
FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

Electricity Spot-Prices and Production Data in Germany 2013



Dipl. Phys. oec. Johannes Mayer

Fraunhofer Institute for Solar
Energy Systems ISE

16.01.2014

www.ise.fraunhofer.de

Stay informed – E-Mail Notification / Twitter

This file can be downloaded from the website of Fraunhofer ISE:

http://www.ise.fraunhofer.de/en/renewable-energy-data/electricity-production-data?set_language=en

If you want to be notified about Updates of this slides, please subscribe to the mailing list by sending a short E-Mail with your contact E-Mail to:

johannes.nikolaus.mayer@ise.fraunhofer.de

You can also follow me on Twitter:

@enerjo (Johannes Mayer)

Summary for 2013

- The average Day-Ahead base price was 37.85 €/MWh, the peak price 42.45 €/MWh (in prices of 2013).
- Day-Ahead prices in 2013 were the lowest since 2004 and almost half the prices of the record year 2008 (inflation adjusted in prices of 2010).
- The spread in Day-Ahead prices between peak and baseload hours reached an all time low of 4.36 €/MWh in 2013, the maximum spread was 2006 with 13.85 €/MWh (inflation adjusted in prices of 2010).
- The total trade volume in 2013 in the German Day-Ahead market was app. 9.3 billion Euros and 660 million Euros in the Intraday market.

Summary for 2013

- In June the lowest Day-Ahead monthly average occurred with 28.28 €/MWh, the highest in February with 44.95 €/MWh.
- Day-Ahead prices were negative in 48 hours, zero in 23 hours and below 10 €/MWh in 326 hours.
- Intraday prices were negative in 79 hours, zero in 2 hours and below 10 €/MWh in 355 hours.

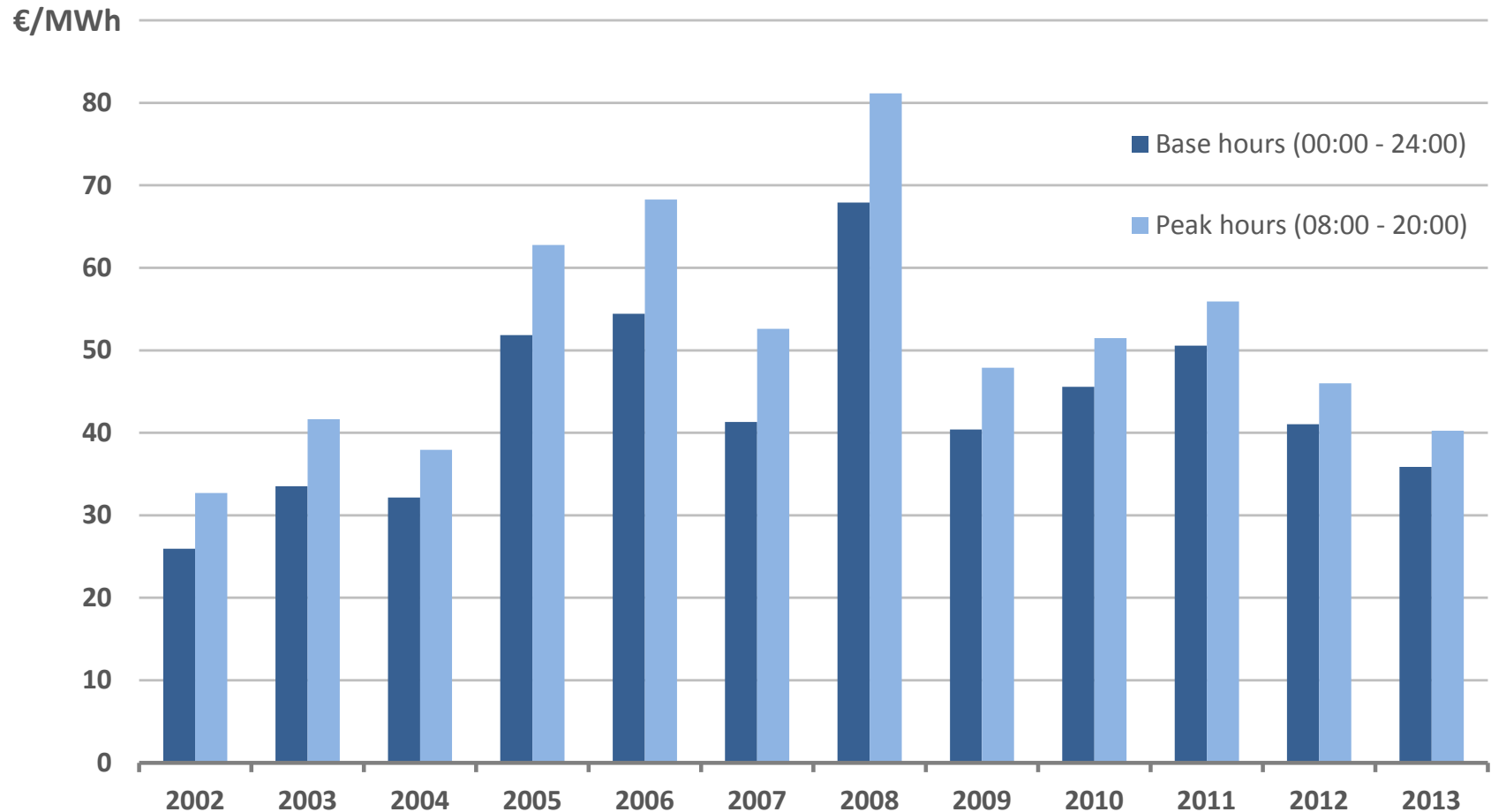
AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Price Extremes
- General energy data
- Instructions
- Sources and Disclaimer

Historical Day-Ahead Base- and Peak-Prices



Day-Ahead Price, volume weighted & inflation-adjusted (2010 prices),
Update: January 2014

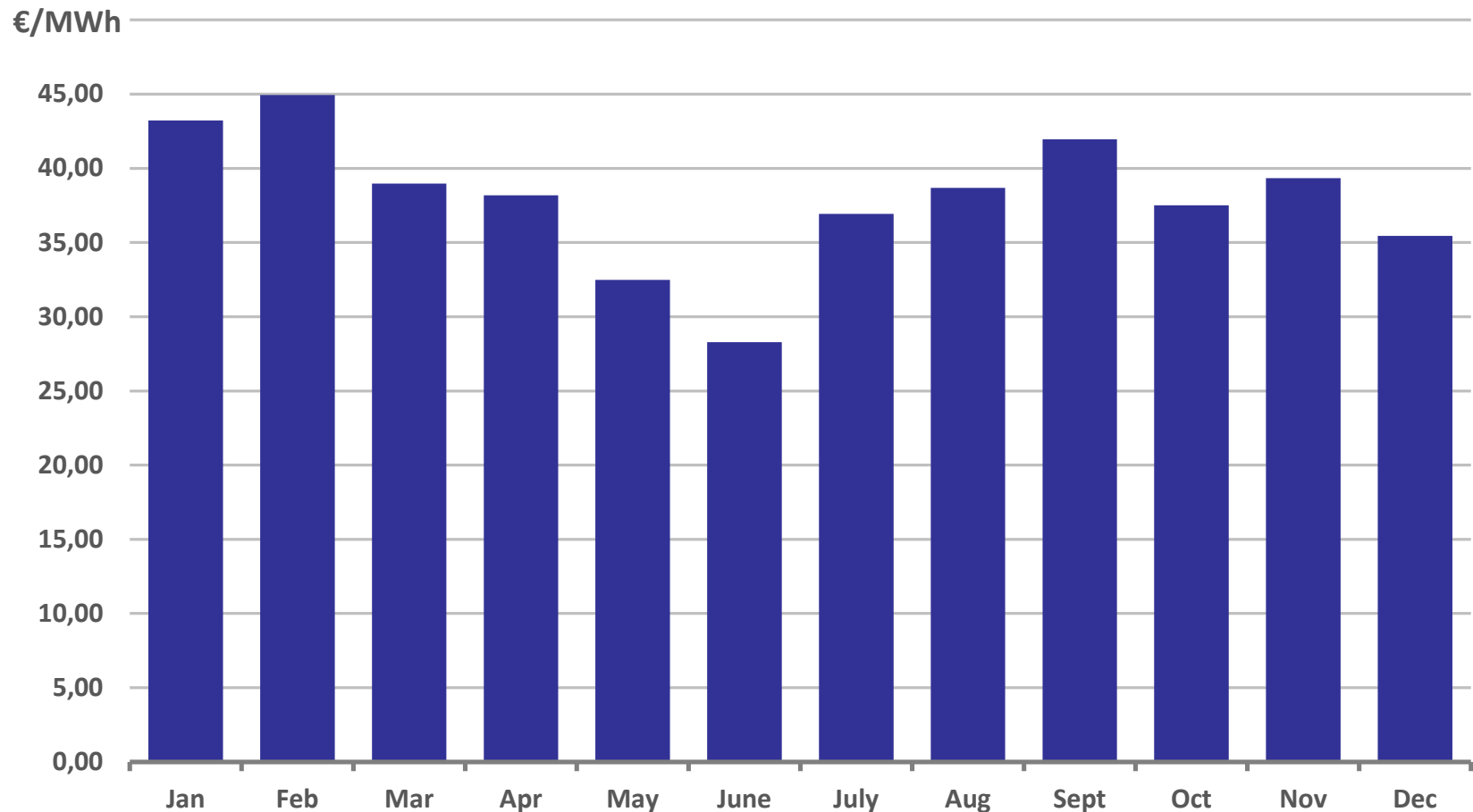


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

Monthly Average of Day-Ahead Prices in 2013



Monthly Average of Day-Ahead Prices in 2013 (volume weighted)

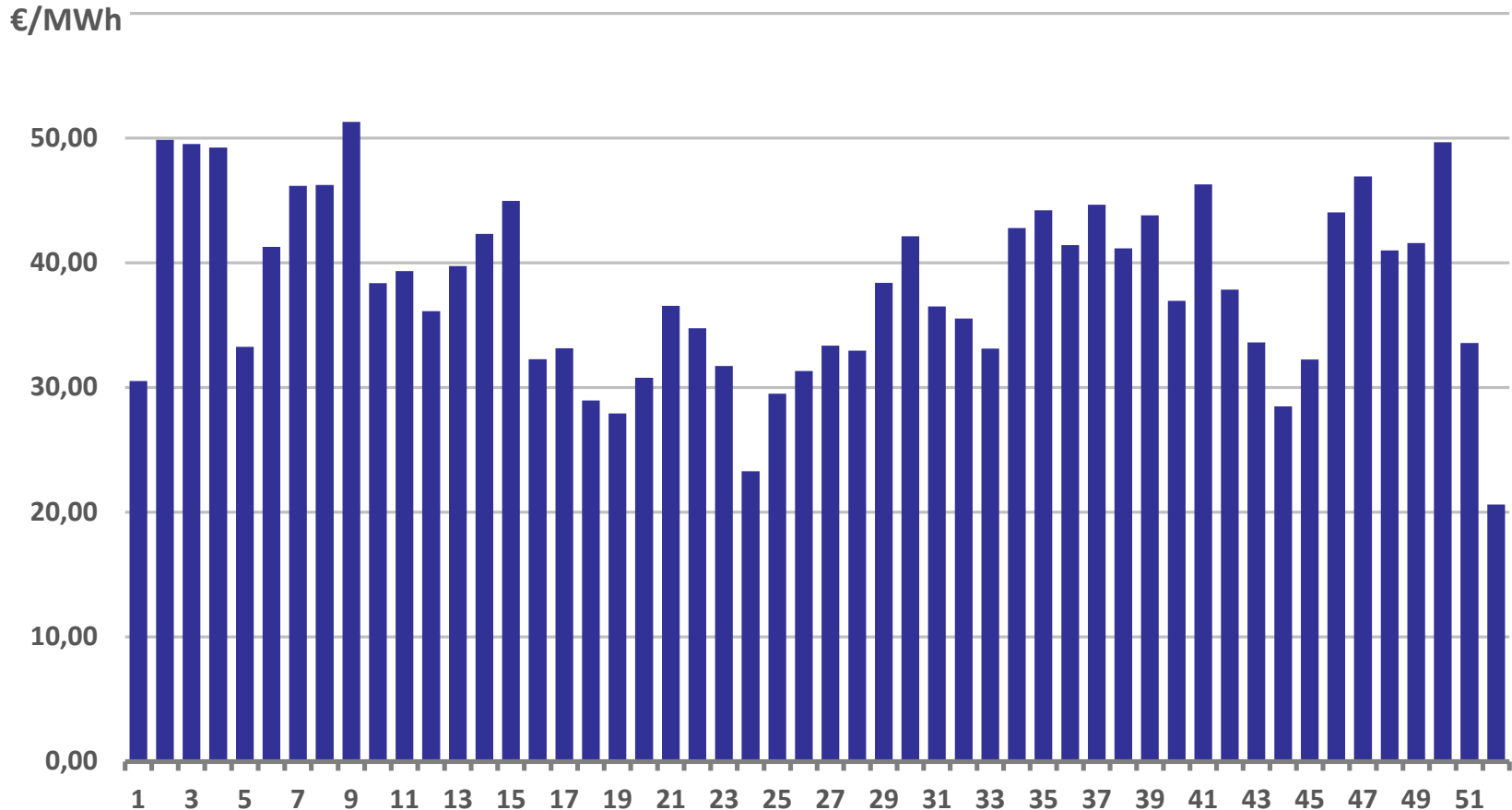


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

Weekly Average of Day-Ahead Prices in 2013



Weekly Average of Day-Ahead Prices in 2013 (volume weighted)

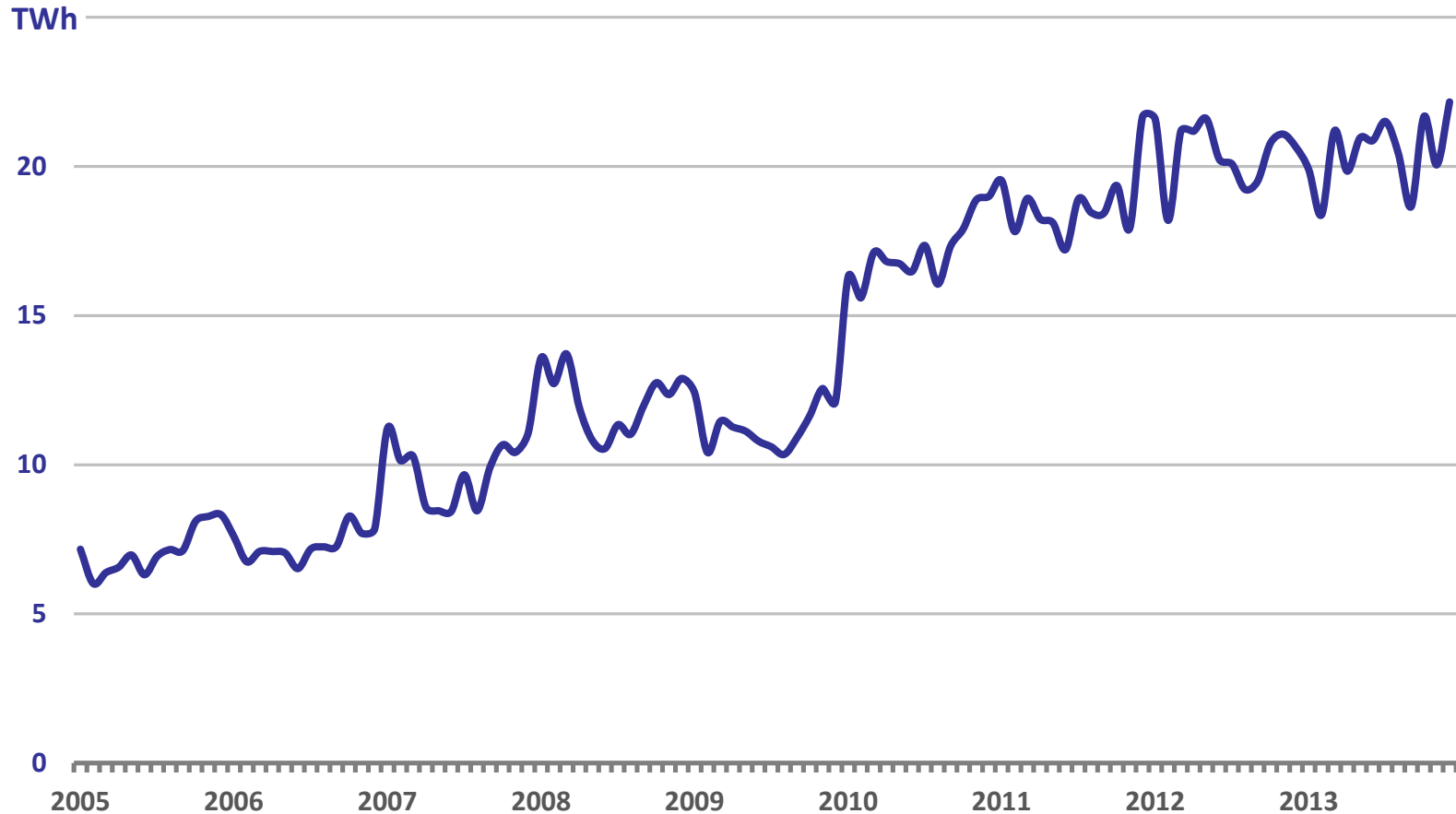


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

Monthly Trading Volume in the Day-Ahead Market



Monthly Day-Ahead trading volumes, Update: Dec. 2013

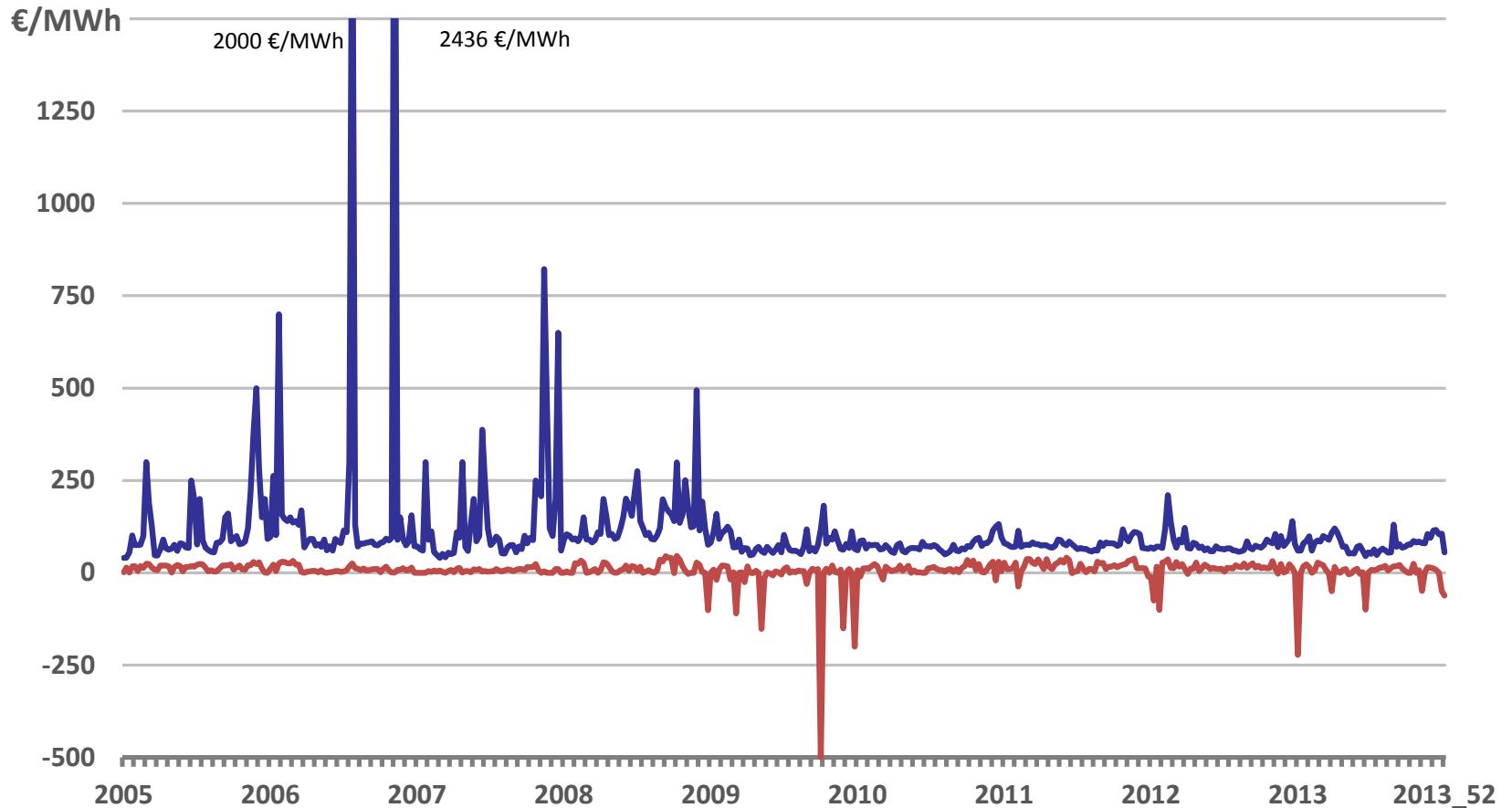


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

History of Price Extremes in the Day-Ahead Market



Weekly Day-Ahead maximum and minimum prices, Update: Dec. 2013

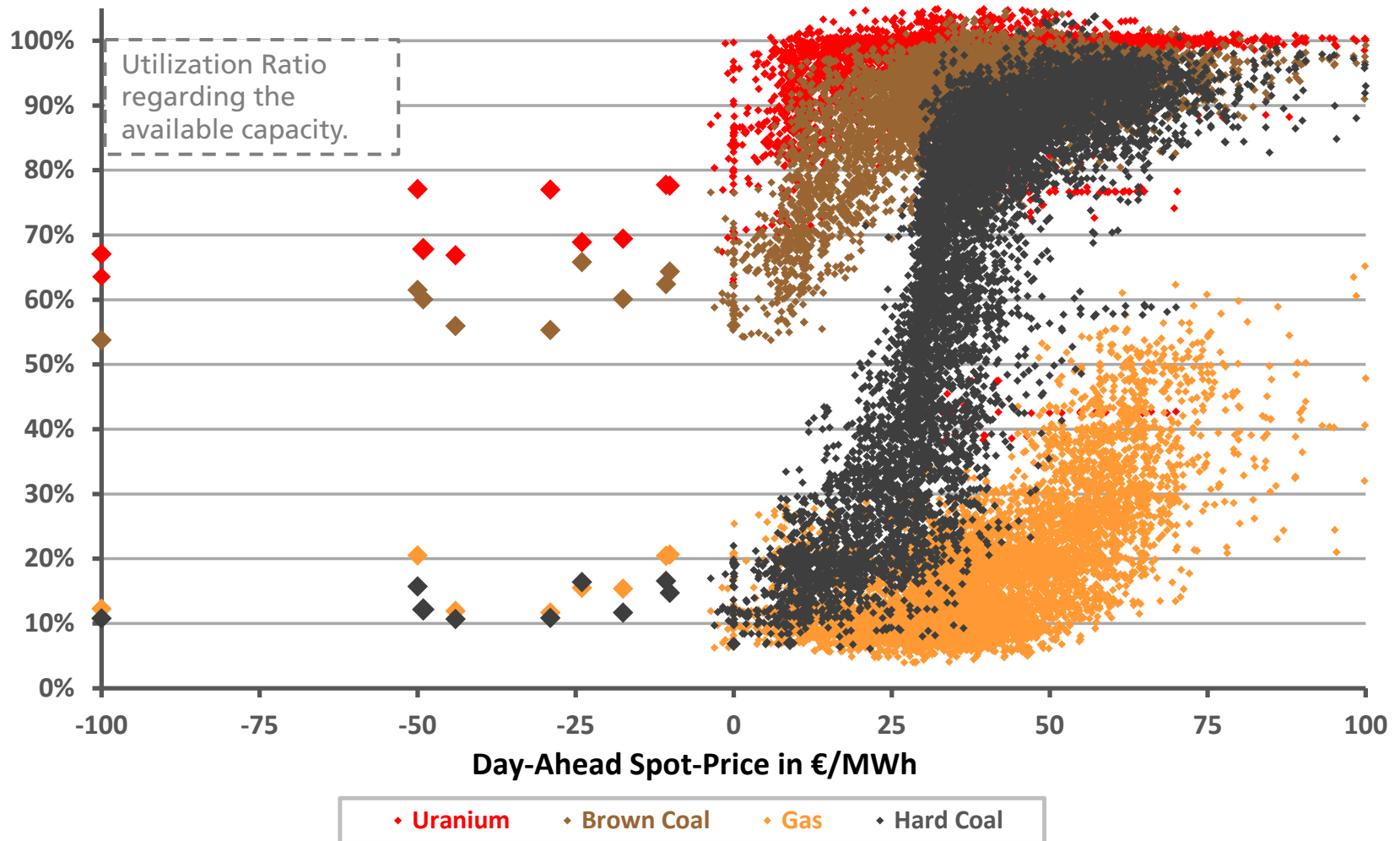


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

Plant System Utilization over Day-Ahead Prices



Utilization Ratio depending on Day-Ahead Spot-Prices (Update: Dec 2013)

