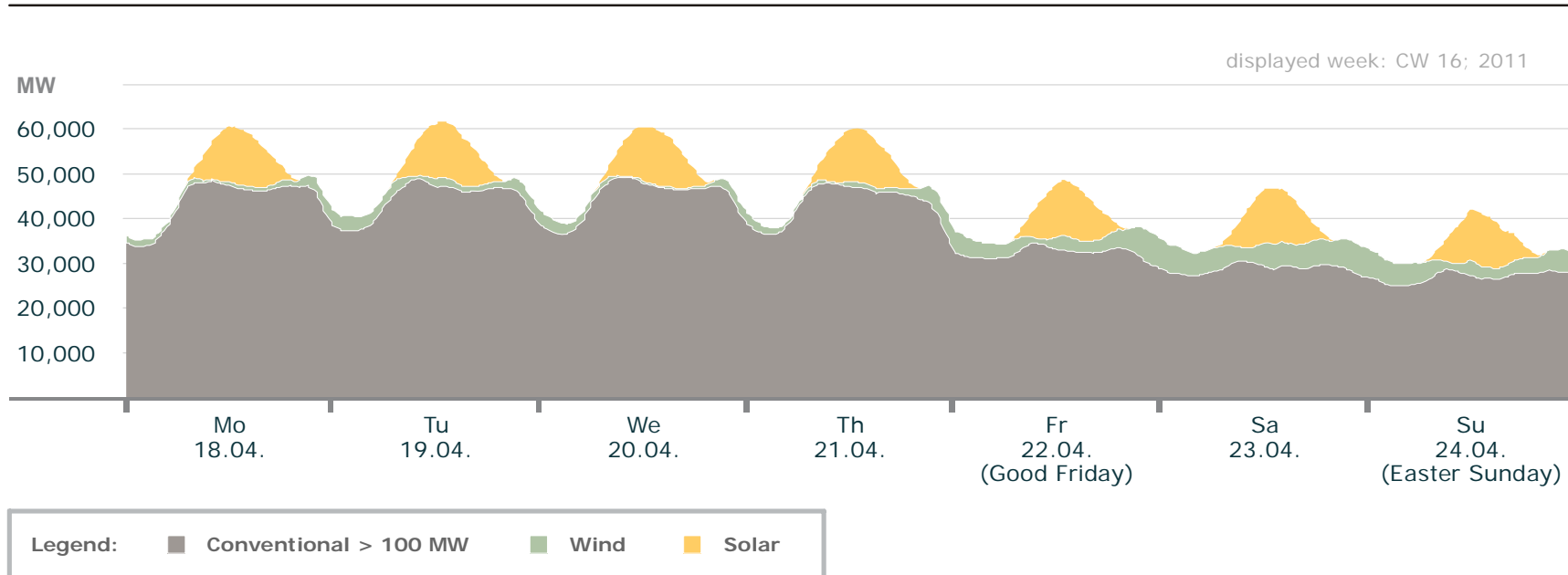


- Solar: max. 11.9 GW; 0.48 TWh
- Wind: max. 6.3 GW; 0.45 TWh
- Conventional: max. 51.2 GW; 7.2 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 16