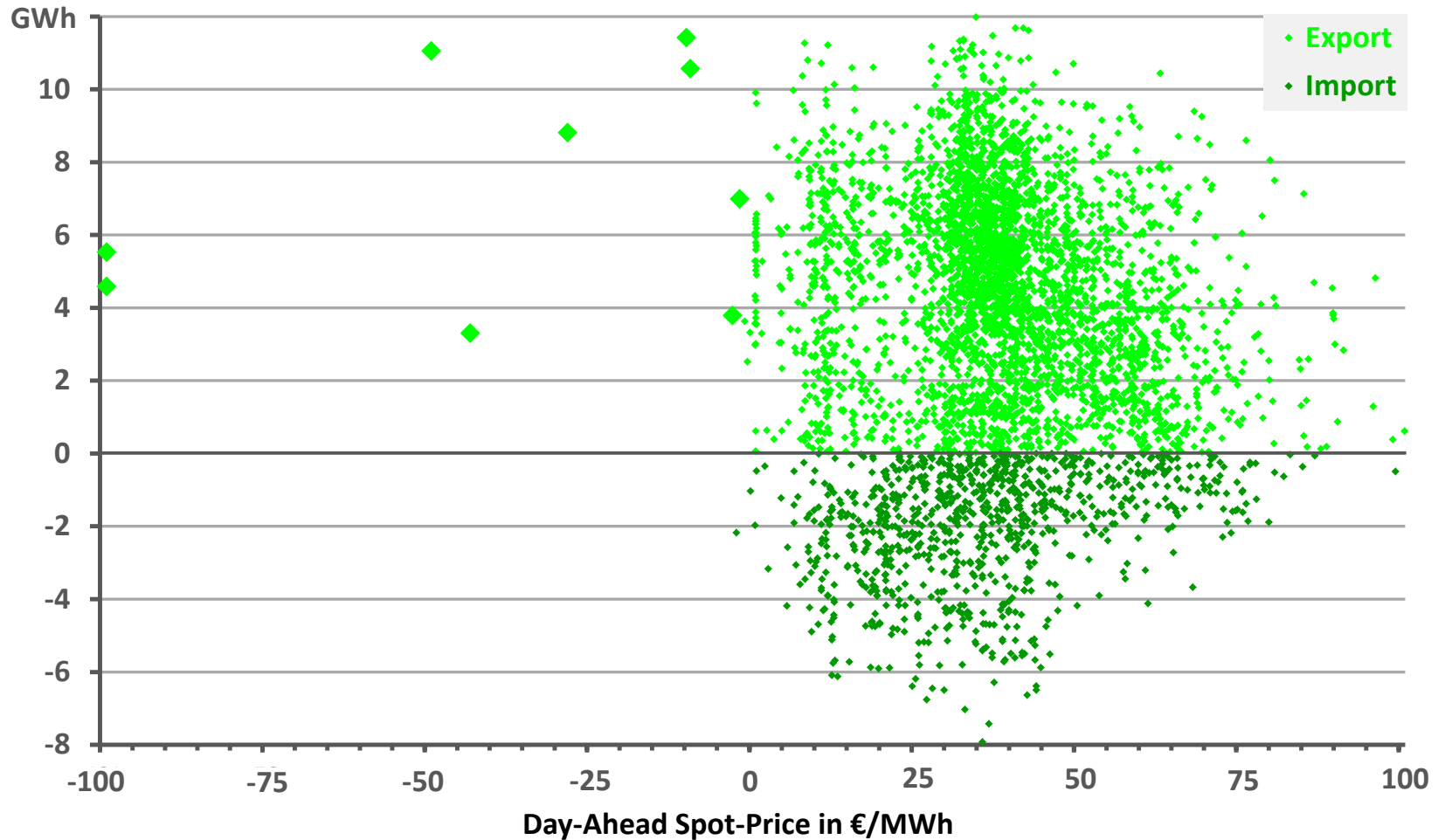


Source: Johannes Mayer, Bruno Burger; Fraunhofer ISE; Data: EEX, dStatis

Import-Export distribution over Day-Ahead Prices



Import-Export distribution over Day-Ahead Spot-Prices, 1. HY 2013

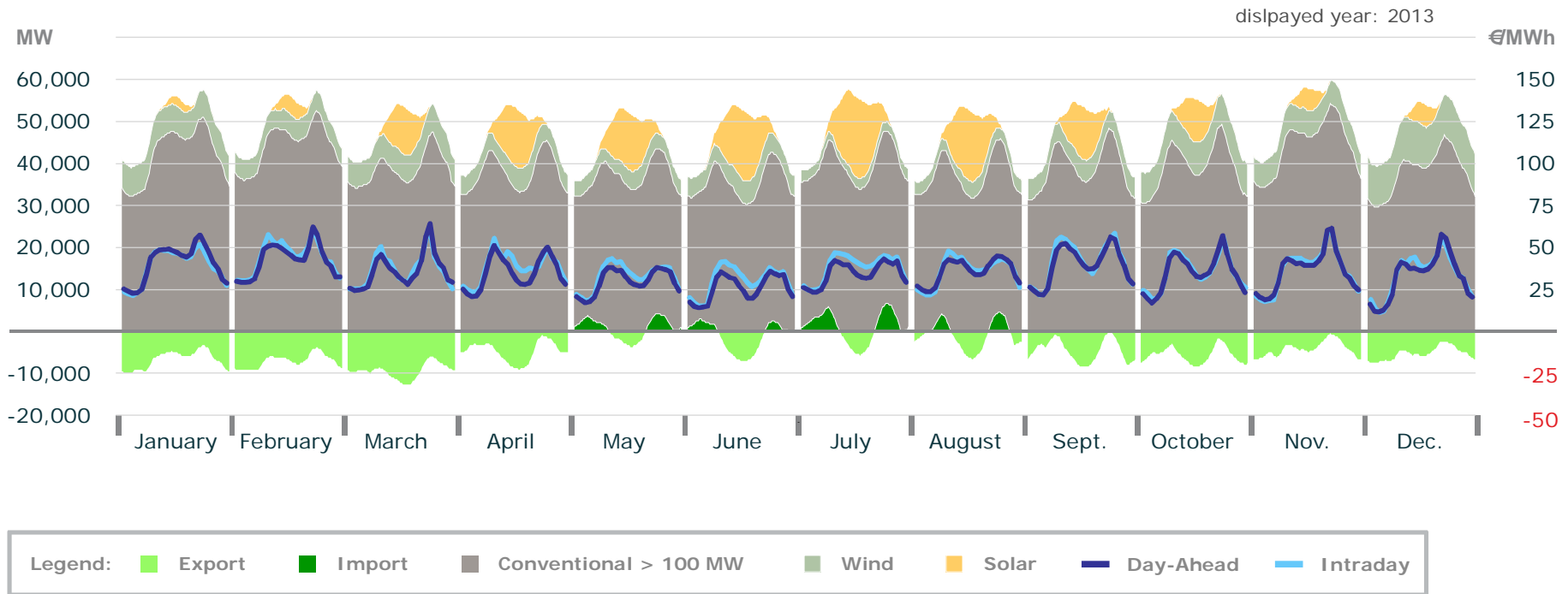


Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Bundesnetzagentur, dStatis

AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer

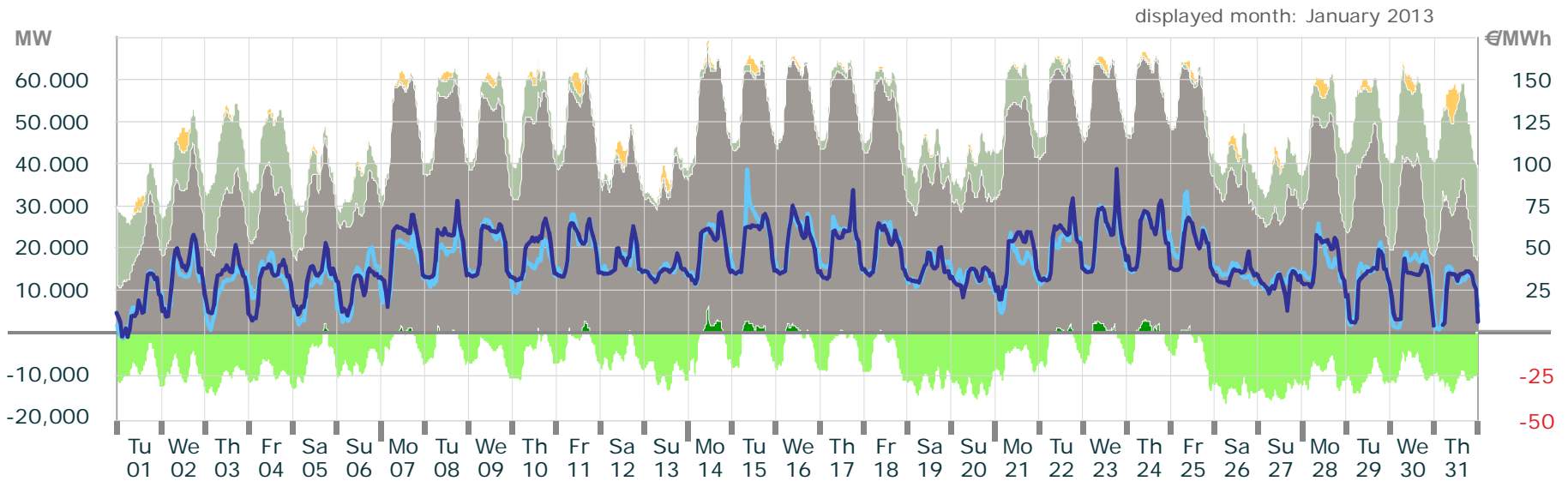
Electricity Production and Spot-Prices: Diurnal Courses



- Diurnal courses of monthly production data and Spot-Prices (volume weighted)

Source: Johannes Mayer, Bruno Burger, Fraunhofer ISE; Data: EEX, Entso-e

Electricity Production and Spot-Prices: January 2013

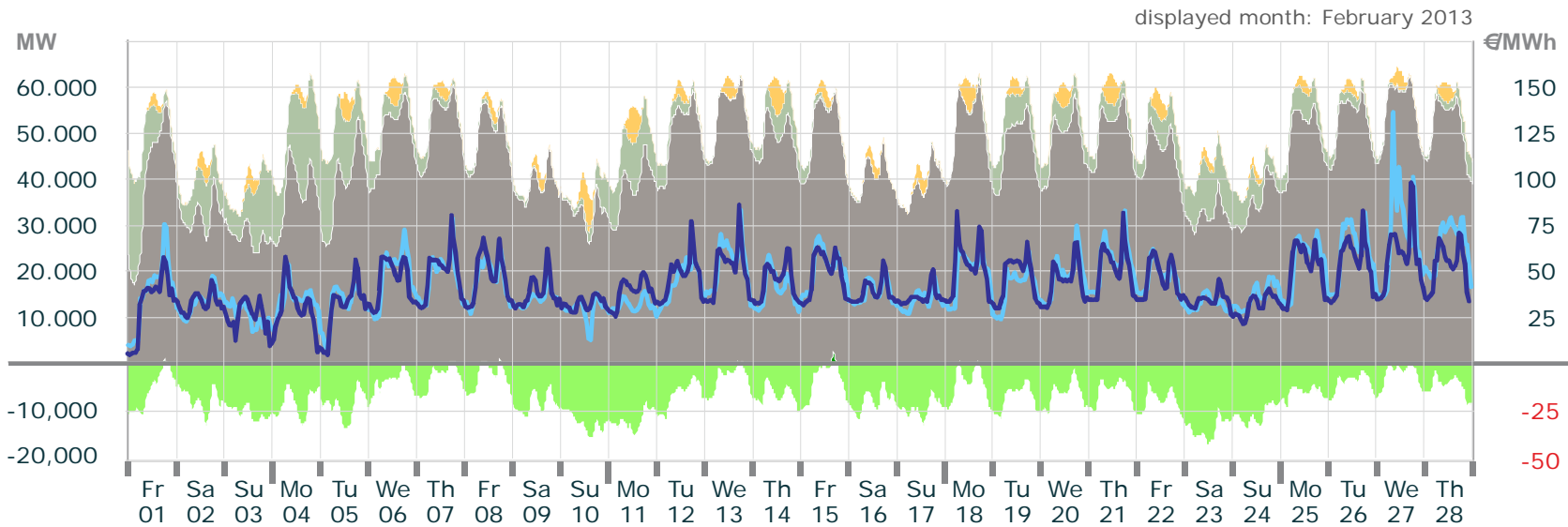


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	43.24	- 0.10	98.50	19 884
Intraday	43.76	- 1.00	98.30	1 561

Source: Johannes Mayer, Bruno Burger, Fraunhofer ISE; Data: EEX, Entso-e

Electricity Production and Spot-Prices: February 2013

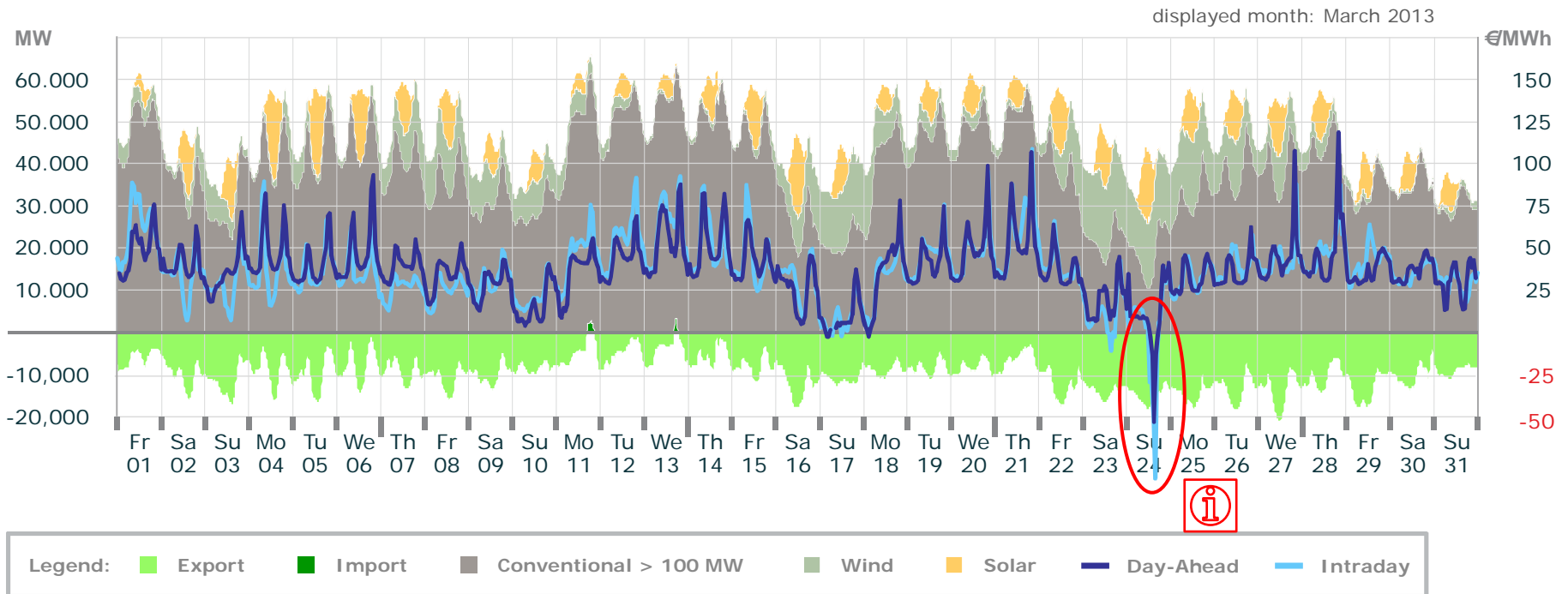


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	44.95	7.30	99.90	18 377
Intraday	47.84	11.10	137.70	1 135

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

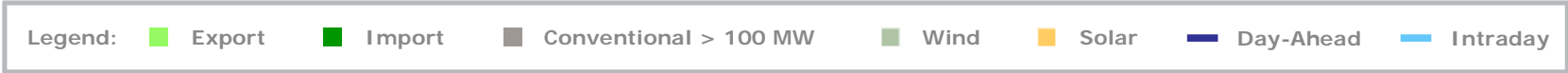
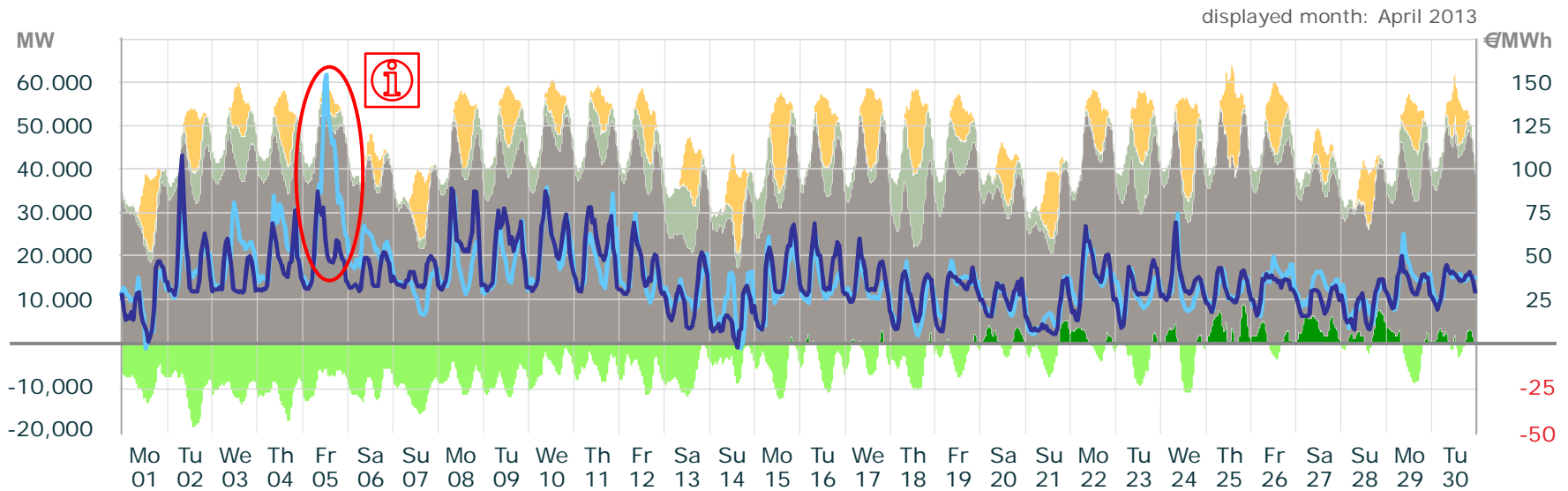
Electricity Production and Spot-Prices: March 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	38.97	- 50.00	120.20	21 190
Intraday	39.72	- 83.20	110.40	980

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

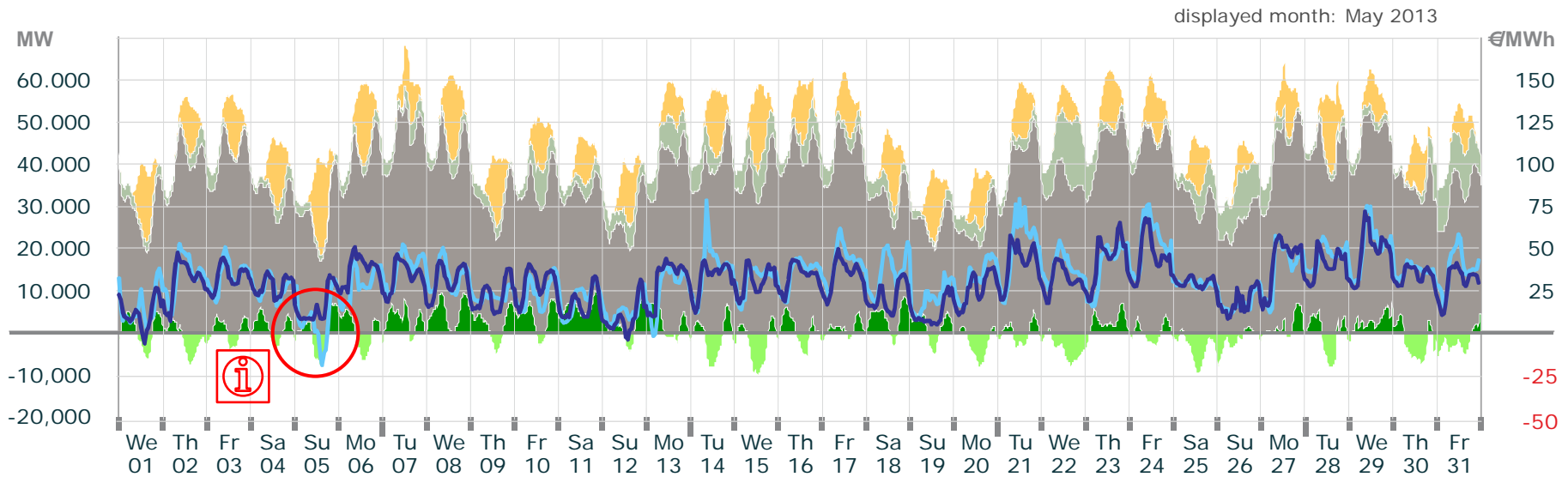
Electricity Production and Spot-Prices: April 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	38.18	0.00	109.40	19 839
Intraday	42.58	- 0.80	155.60	1 375

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: May 2013

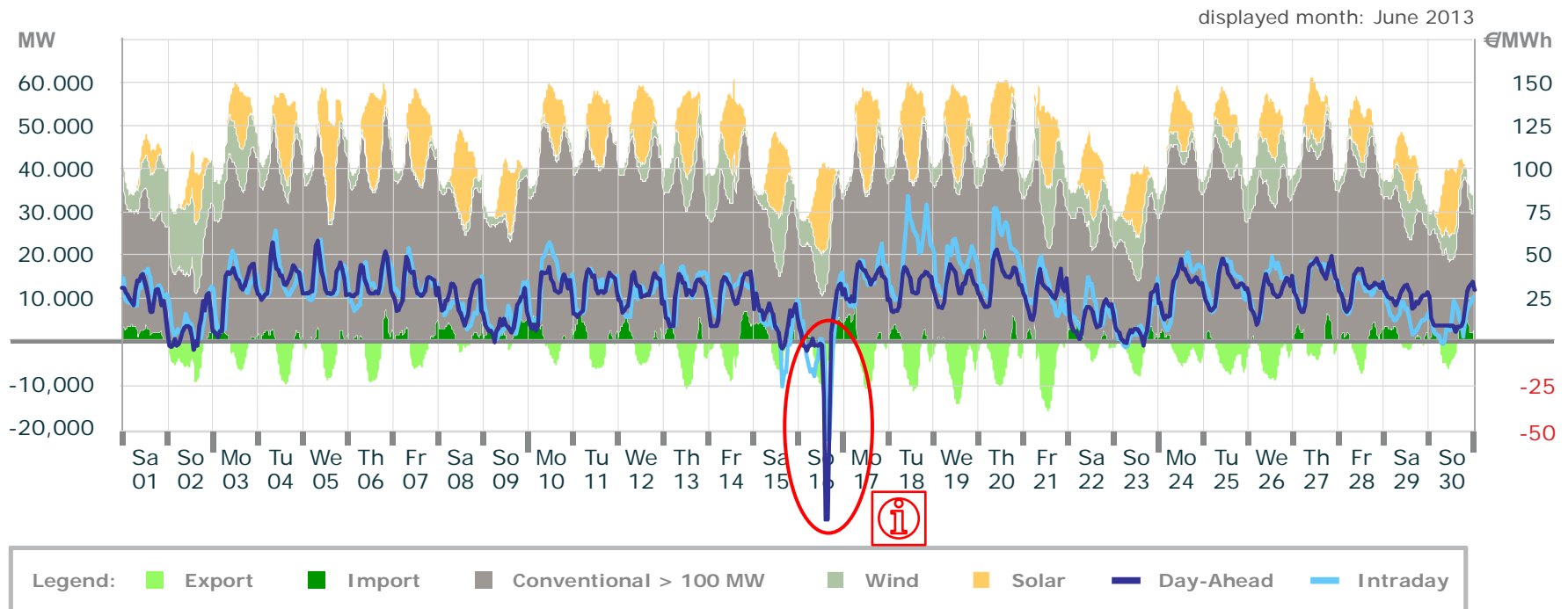


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	32.47	- 3.60	73.90	20 953
Intraday	36.64	- 16.30	81.30	1 397

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

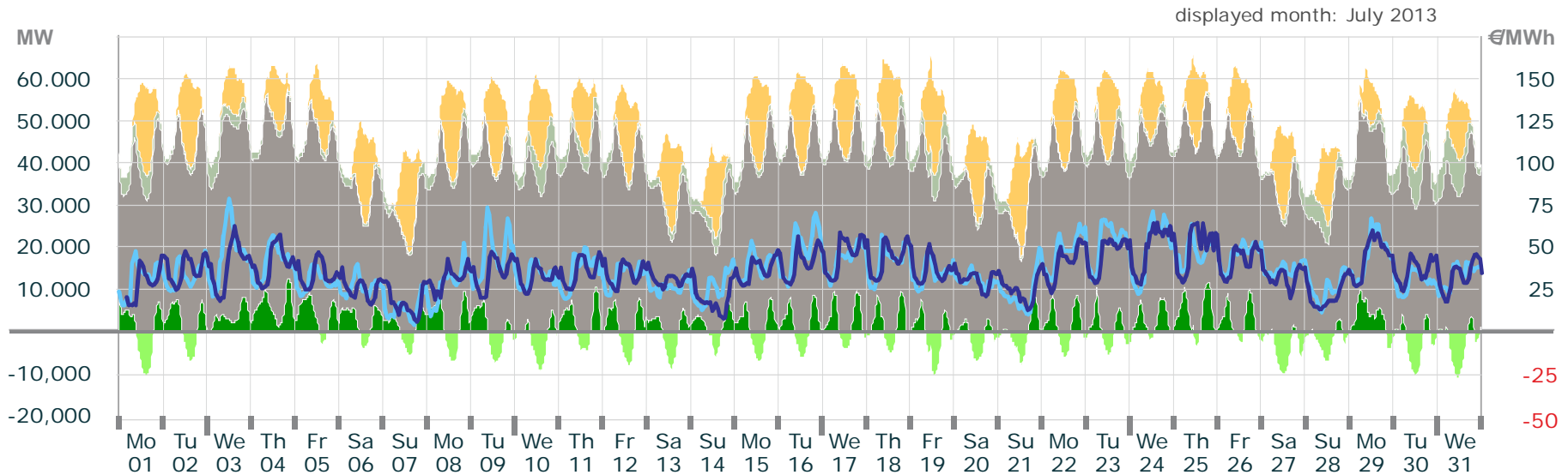
Electricity Production and Spot-Prices: June 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	28.28	- 100.00	60.00	20 864
Intraday	33.70	- 53.50	86.00	1 493

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: July 2013

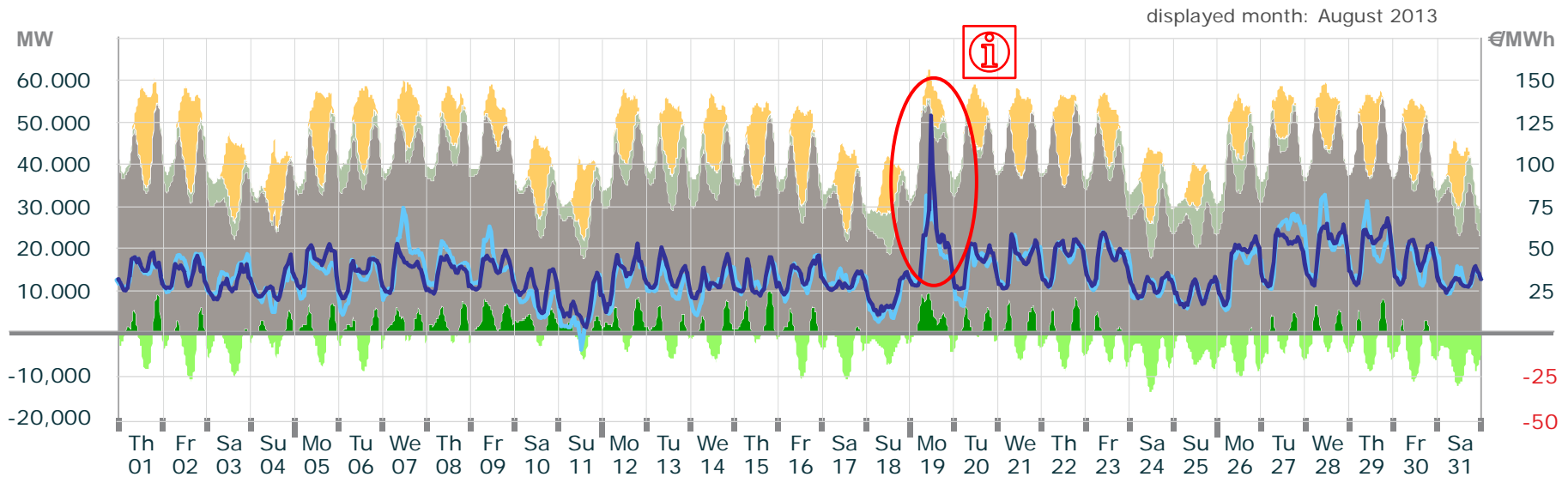


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar ■ Day-Ahead ■ Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	36.92	7.00	65.30	21 504
Intraday	42.01	6.30	80.50	1 323

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: August 2013

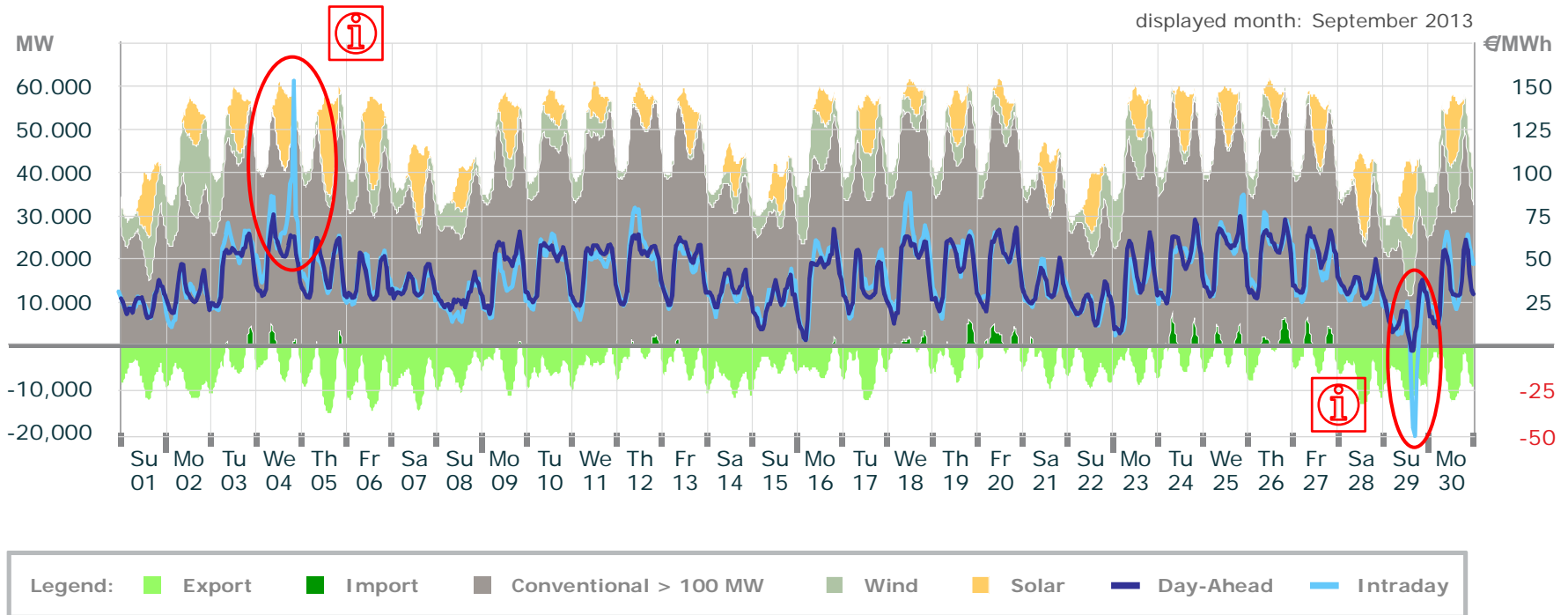


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	38.69	6.00	130.30	20 429
Intraday	40.17	- 7.20	83.70	1 440

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

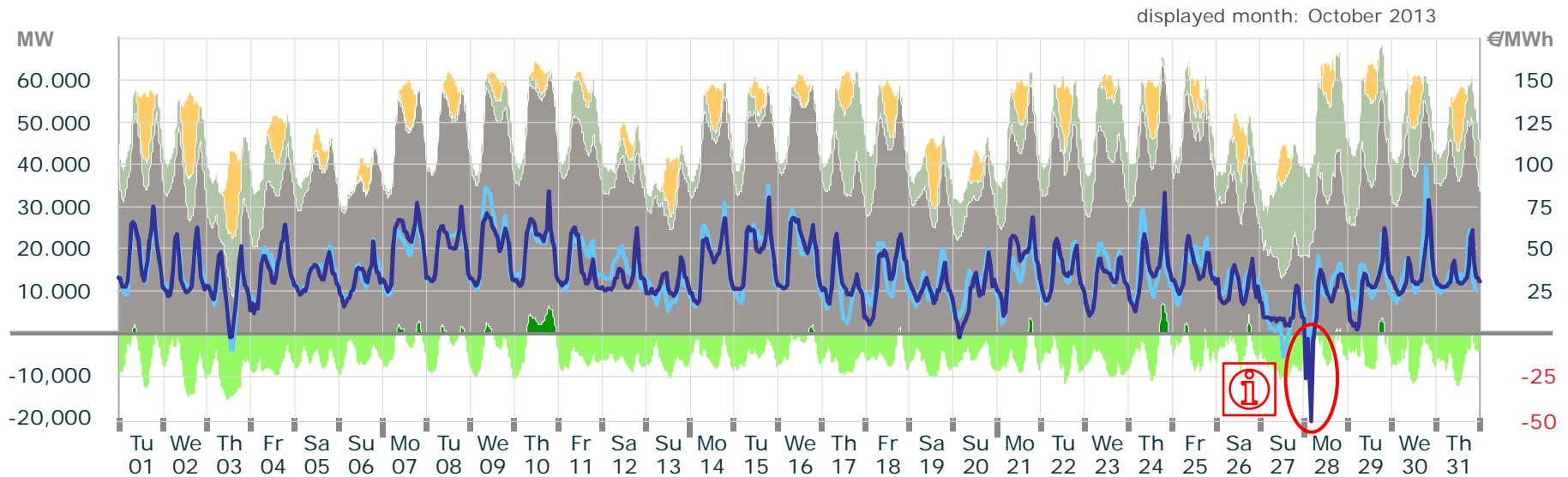
Electricity Production and Spot-Prices: September 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	41.96	- 0.10	77.70	18 649
Intraday	44.73	- 48.90	154.10	1 256

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: October 2013

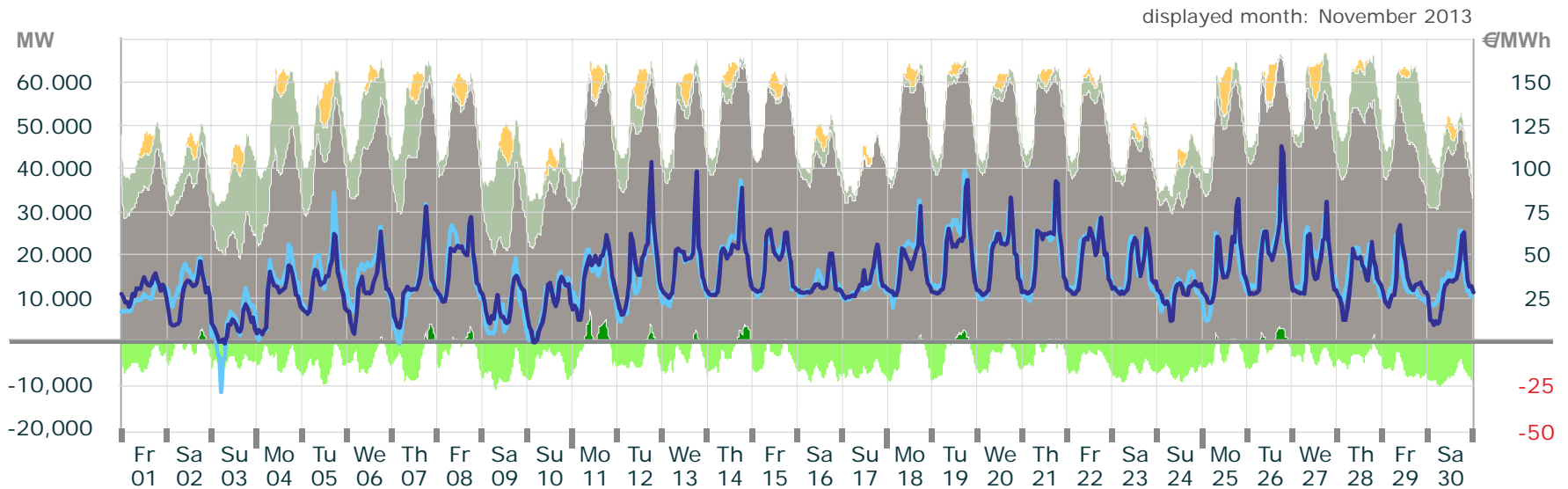


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	37.51	- 49.10	85.80	21 670
Intraday	39.06	- 11.20	101.20	1 439

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: November 2013

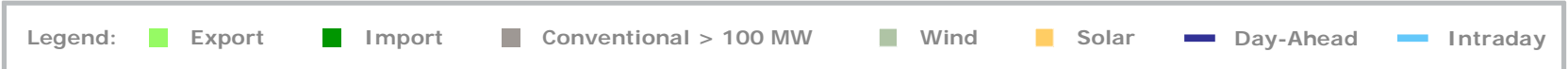
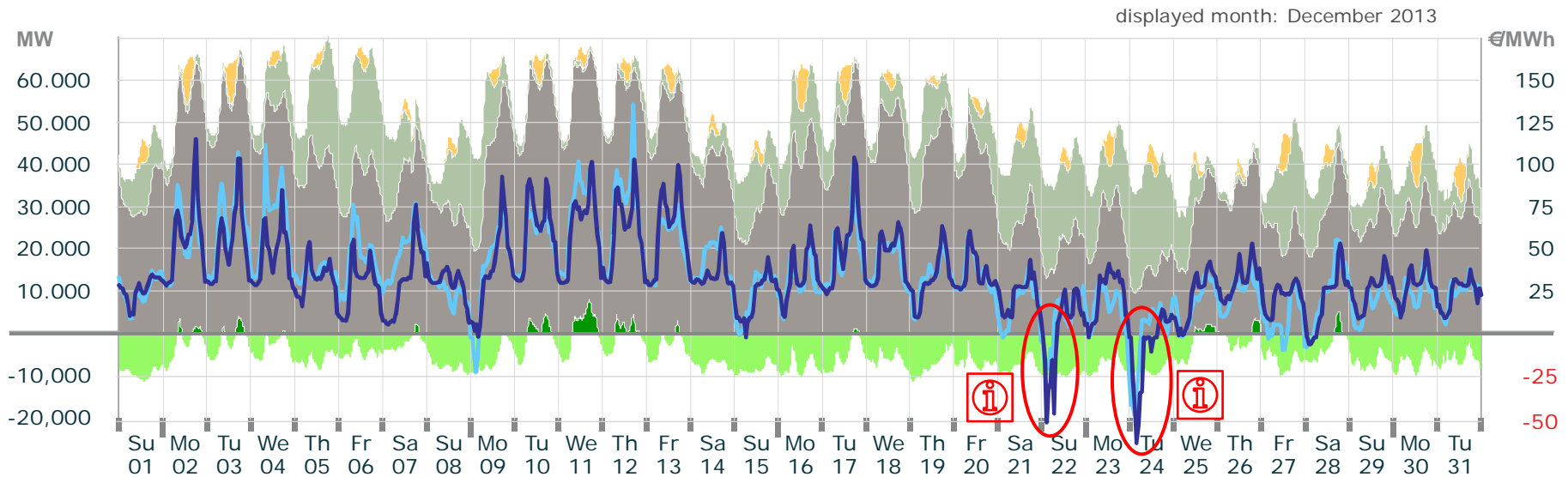


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	39.33	1.40	114.30	20 050
Intraday	42.14	- 26.90	100.00	1 311

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: December 2013



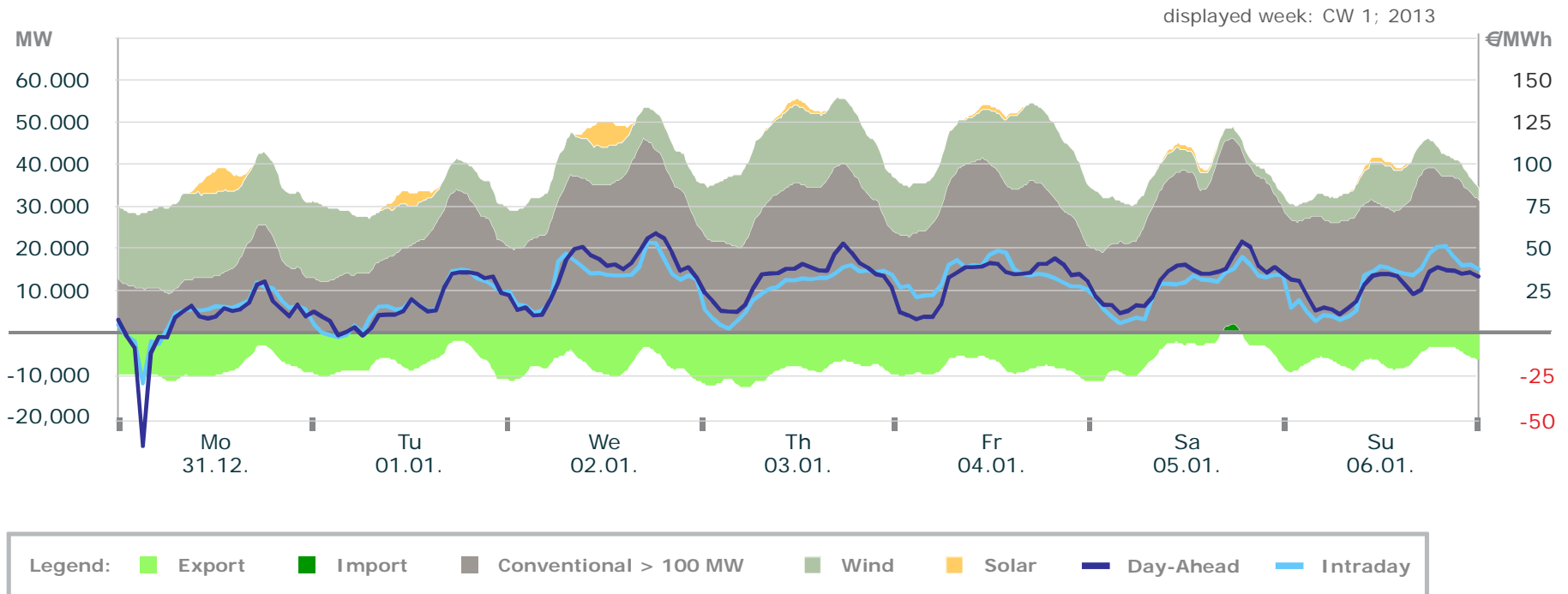
€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	35.44	- 62.00	116.50	22 159
Intraday	39.14	- 45.40	136.60	1 757

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer

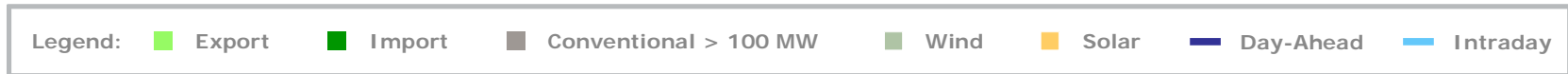
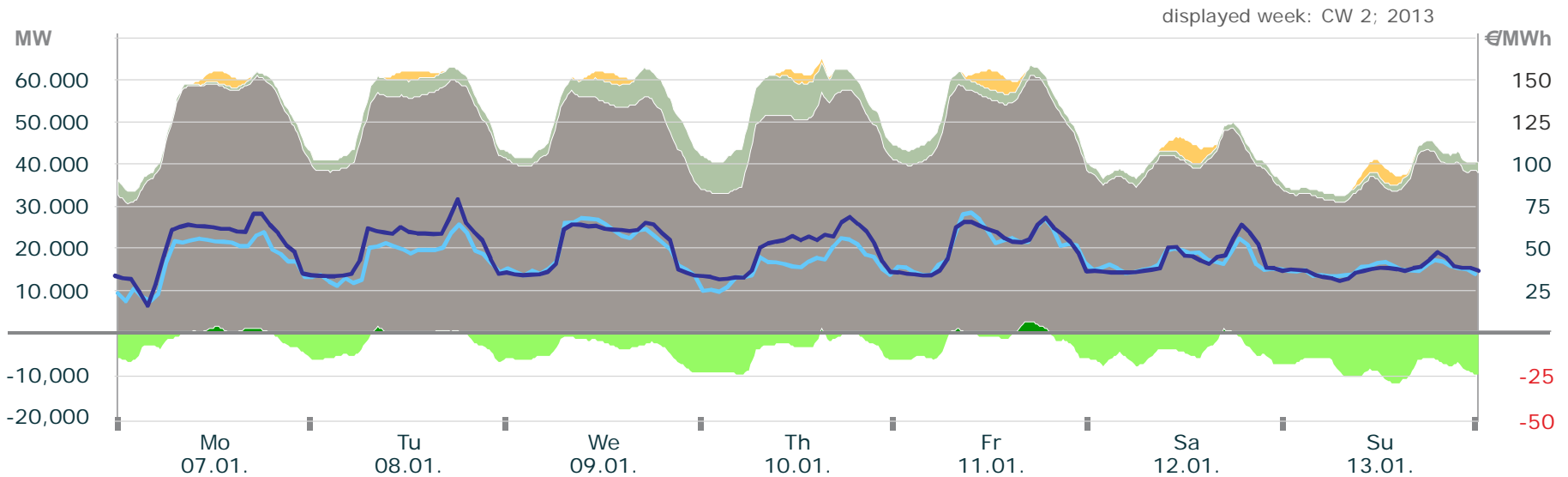
Electricity Production and Spot-Prices: CW 1 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	29.40	- 64.90	59.90	3 969
Intraday	28.70	- 28.10	54.50	538