## Actual production



■ Solar: max. 12.6 GW; 0.65 TWh

■ Wind: max. 7.3 GW; 0.46 TWh

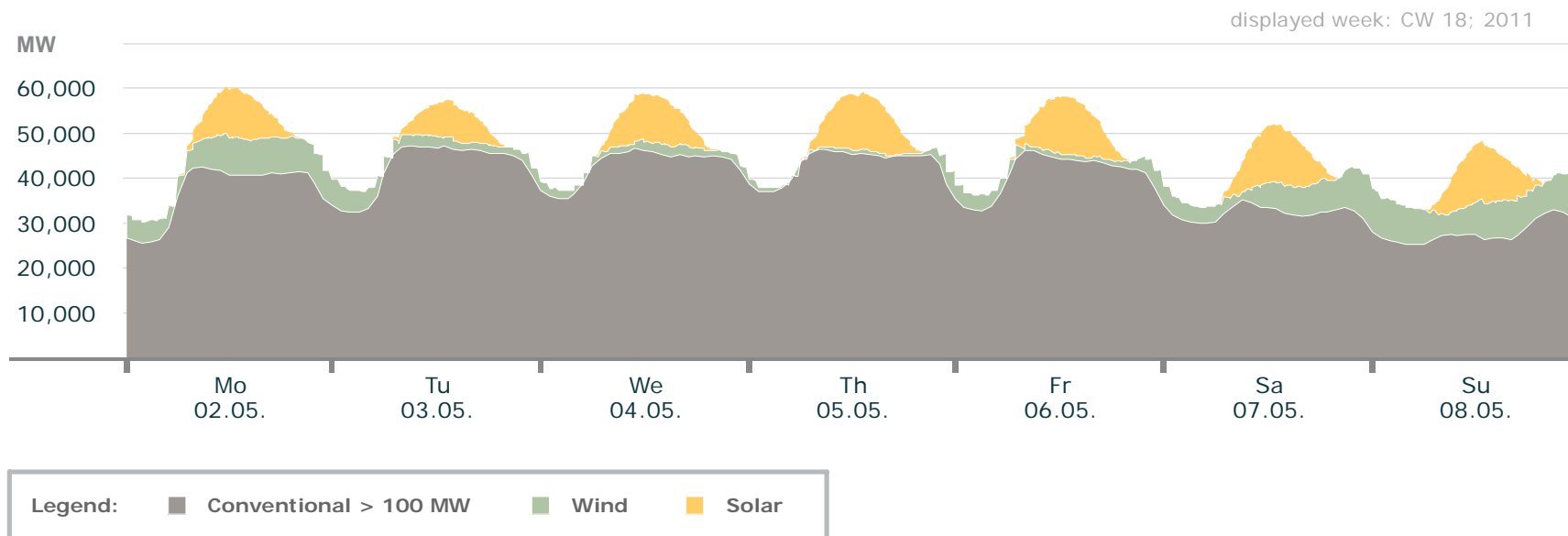
■ Conventional: max. 49.3 GW; 6.4 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform