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

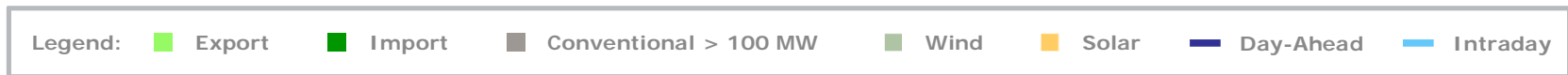
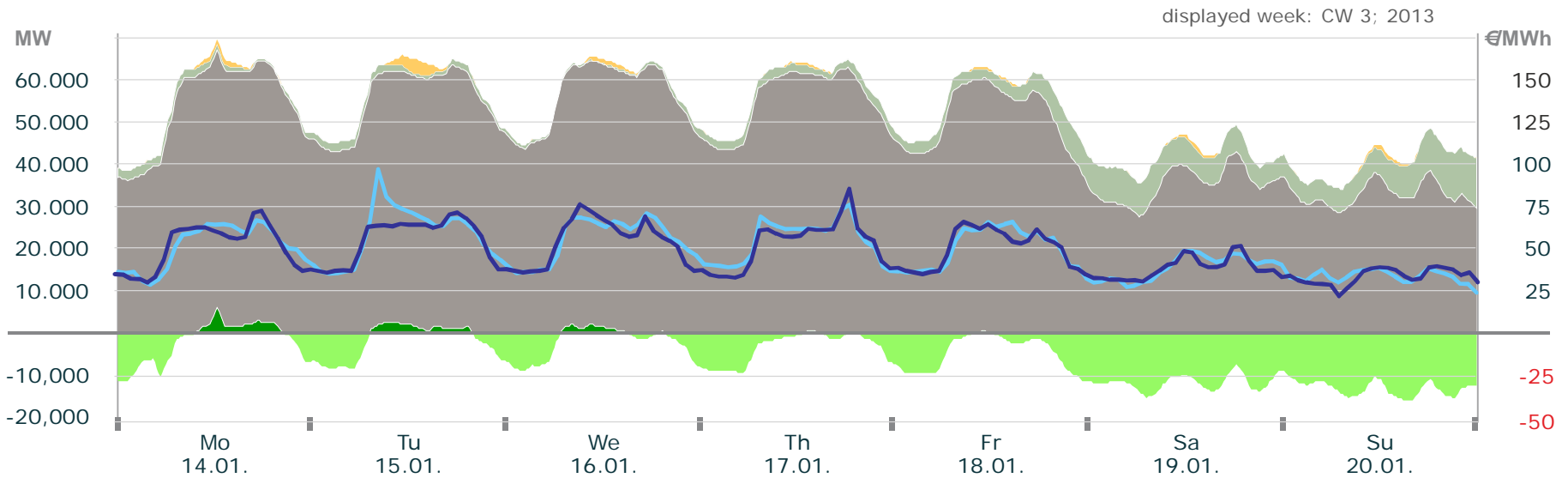
Electricity Production and Spot-Prices: CW 2 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	49.85	17.50	79.80	4 318
Intraday	49.67	20.10	72.00	339

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

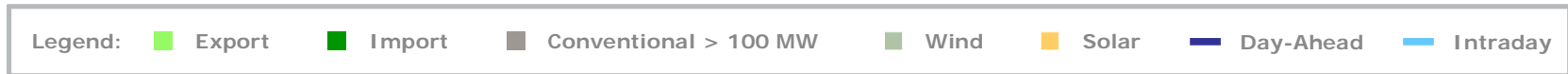
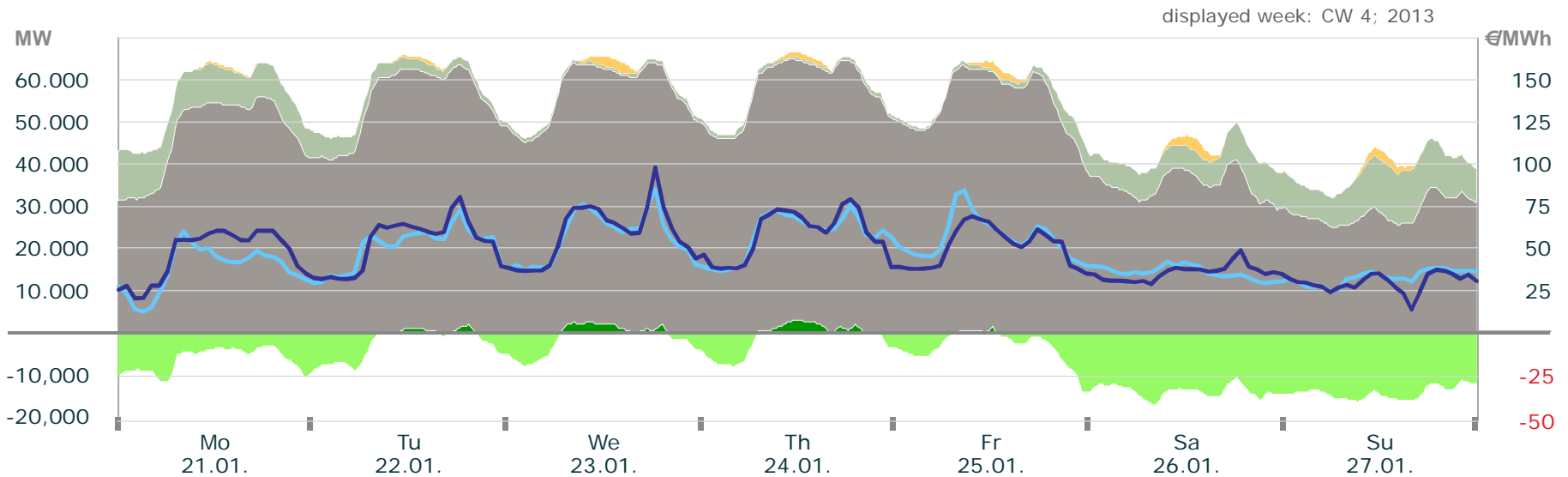
Electricity Production and Spot-Prices: CW 3 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	49.53	23.10	86.10	4 350
Intraday	54.73	25.70	98.30	340

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

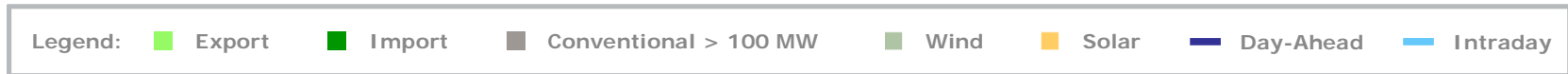
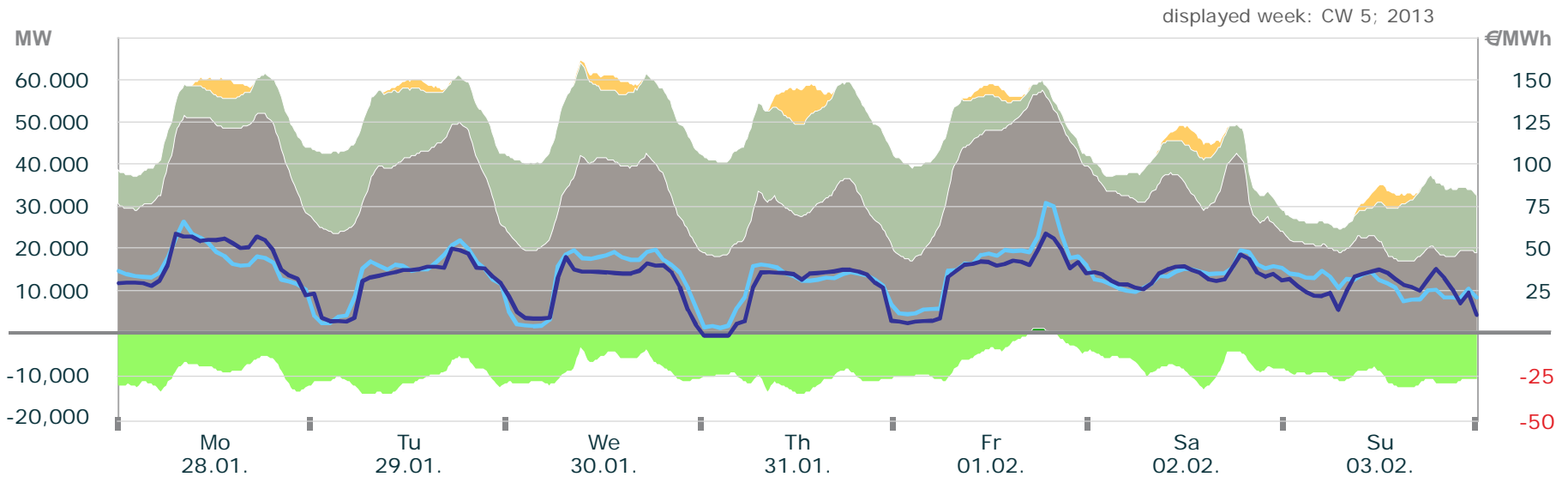
Electricity Production and Spot-Prices: CW 4 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	49.23	15.20	98.50	4 191
Intraday	49.65	14.00	85.80	197

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

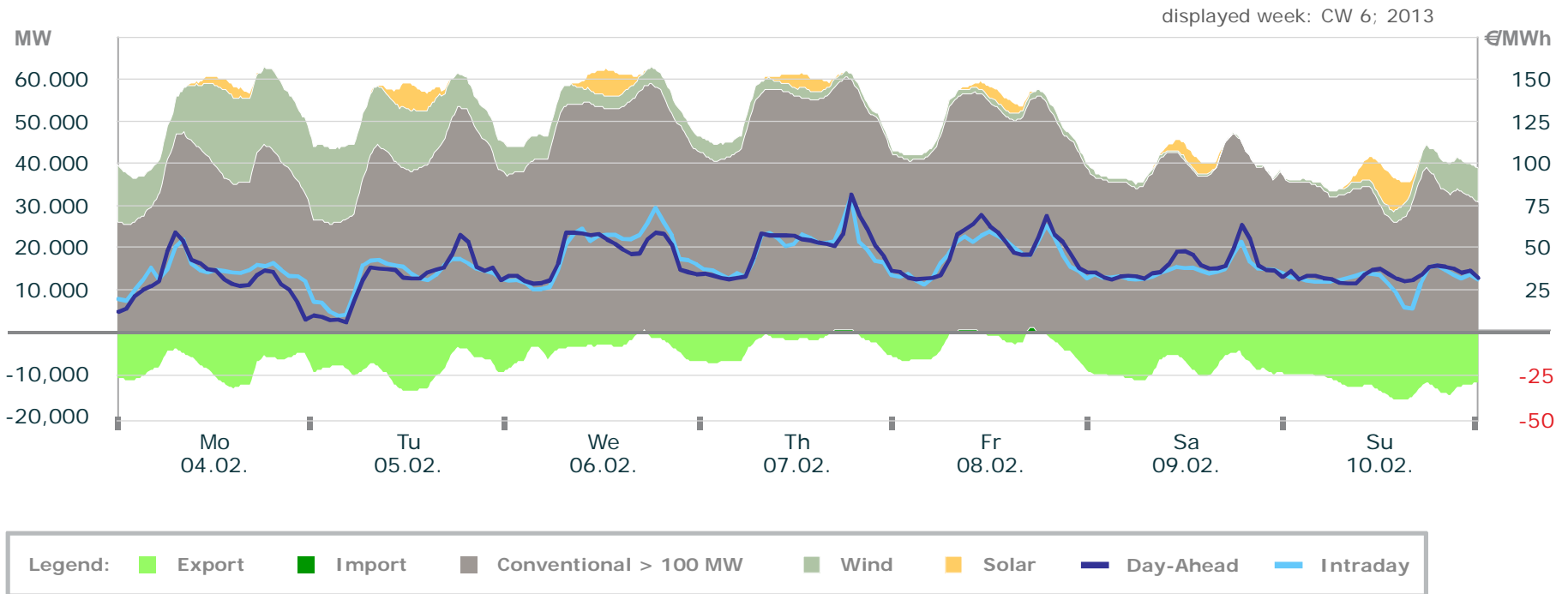
Electricity Production and Spot-Prices: CW 5 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.26	- 0.10	59.80	5 076
Intraday	37.71	4.20	77.60	261

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

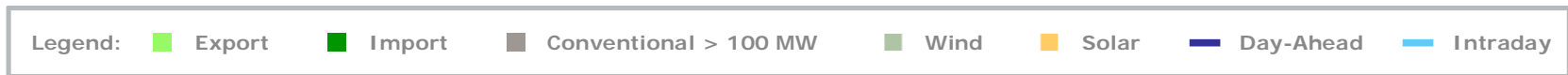
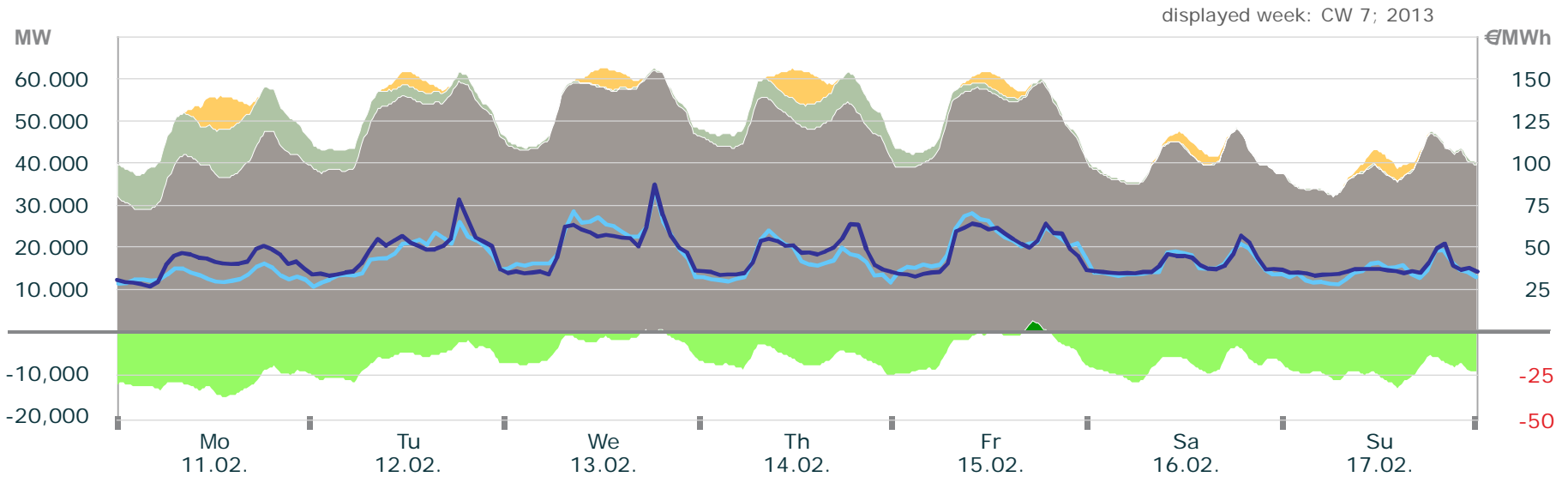
Electricity Production and Spot-Prices: CW 6 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	41.27	7.30	82.30	4 666
Intraday	42.12	11.10	80.60	233

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

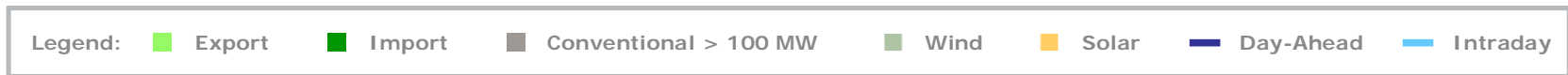
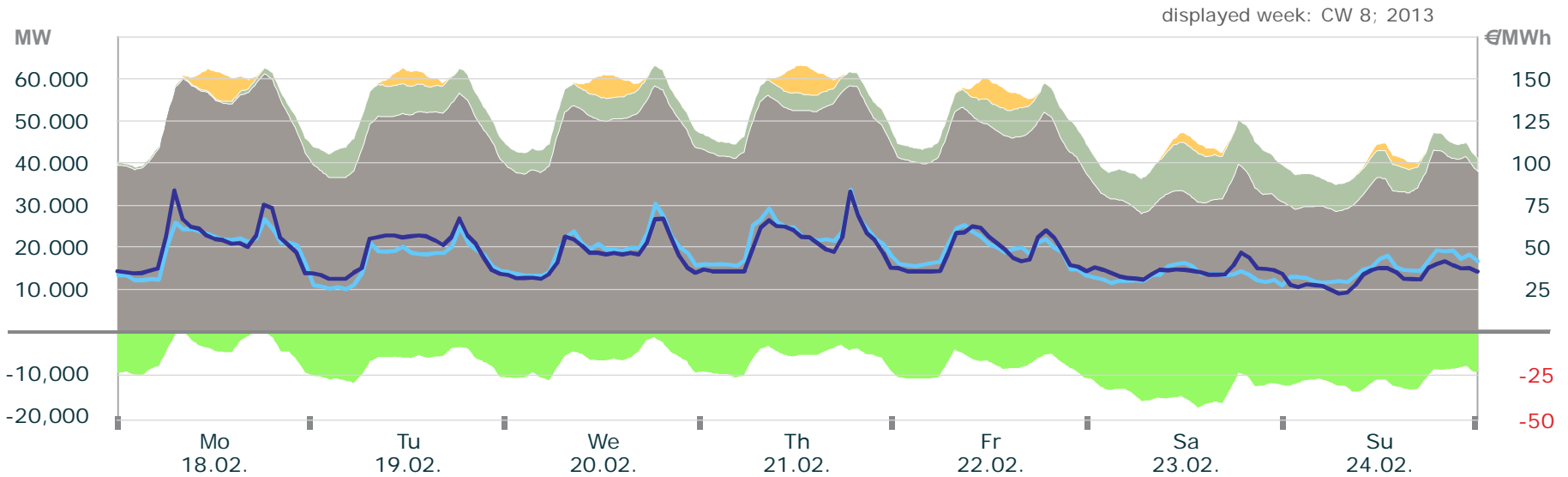
Electricity Production and Spot-Prices: CW 7 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	46.15	28.00	87.90	4 448
Intraday	45.41	28.00	85.40	298

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

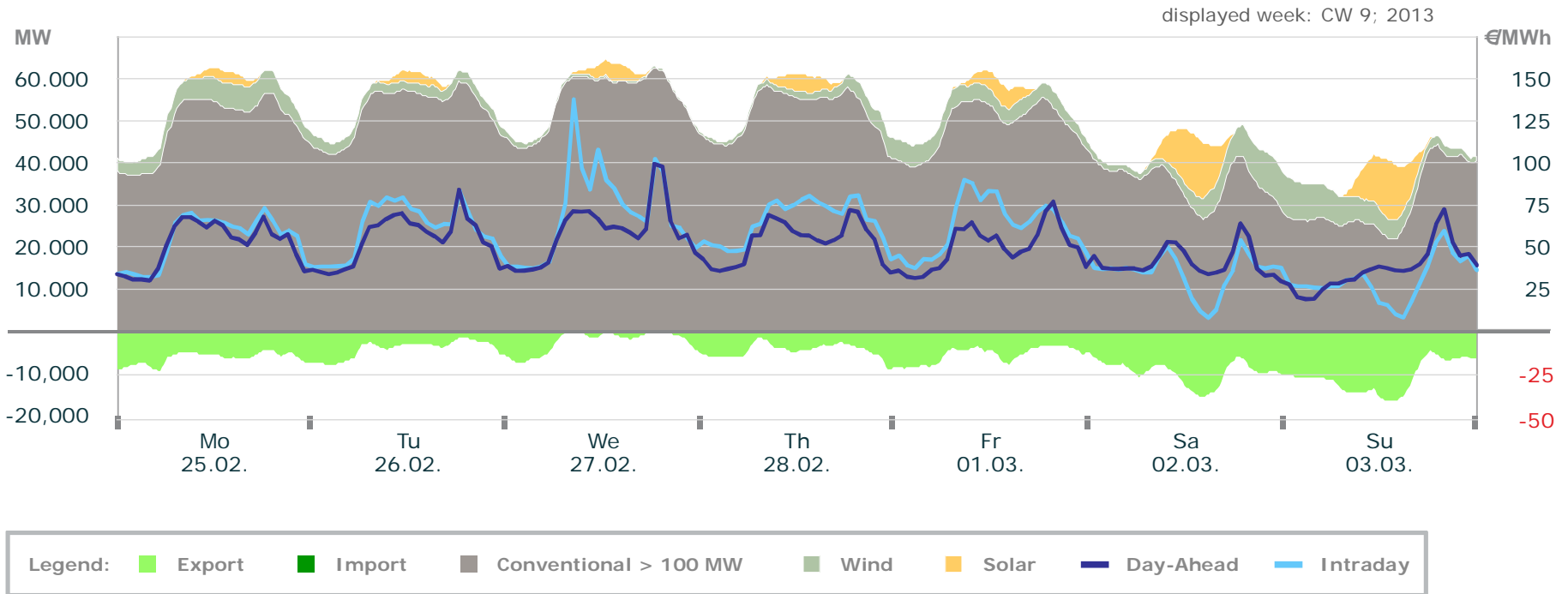
Electricity Production and Spot-Prices: CW 8 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	46.22	23.90	84.40	4 657
Intraday	47.18	26.50	84.80	349

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

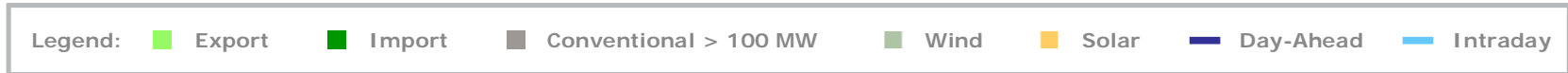
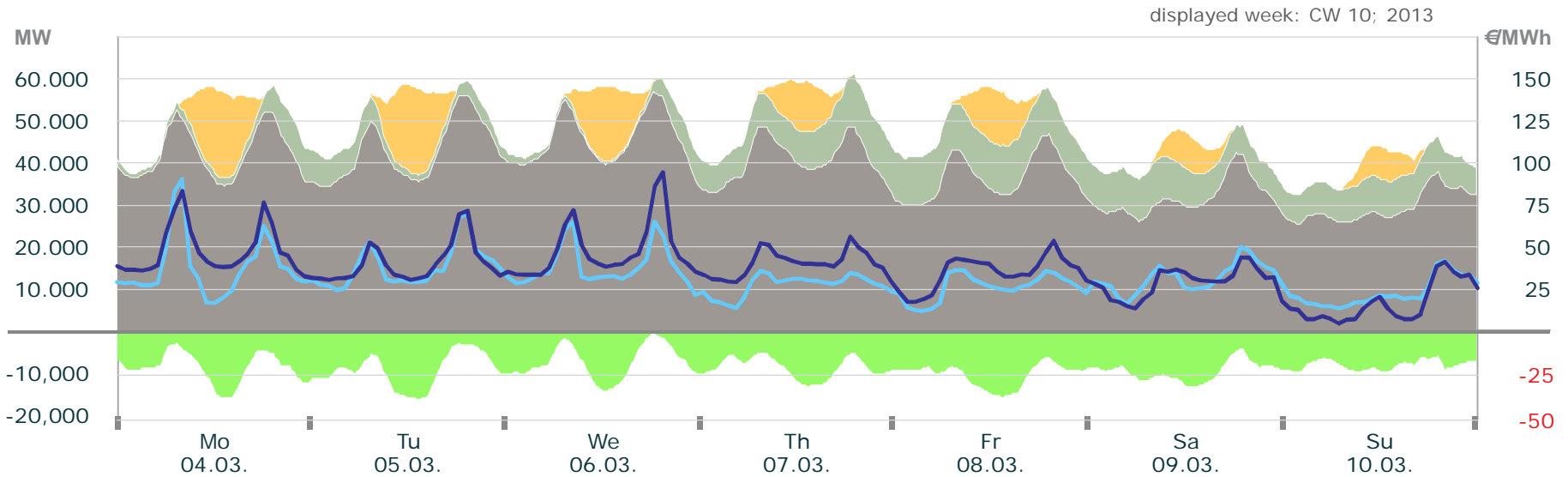
Electricity Production and Spot-Prices: CW 9 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	51.30	20.50	99.90	4 546
Intraday	56.76	9.60	137.70	203

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

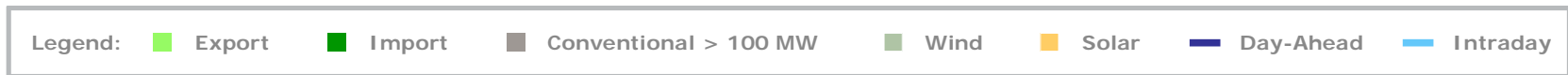
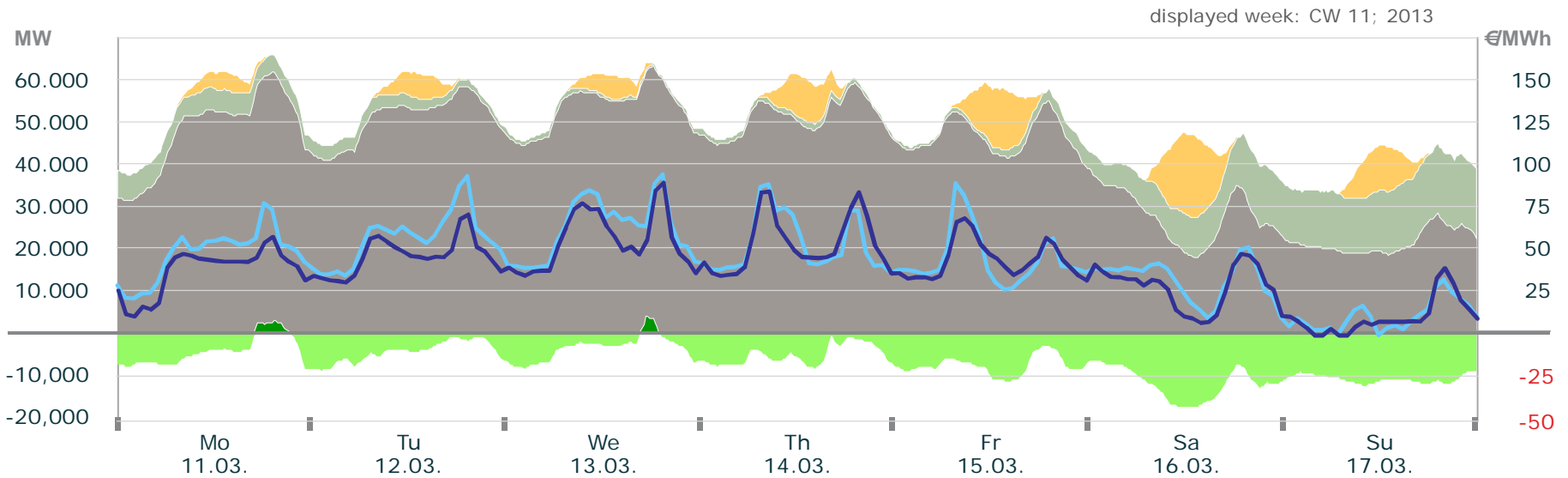
Electricity Production and Spot-Prices: CW 10 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	38.35	6.50	95.10	4 818
Intraday	32.31	13.90	91.30	247

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

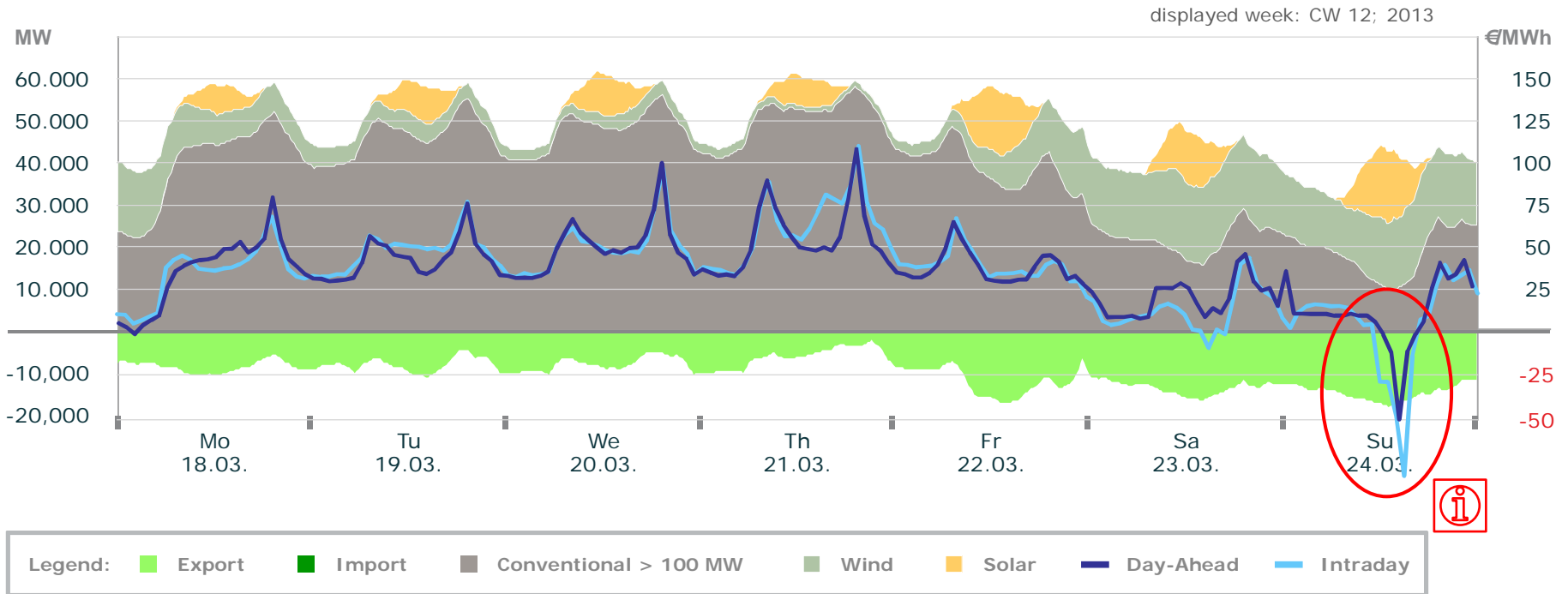
Electricity Production and Spot-Prices: CW 11 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	39.33	0.00	89.60	4 492
Intraday	45.38	0.30	94.50	219

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

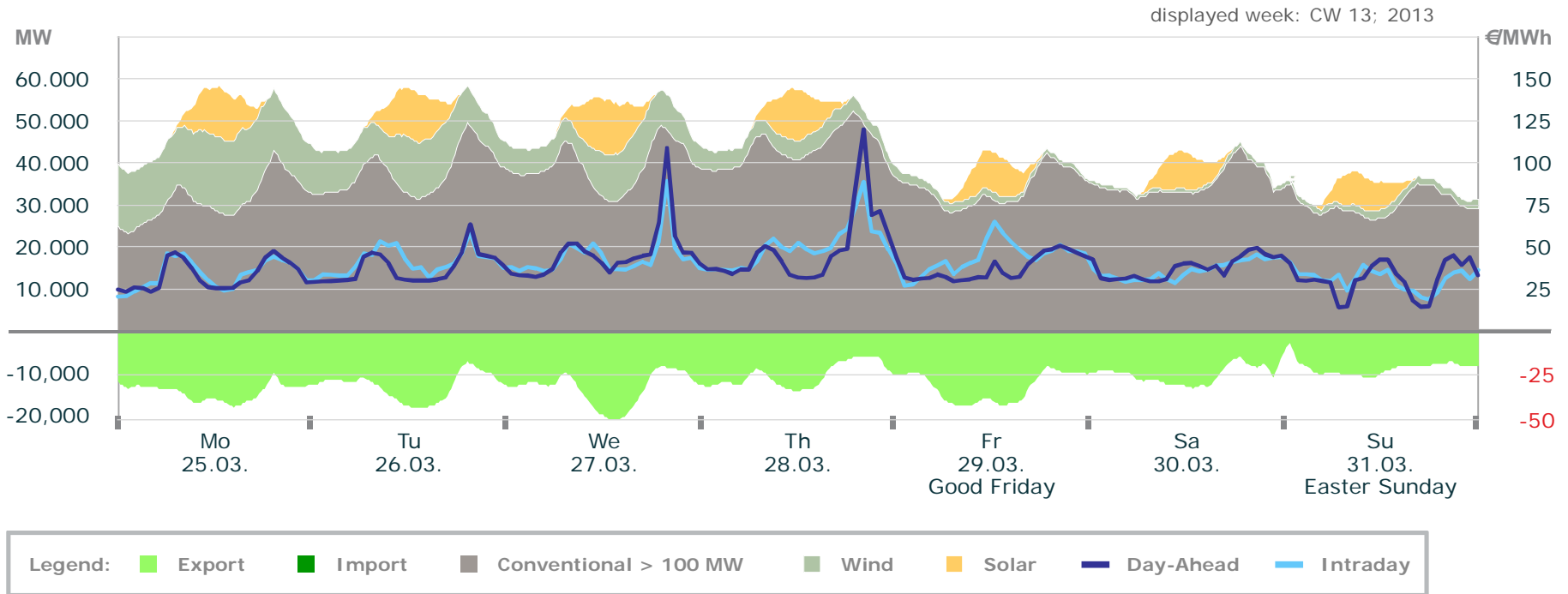
Electricity Production and Spot-Prices: CW 12 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	36.12	- 50.00	108.60	4 821
Intraday	36.33	- 83.20	110.40	177

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

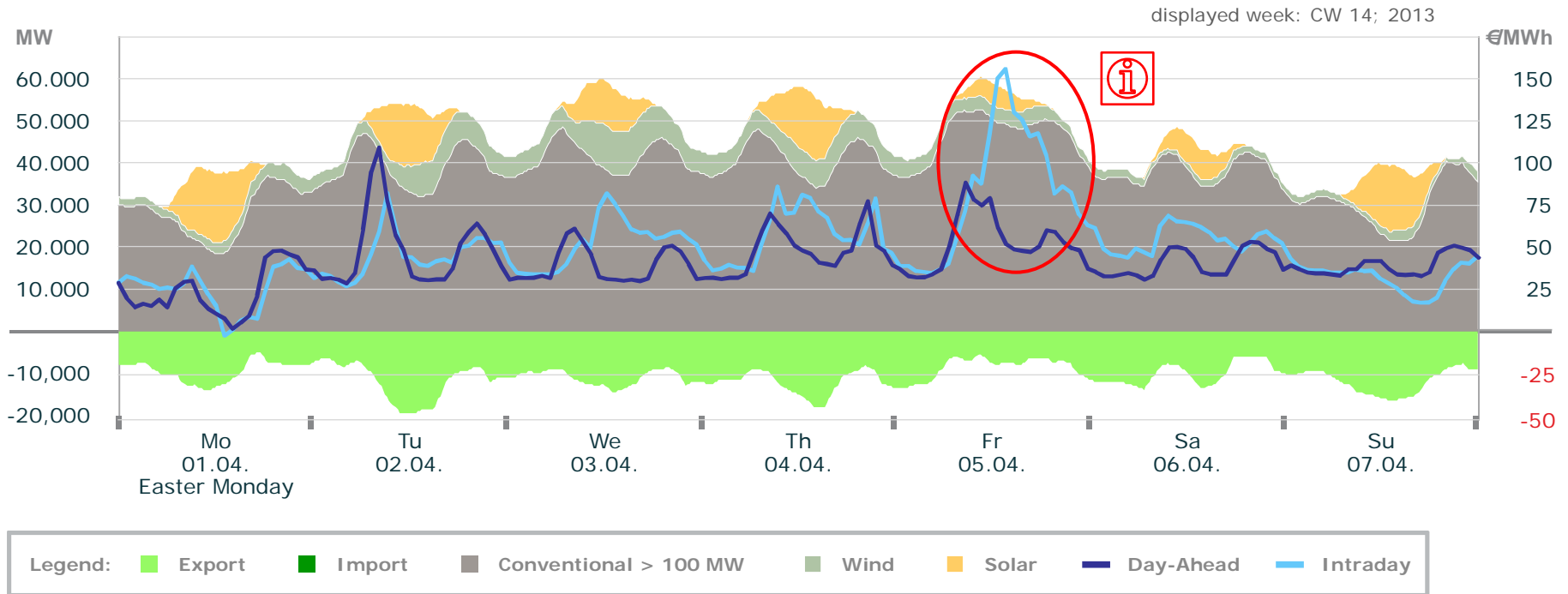
Electricity Production and Spot-Prices: CW 13 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	39.74	15.80	120.20	5 099
Intraday	44.41	20.50	89.80	264

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

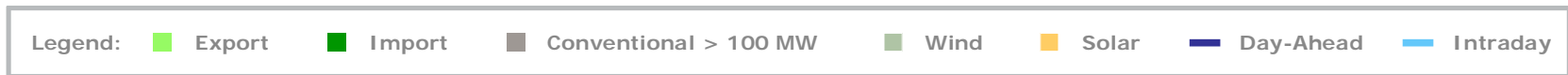
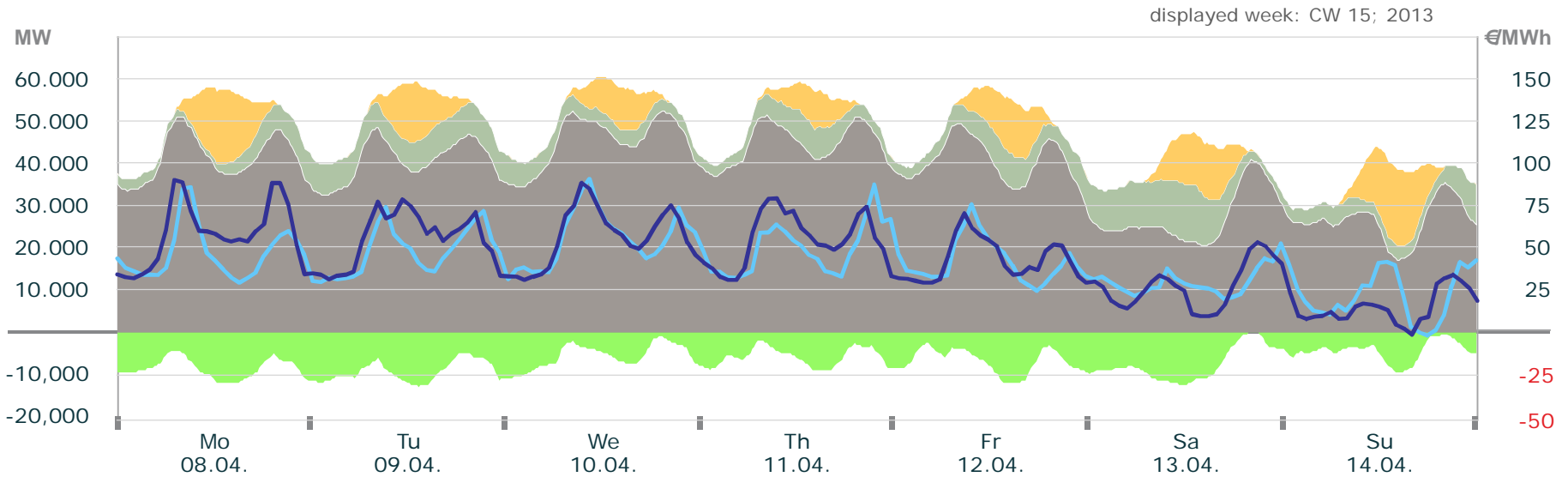
Electricity Production and Spot-Prices: CW 14 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	42.31	3.20	109.40	4 875
Intraday	62.40	- 0.80	155.60	216

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

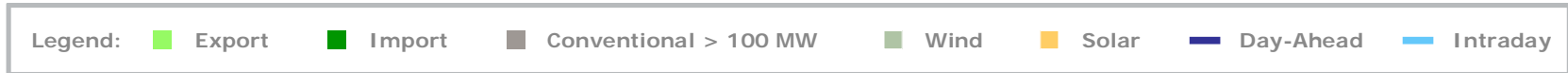
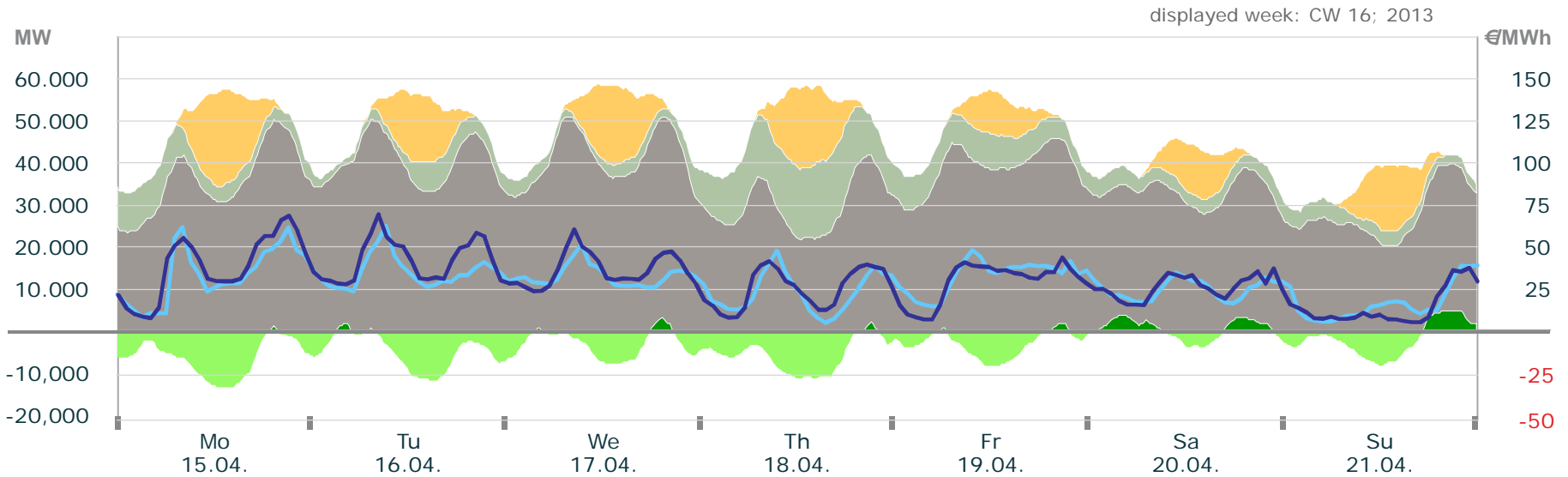
Electricity Production and Spot-Prices: CW 15 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	44.96	0.00	90.50	4 638
Intraday	42.46	- 0.70	91.20	180

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

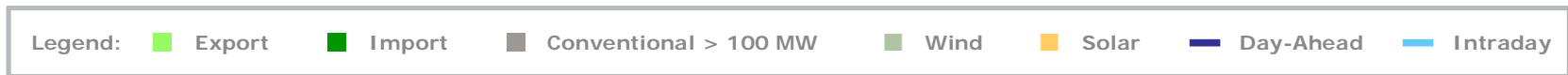
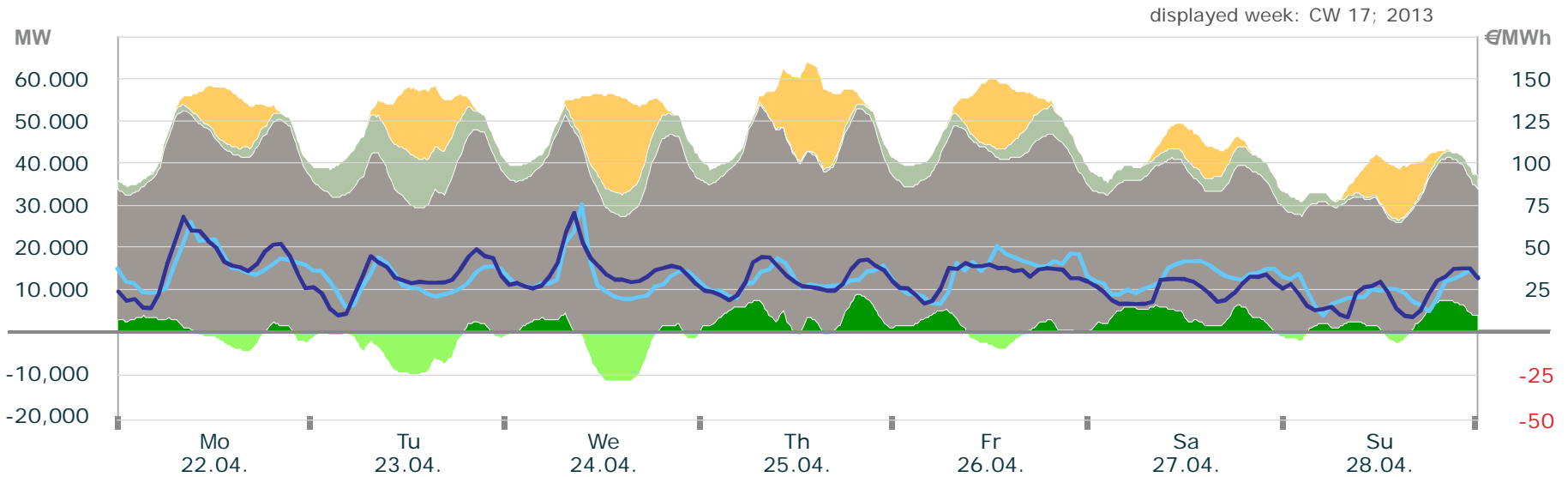
Electricity Production and Spot-Prices: CW 16 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	32.25	7.60	70.70	4 634
Intraday	30.74	6.80	63.70	192

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

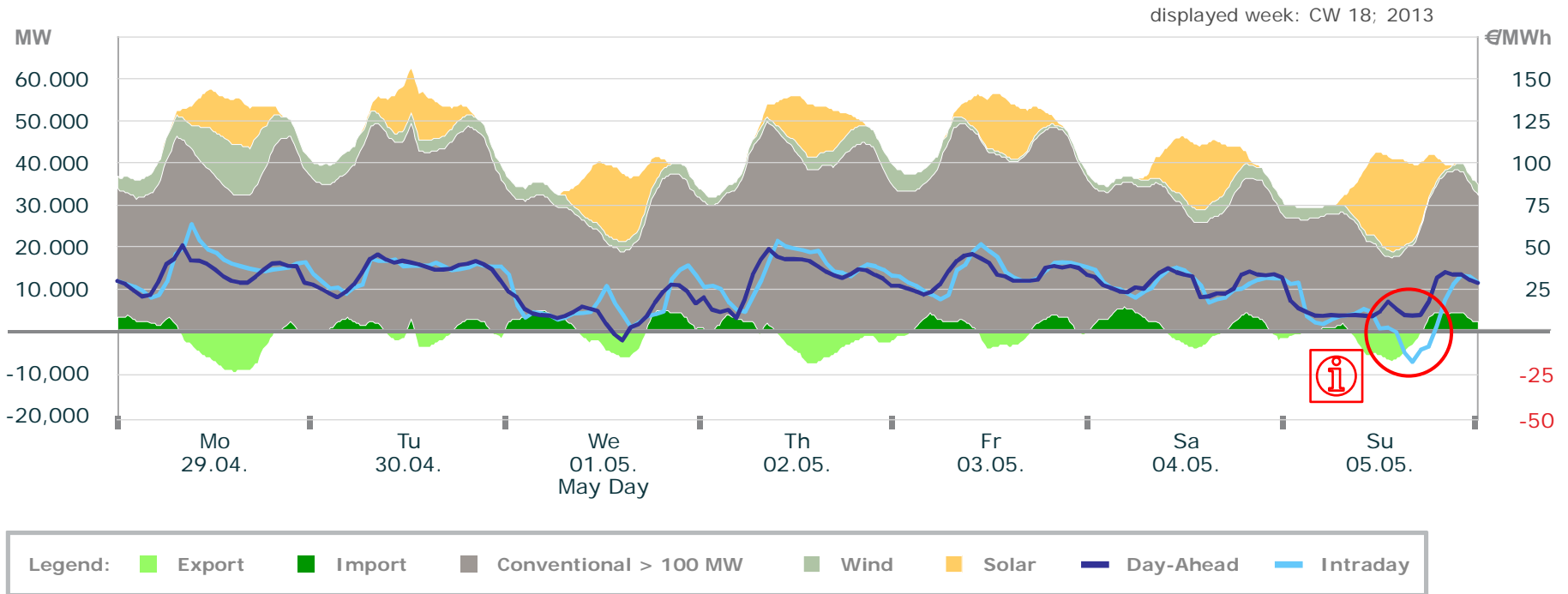
Electricity Production and Spot-Prices: CW 17 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.13	10.10	71.20	4 392
Intraday	33.03	10.90	76.30	296