# Electricity Production in Germany : Calendar Week 18

## Actual production

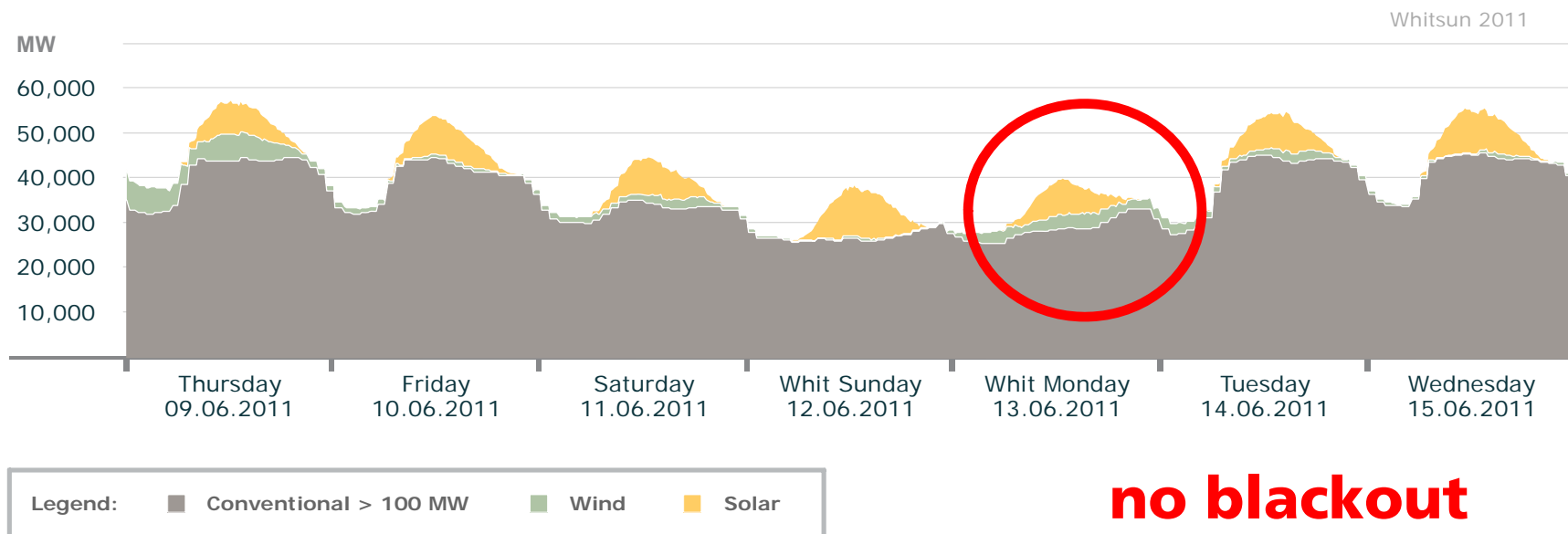


- Solar: max. 13 GW; 0.64 TWh
- Wind: max. 9.8 GW; 0.65 TWh
- Conventional: max. 47.2 GW; 6.4 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany at Whitsun

## Actual production



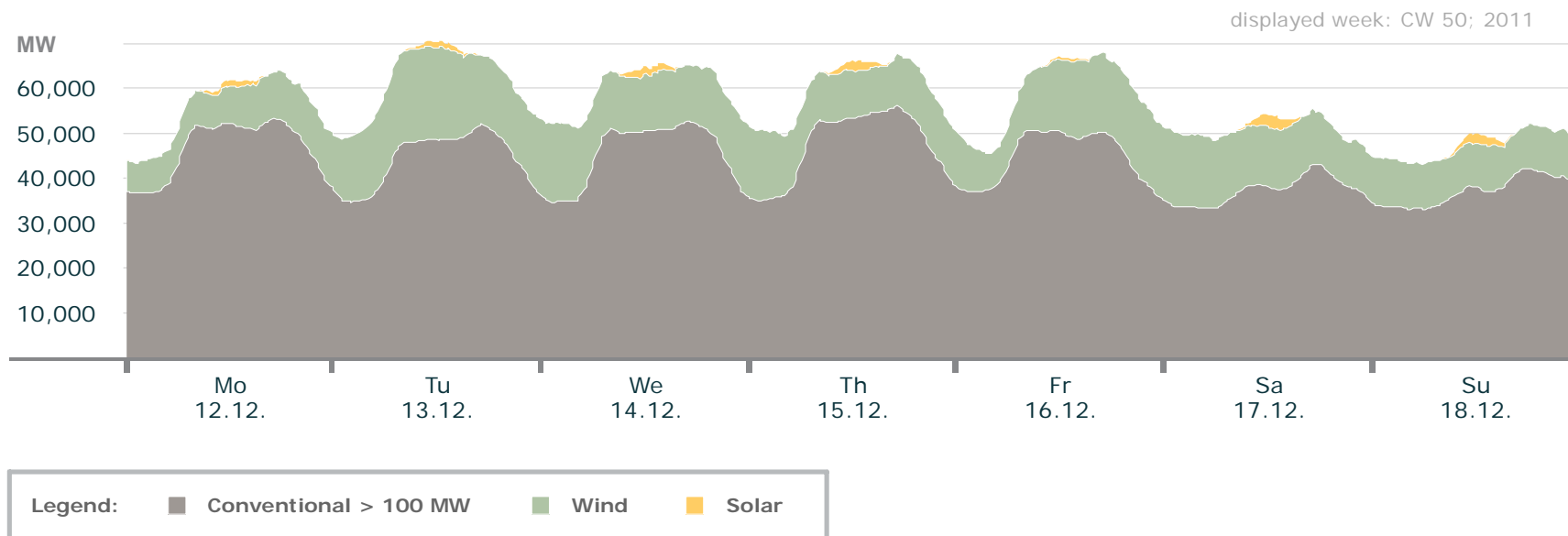
**no blackout  
at Whitsun!!!**

- There was no risk of a blackout during Whitsun
- Solar plants stabilize the grid, since they deliver peak load