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

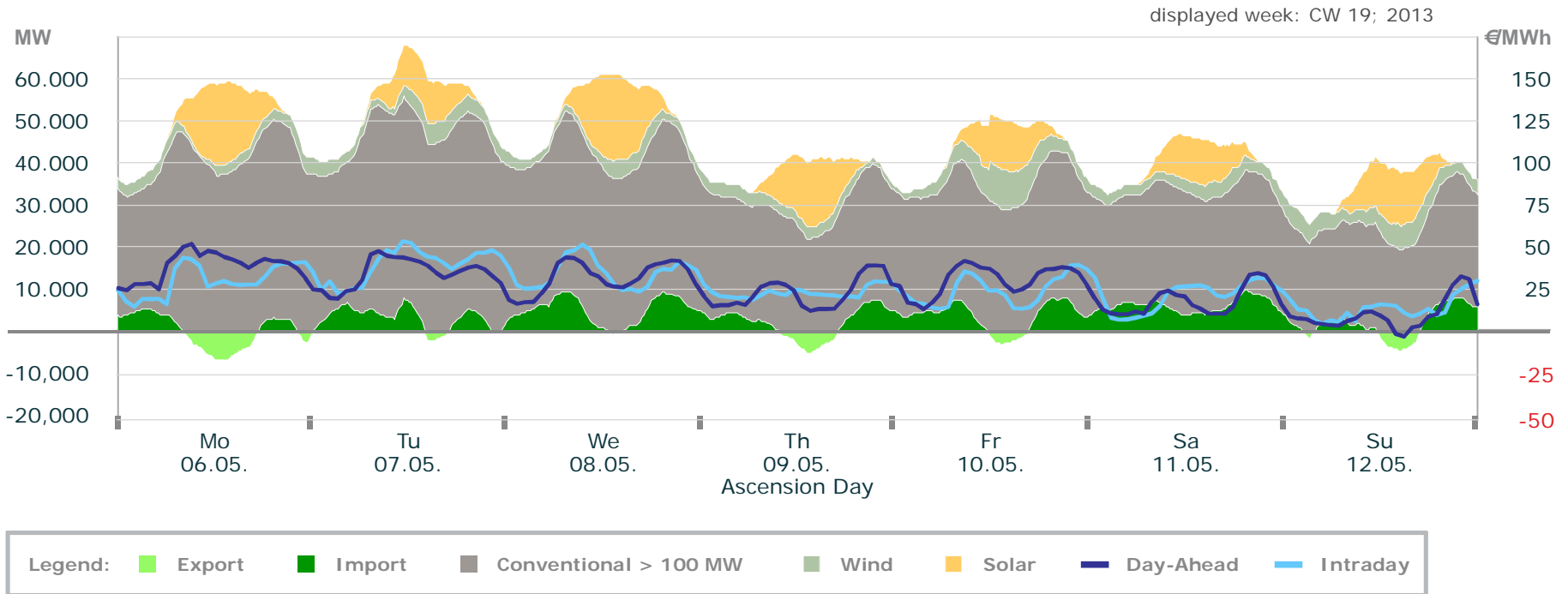
Electricity Production and Spot-Prices: CW 18 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	28.95	- 3.60	52.10	4 521
Intraday	29.90	- 16.30	64.60	320

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

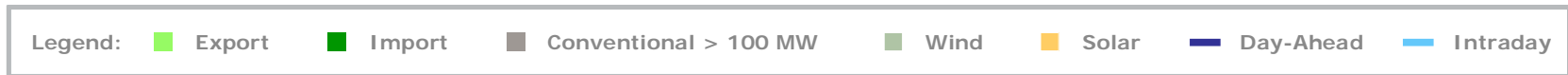
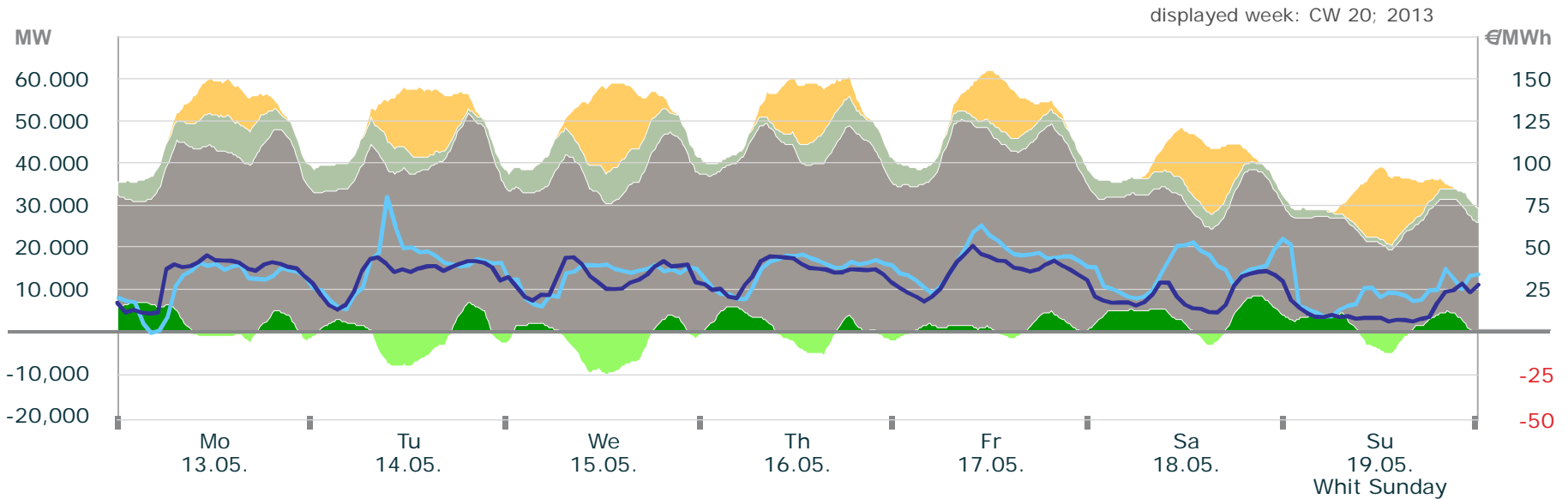
Electricity Production and Spot-Prices: CW 19 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	27.92	- 1.30	53.00	4 592
Intraday	28.82	6.30	54.60	301

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

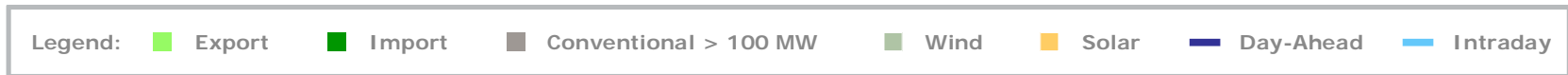
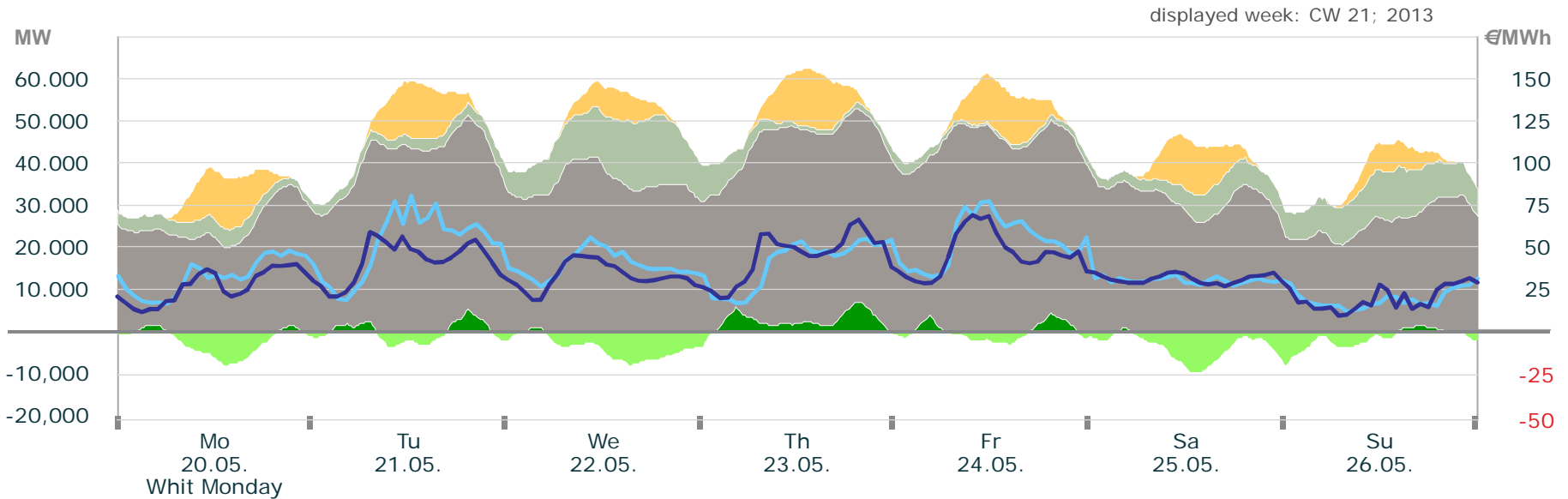
Electricity Production and Spot-Prices: CW 20 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	30.78	7.40	51.80	4 805
Intraday	37.74	0.80	80.50	335

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

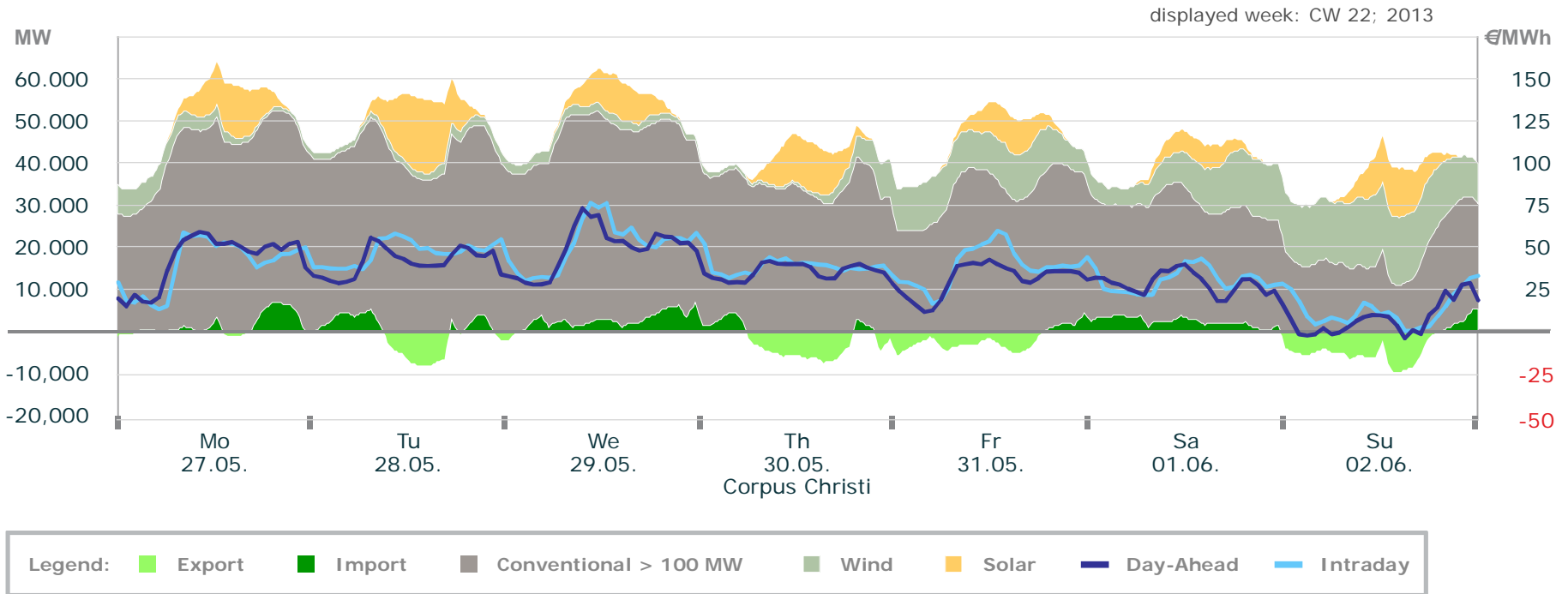
Electricity Production and Spot-Prices: CW 21 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	36.54	10.90	70.00	4 954
Intraday	43.23	13.20	81.30	313

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

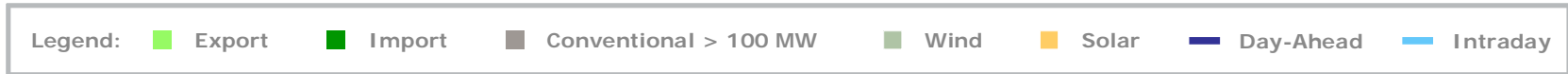
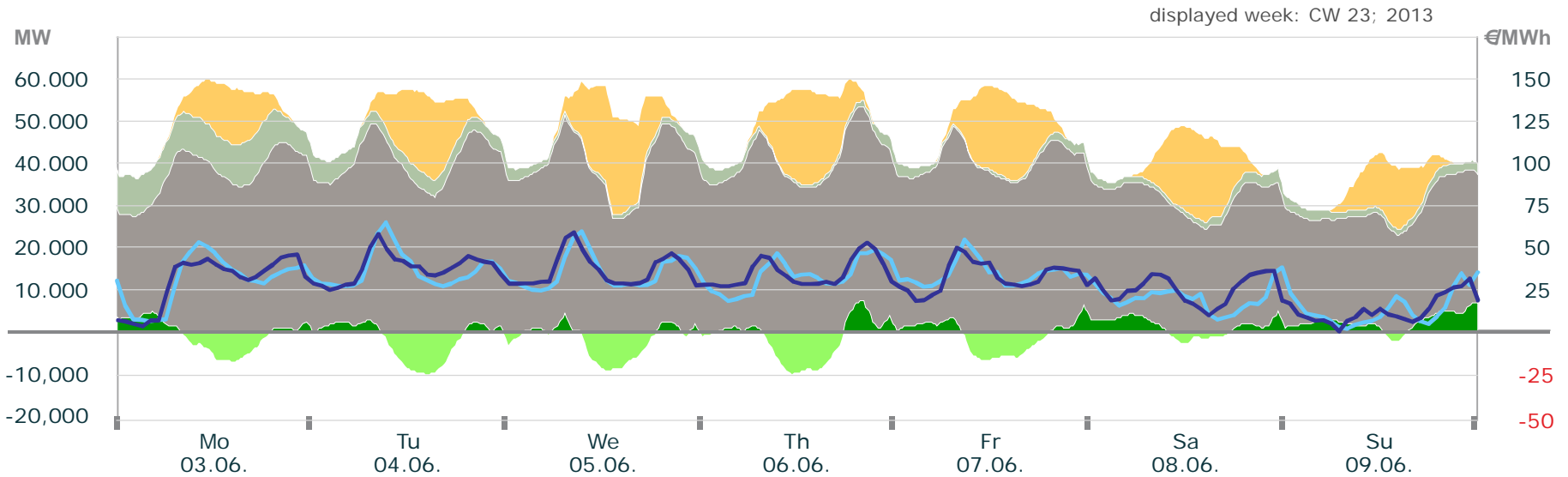
Electricity Production and Spot-Prices: CW 22 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	34.75	- 2.50	73.90	4 783
Intraday	39.45	1.80	77.10	349

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

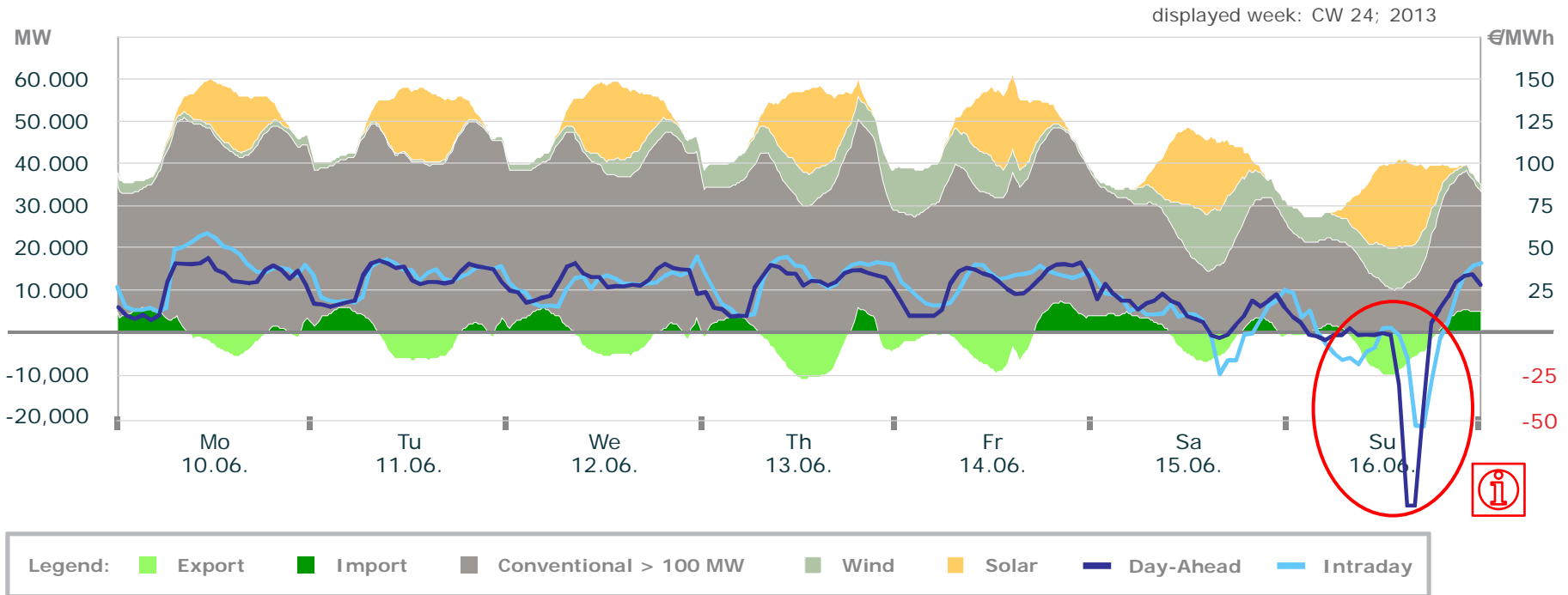
Electricity Production and Spot-Prices: CW 23 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	31.71	1.90	60.00	4 826
Intraday	32.67	4.00	66.20	295

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

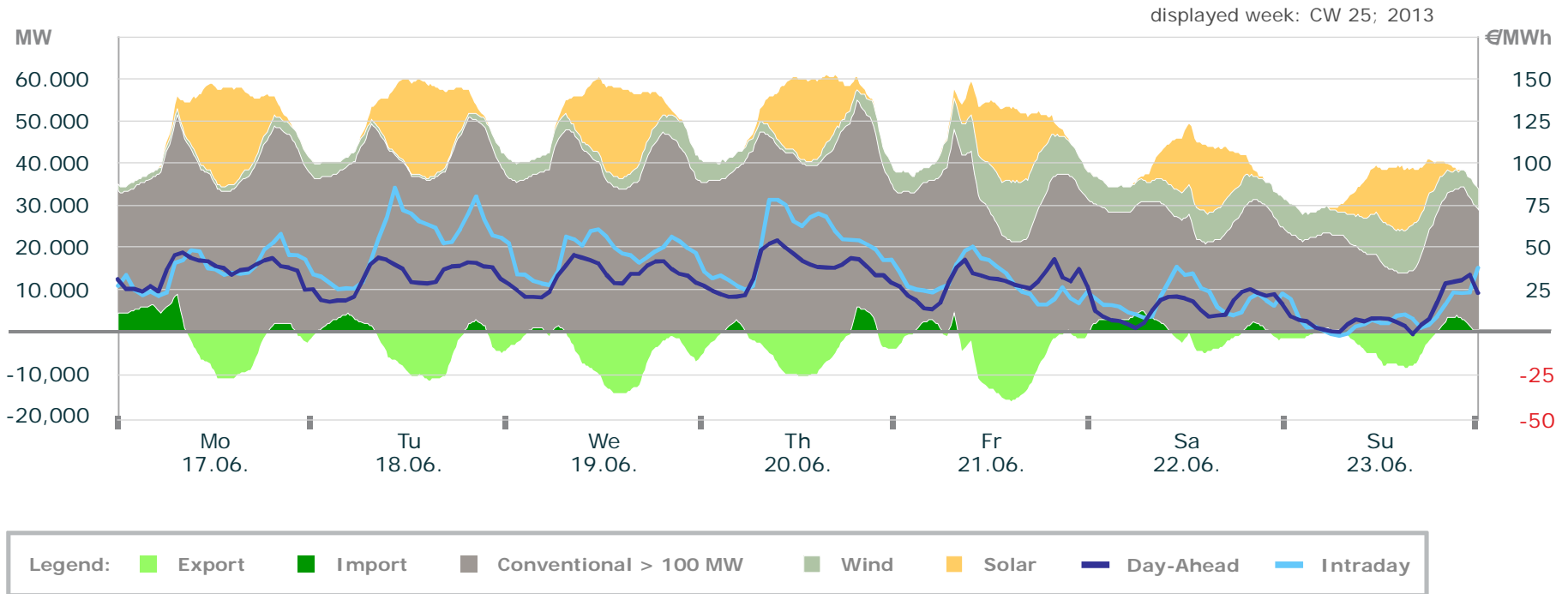
Electricity Production and Spot-Prices: CW 24 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	23.28	- 100.00	45.00	4 783
Intraday	26.95	- 53.50	59.50	288

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

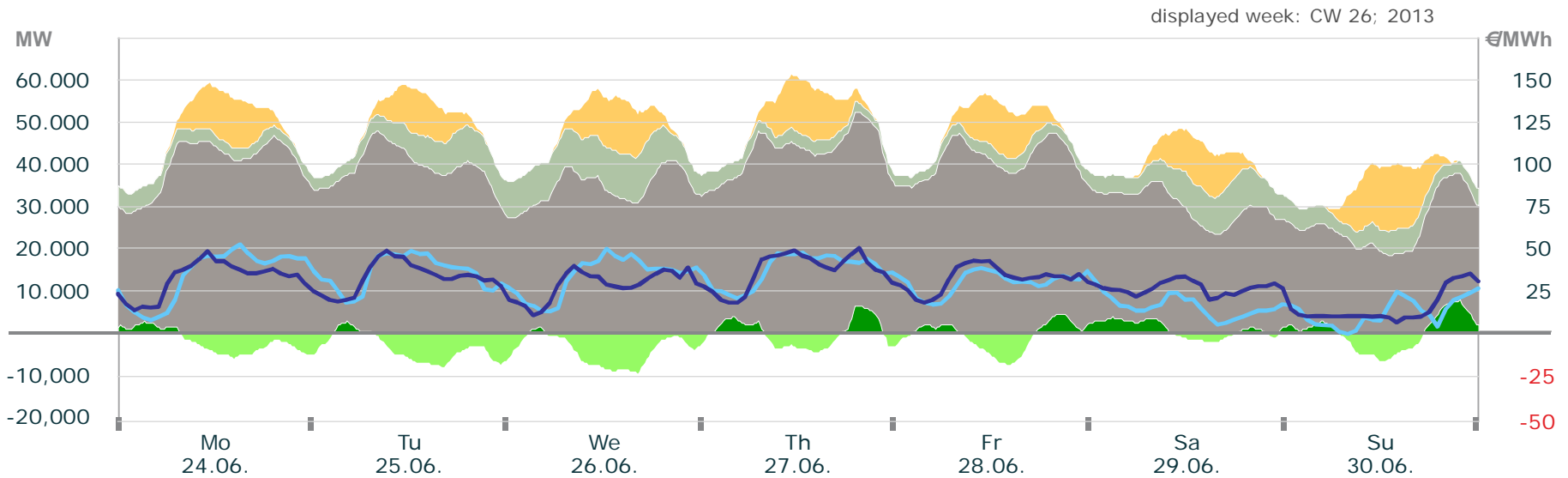
Electricity Production and Spot-Prices: CW 25 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	29.50	0.00	55.10	5 017
Intraday	43.66	- 0.80	86.00	390

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 26 2013

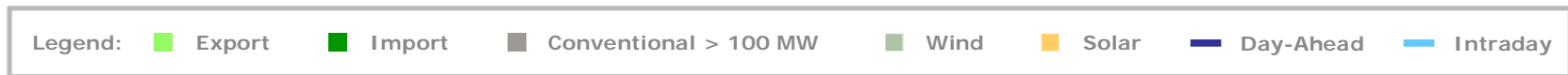
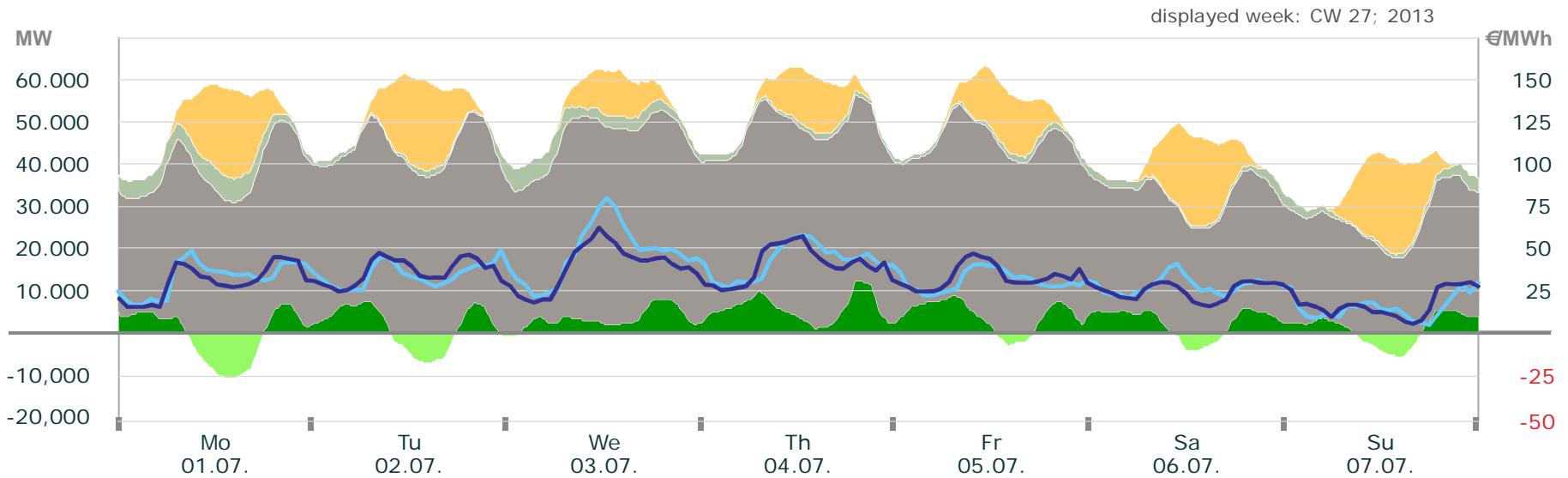


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar ■ Day-Ahead ■ Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	31.31	7.90	51.40	4 837
Intraday	32.12	1.20	53.50	395

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

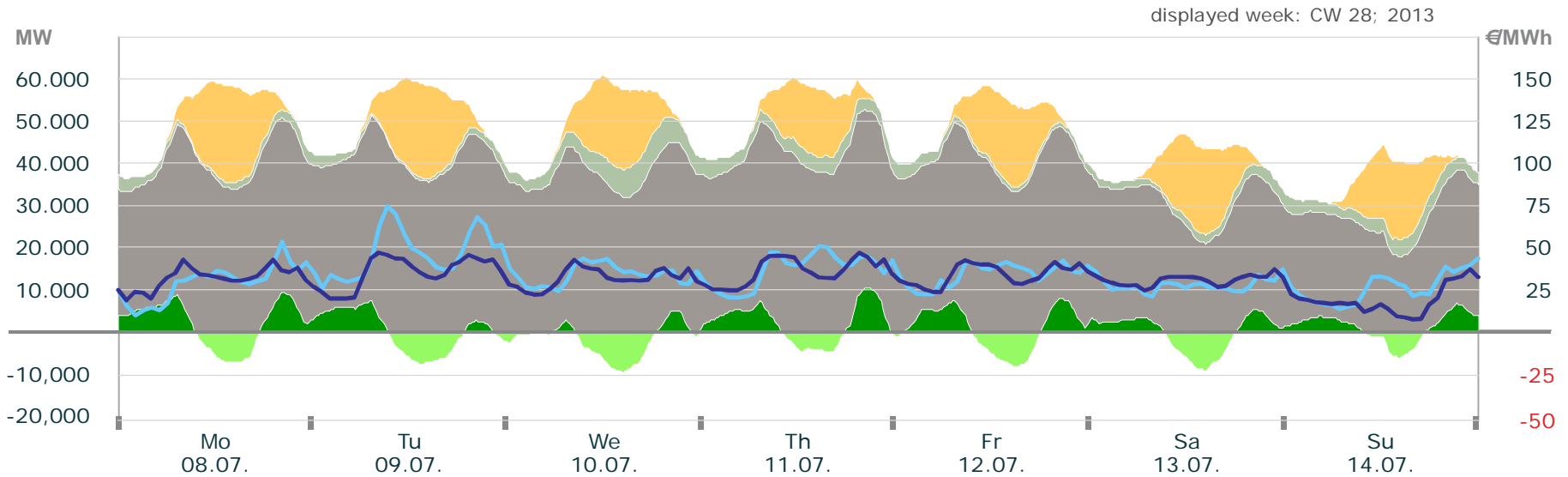
Electricity Production and Spot-Prices: CW 27 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.34	7.00	63.20	4 865
Intraday	39.69	6.30	80.50	261

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

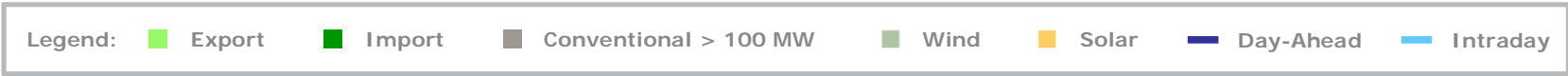
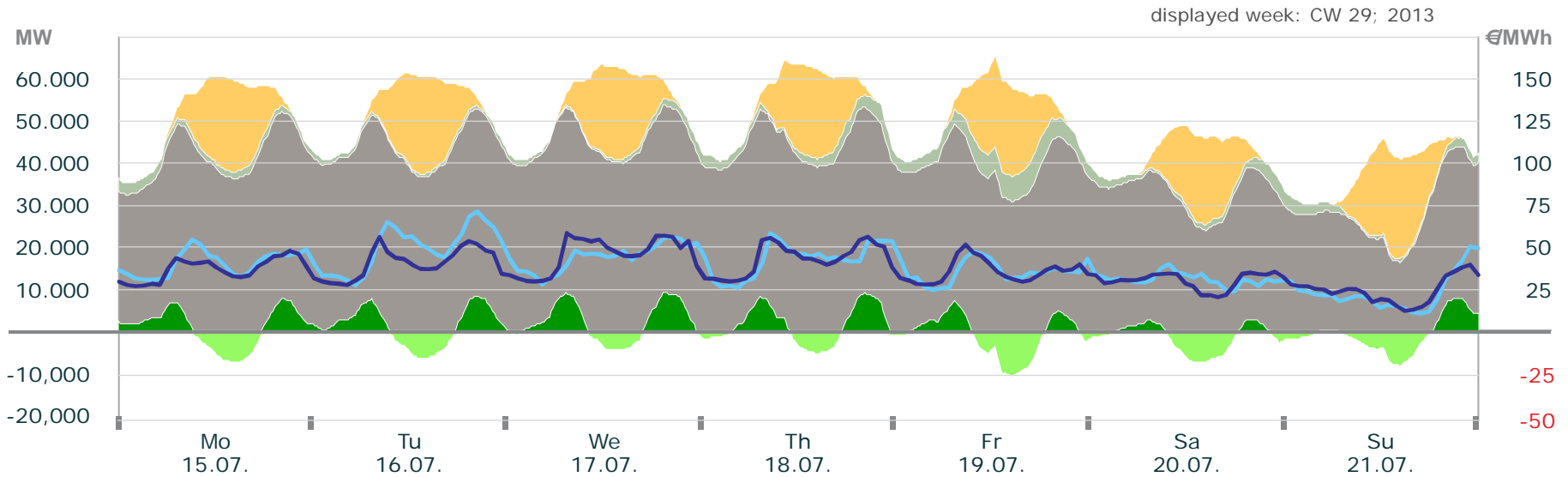
Electricity Production and Spot-Prices: CW 28 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	32.93	9.00	48.00	4 759
Intraday	38.58	11.40	75.40	293

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

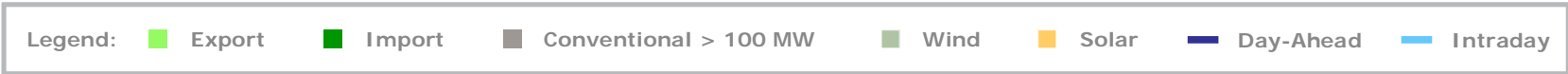
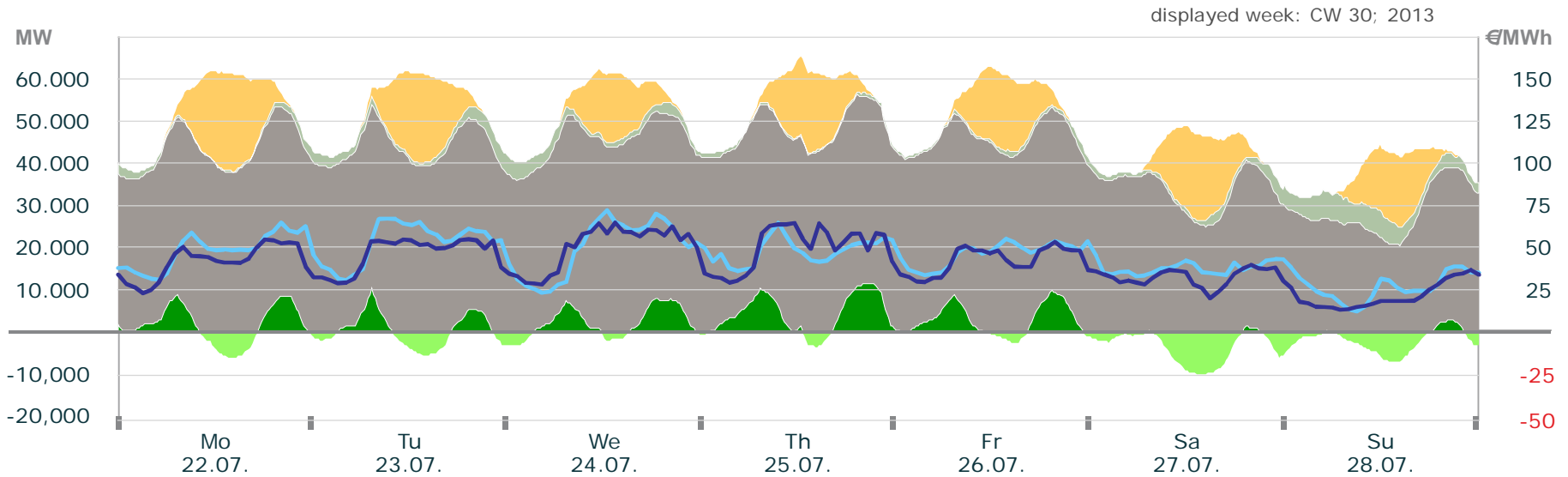
Electricity Production and Spot-Prices: CW 29 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	38.38	13.90	59.50	4 938
Intraday	42.14	12.50	72.20	258

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

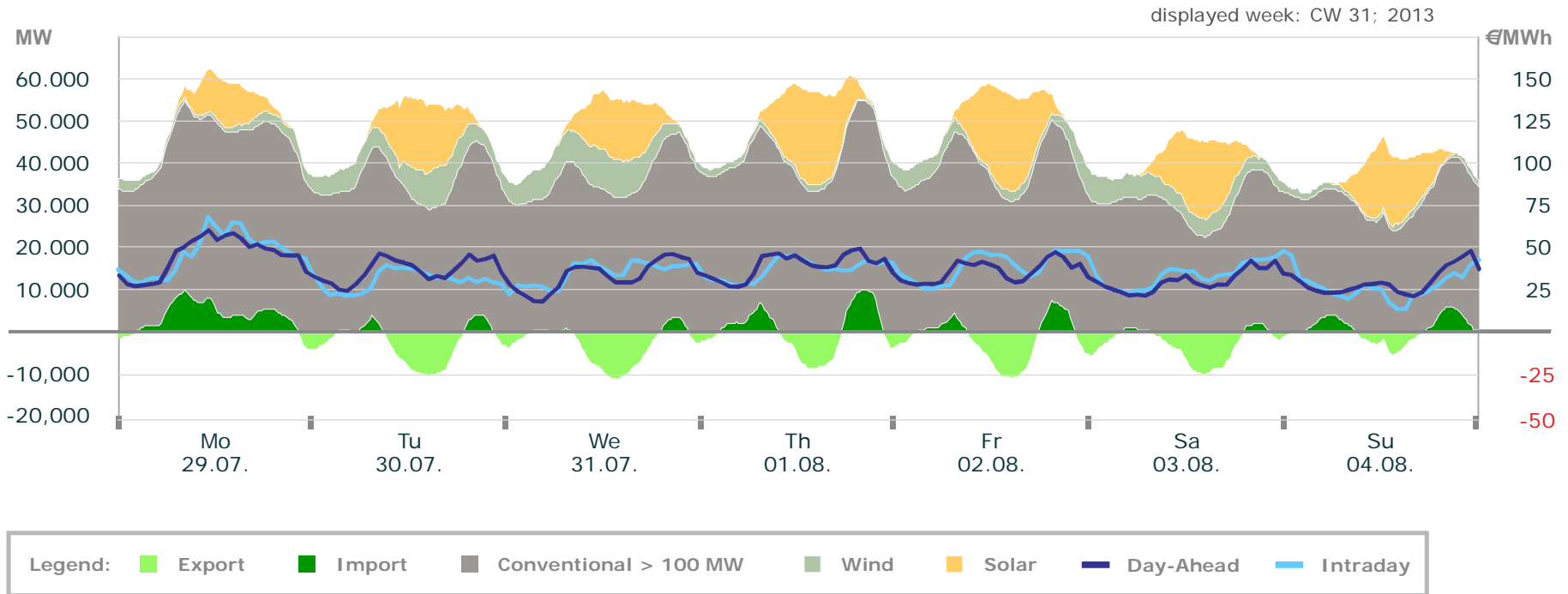
Electricity Production and Spot-Prices: CW 30 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	42.12	14.30	65.30	4 787
Intraday	47.51	13.70	73.10	341

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

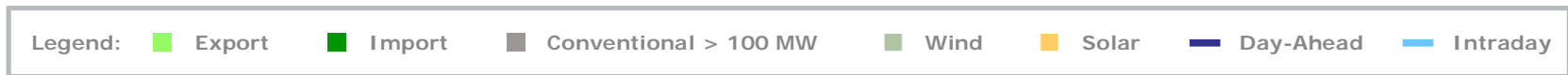
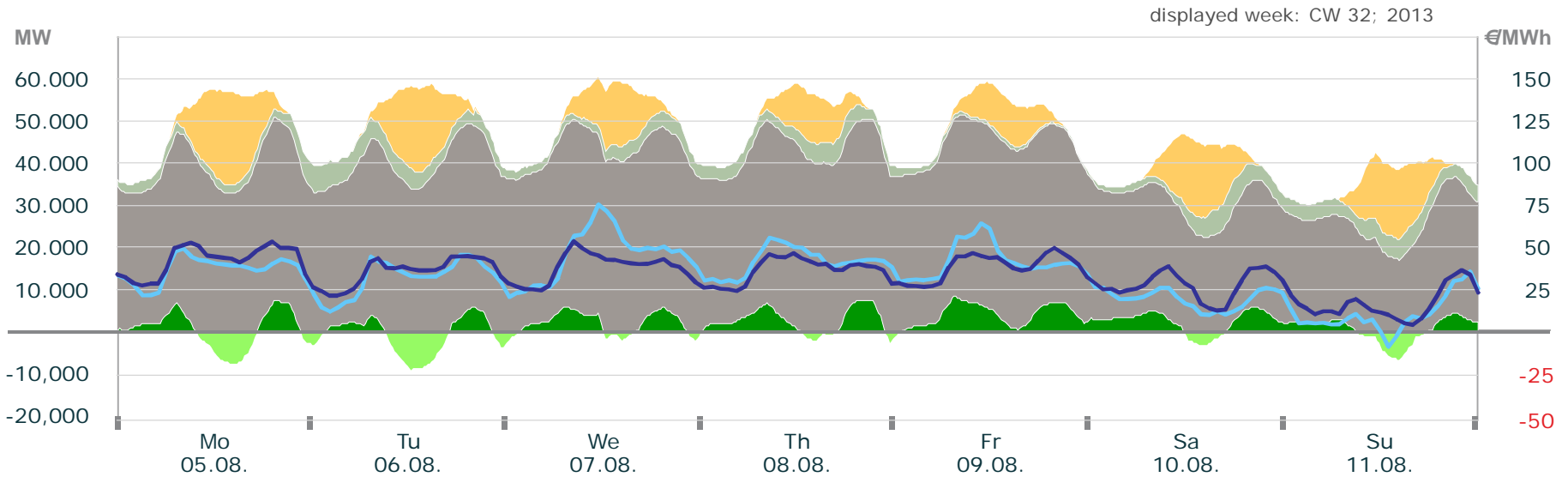
Electricity Production and Spot-Prices: CW 31 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	36.48	18.90	60.70	4 872
Intraday	38.18	14.80	68.90	349

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

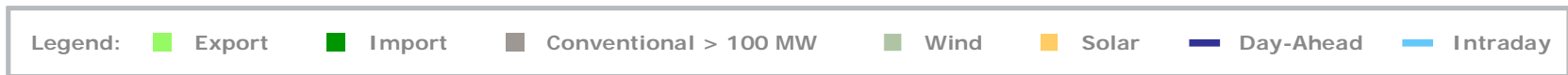
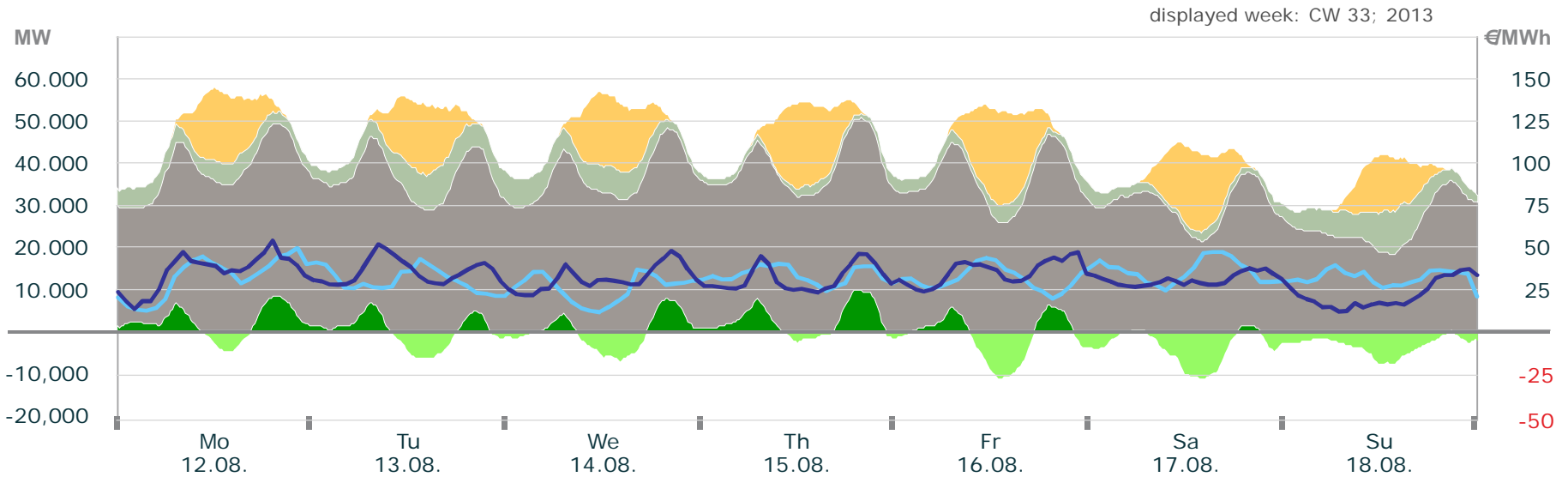
Electricity Production and Spot-Prices: CW 32 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	35.53	6.00	54.90	4 513
Intraday	25.95	- 7.24	76.20	359

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

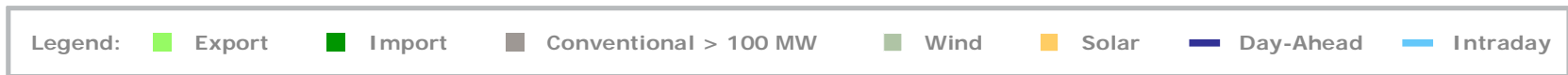
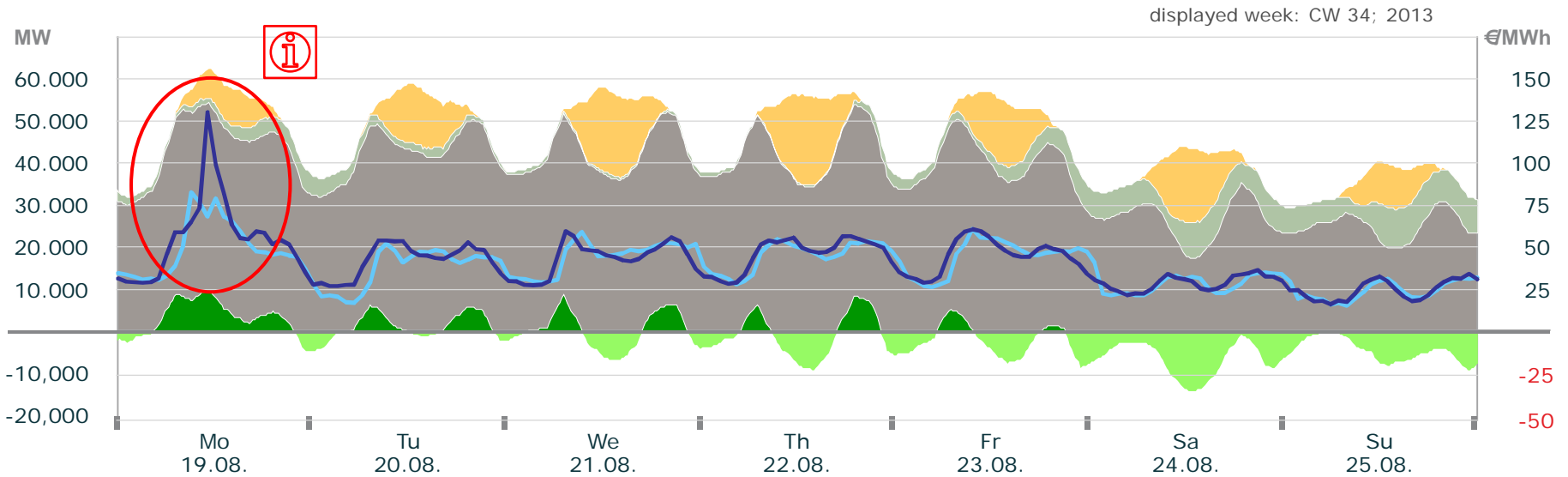
Electricity Production and Spot-Prices: CW 33 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.10	13.50	55.00	4 686
Intraday	33.29	13.10	50.62	283

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

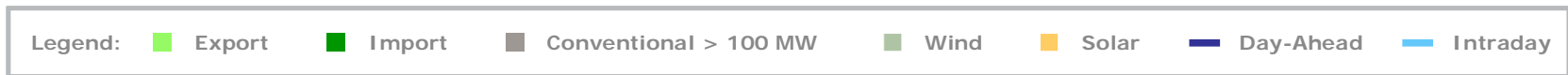
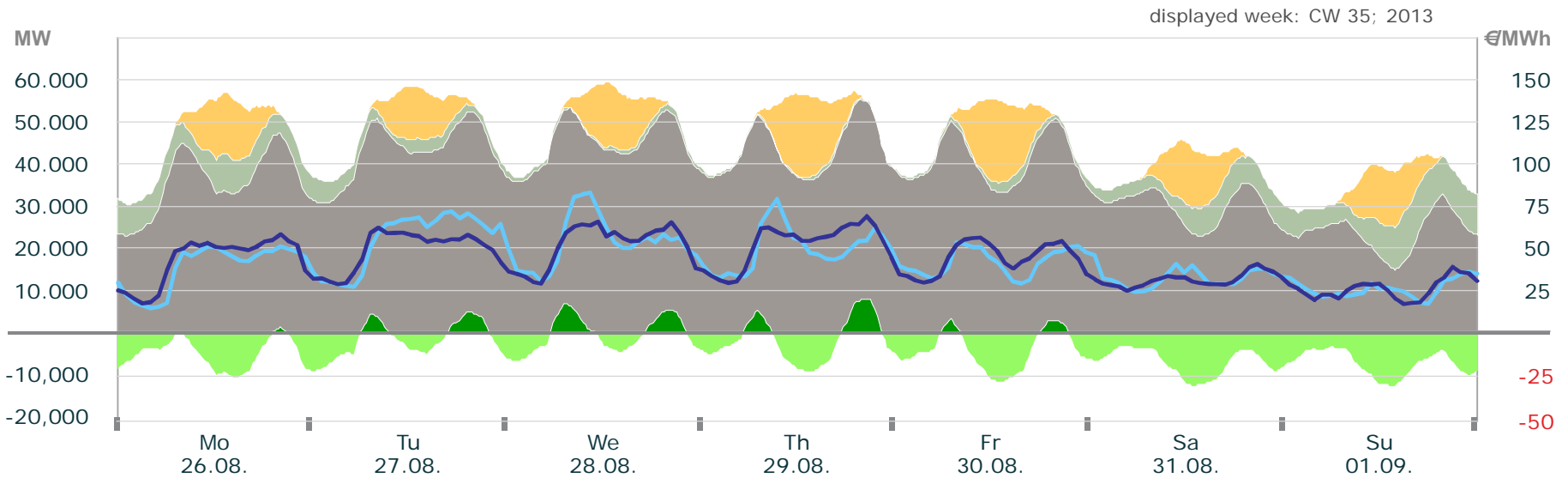
Electricity Production and Spot-Prices: CW 34 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	42.78	17.70	130.30	4 503
Intraday	43.29	17.00	83.40	340