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

# Electricity Production in Germany : Calendar Week 50

## Actual production



■ Solar: max. 2.9 GW; 0.05 TWh

■ Wind: max. 20.8 GW; 2.2 TWh

■ Conventional: max. 56.2 GW; 7.3 TWh

Graph: B. Burger, Fraunhofer ISE; data: EEX Transparency Platform

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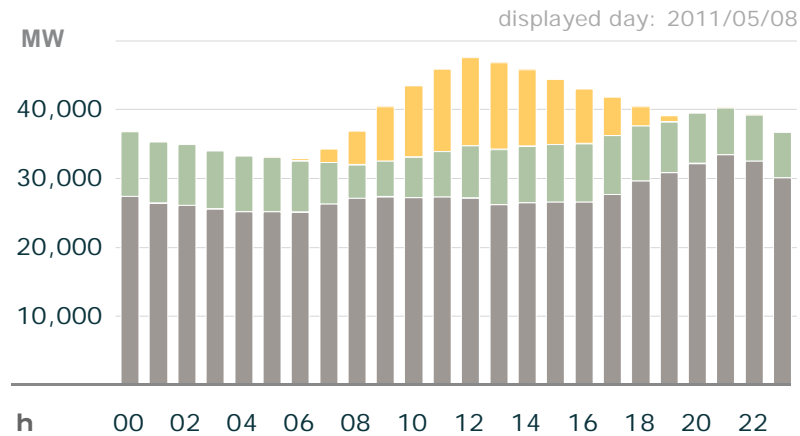
# Agenda

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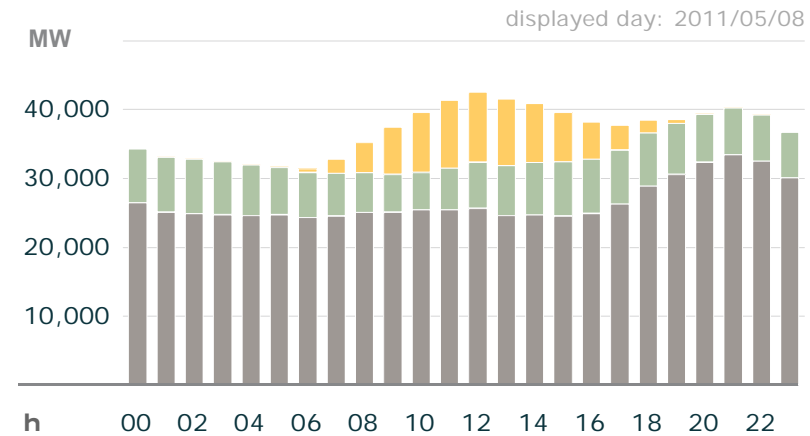
- Facts solar and wind energy
- Annual energies
- Monthly energies
- Weekly energies
- Daily energies
- Annual power curves
- Monthly power curves
- Diurnal power courses
- Exemplary weekly power curves
- **Exemplary daily power curves**

# Electricity Production in Germany: Sunday, 08.05.2011

## Actual production



## Planned production



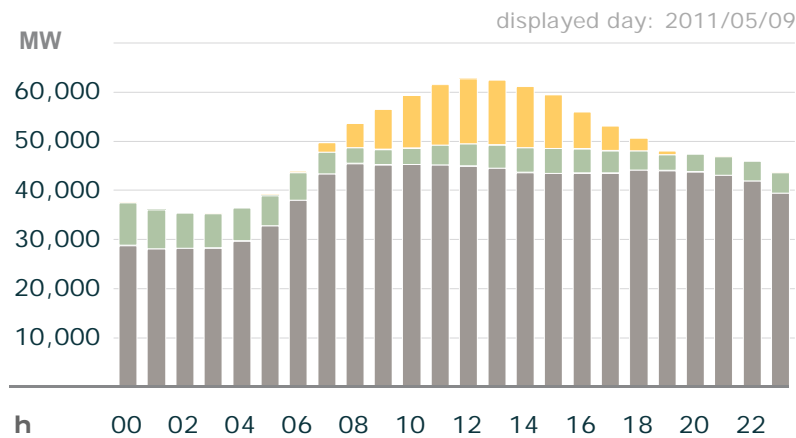
Legend: ■ Conventional > 100 MW ■ Wind ■ Solar

- Solar: max. 12.9 GW; 101 GWh
- Wind: max. 9.7 GW; 185 GWh
- Conventional: max. 32.9 GW; 667 GWh

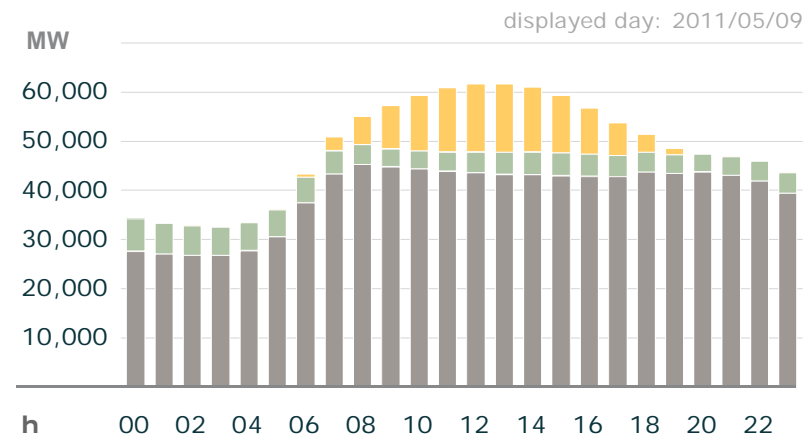
Graph: European Electricity Stock Exchange EEX, <http://www.transparency.eex.com>

# Electricity Production in Germany: Monday, 09.05.2011

## Actual production



## Planned production

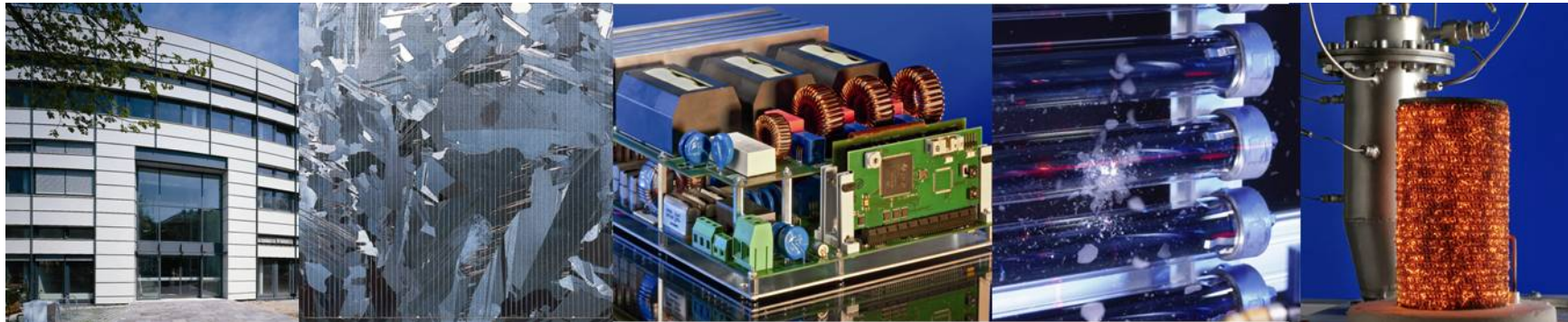


Legend:  Conventional > 100 MW  Wind  Solar

- Solar: max. 13.2 GW; 106 GWh
- Wind: max. 8.7 GW; 121 GWh
- Conventional: max. 45.2 GW; 955 GWh

Graph: European Electricity Stock Exchange EEX, <http://www.transparency.eex.com>

# Thank you for your Attention!



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