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

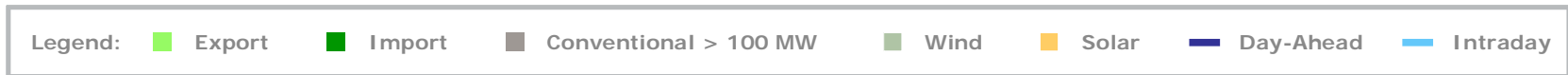
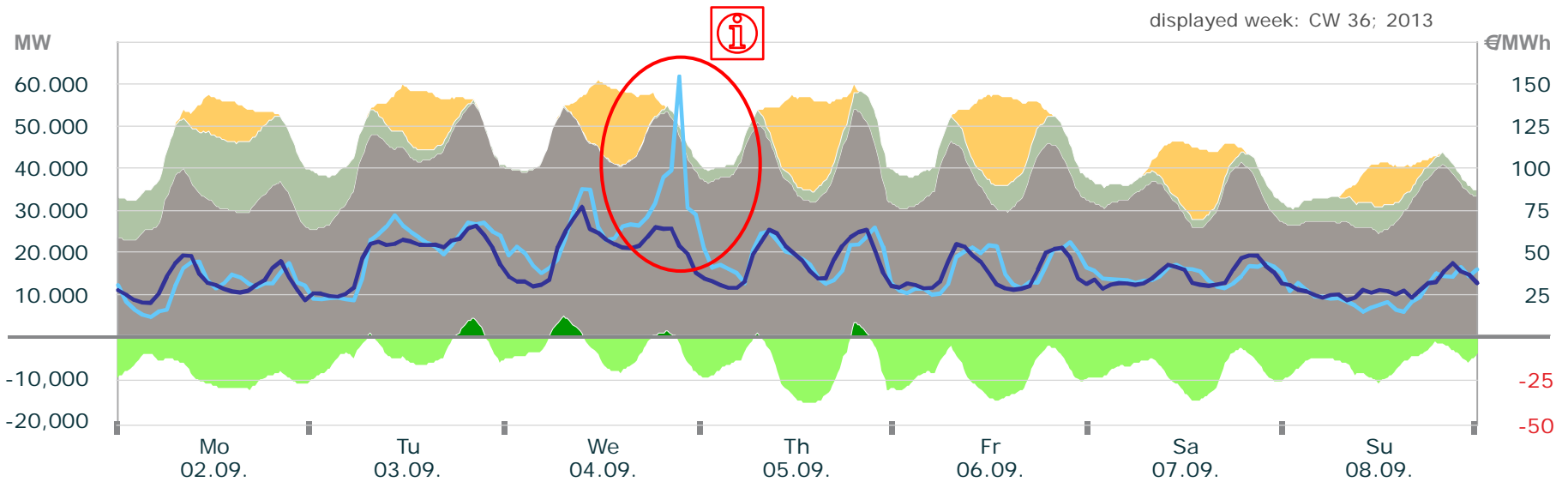
Electricity Production and Spot-Prices: CW 35 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	44.21	18.50	70.00	4 663
Intraday	47.61	16.00	83.70	319

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

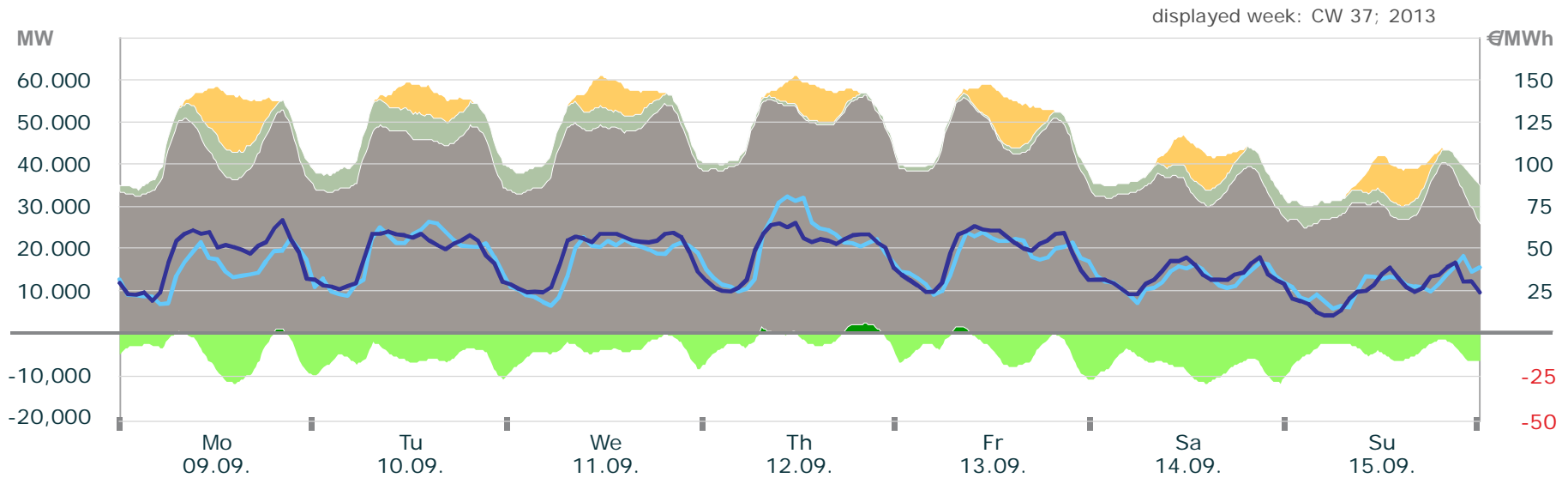
Electricity Production and Spot-Prices: CW 36 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	41.41	21.50	77.70	4 580
Intraday	46.47	13.20	154.10	281

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 37 2013

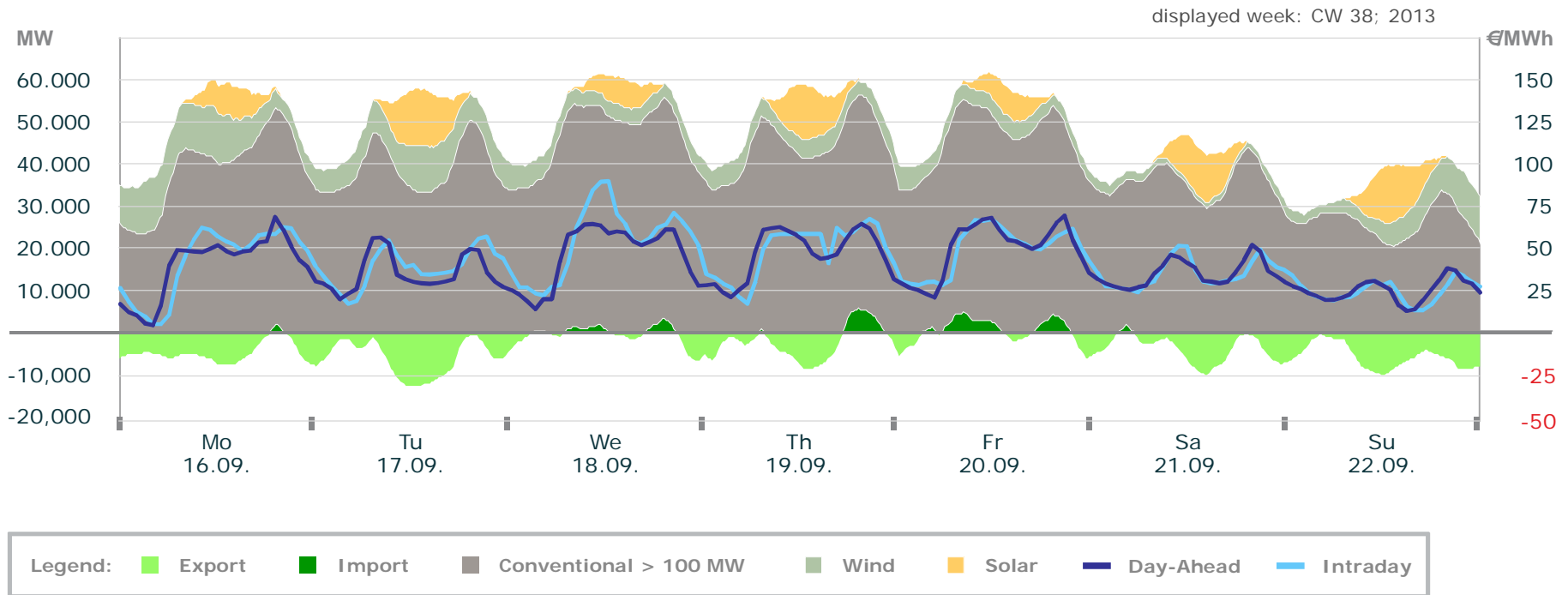


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar ■ Day-Ahead ■ Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	44.64	12.10	67.90	4 016
Intraday	45.67	15.80	81.50	313

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

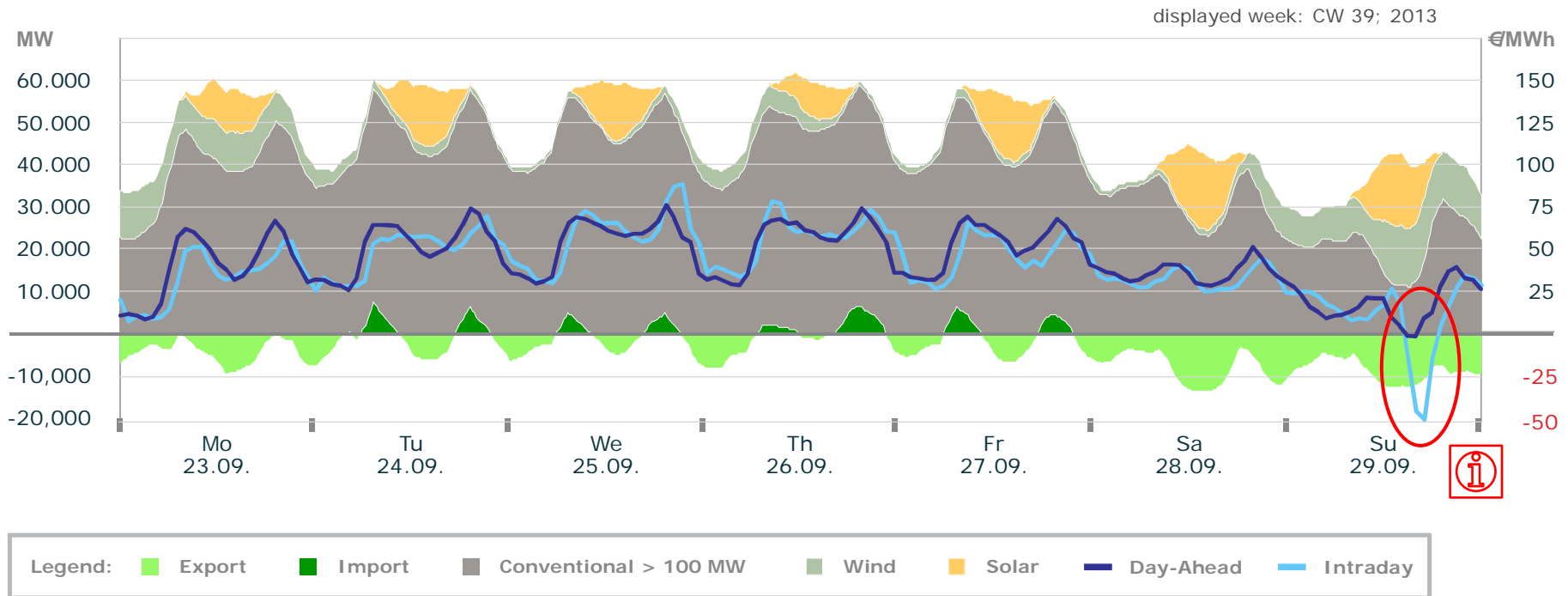
Electricity Production and Spot-Prices: CW 38 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	41.15	5.80	70.20	4 318
Intraday	45.63	6.30	90.10	276

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

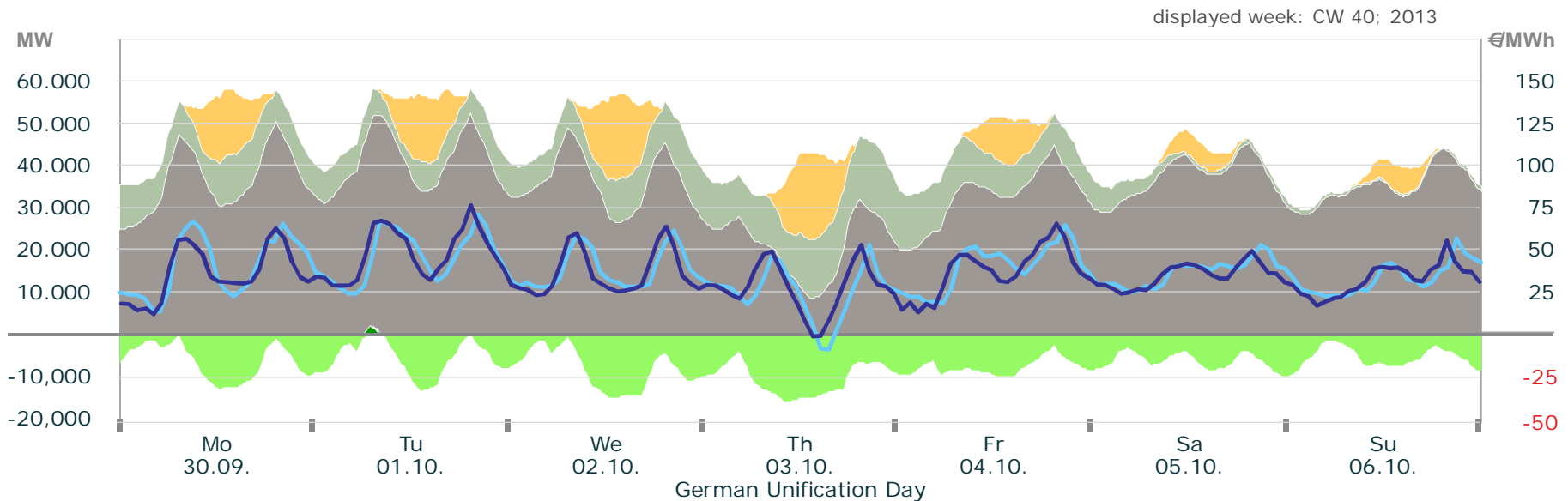
Electricity Production and Spot-Prices: CW 39 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	43.79	- 0.10	76.70	4 403
Intraday	43.76	- 48.90	89.00	307

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 40 2013

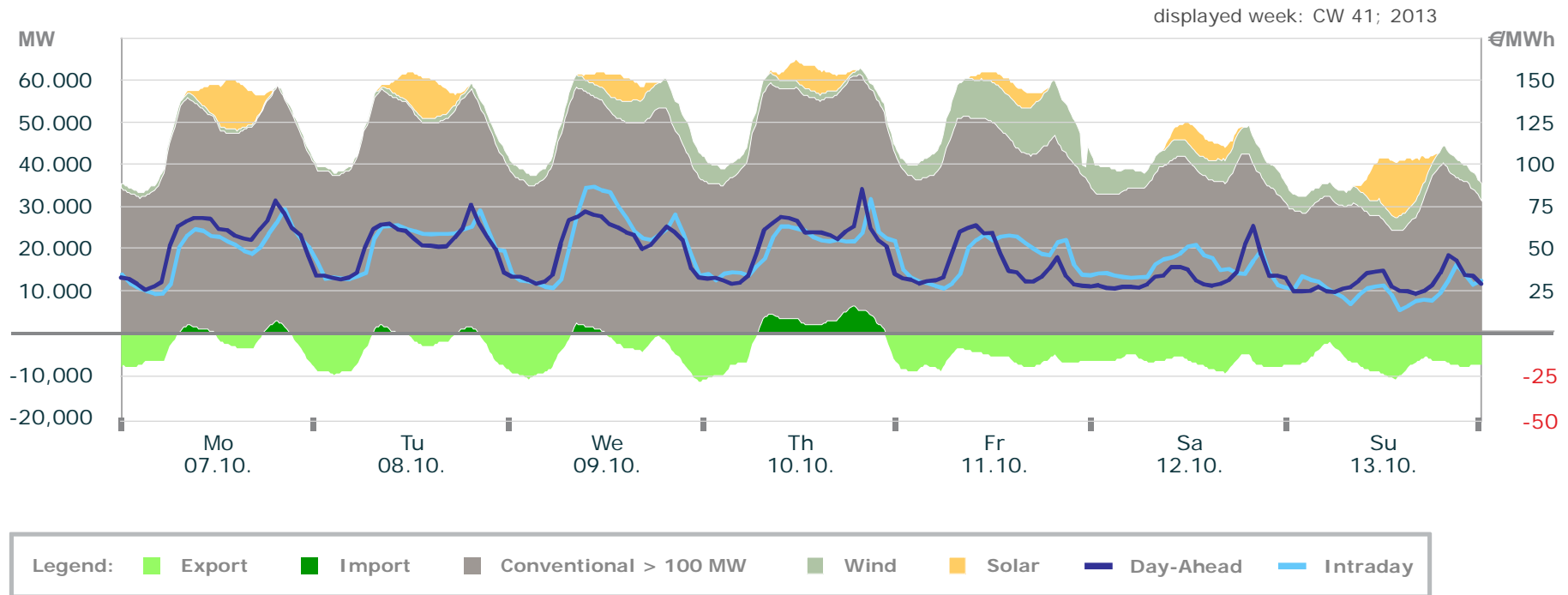


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	36.93	0.20	76.90	4 805
Intraday	37.74	- 7.60	71.70	269

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

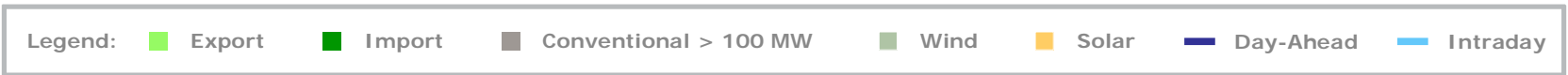
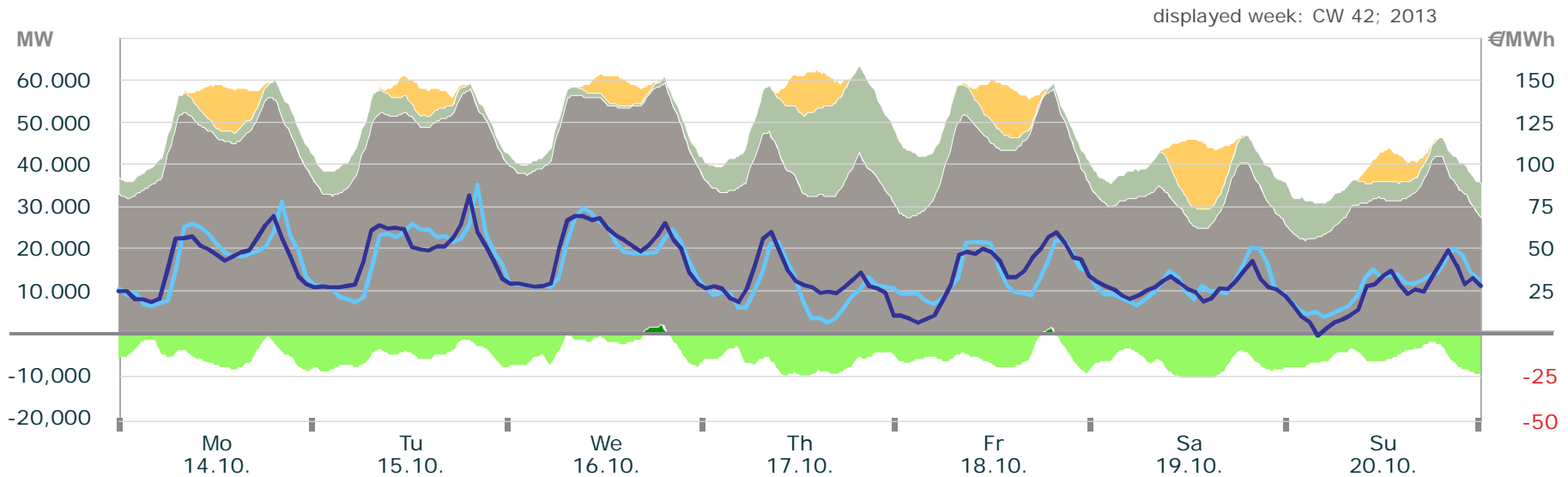
Electricity Production and Spot-Prices: CW 41 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	46.28	24.40	85.80	4 655
Intraday	49.03	15.40	87.60	375

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

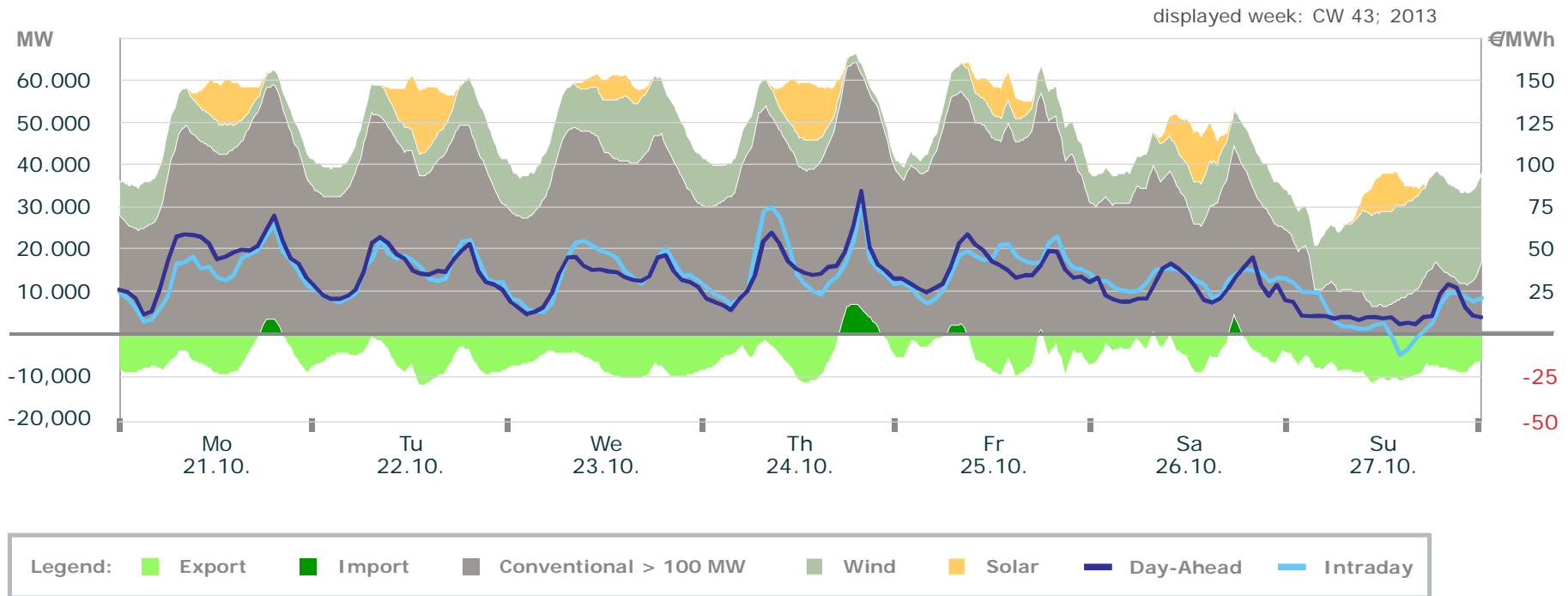
Electricity Production and Spot-Prices: CW 42 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	37.85	0.00	82.20	4 678
Intraday	39.14	8.20	88.90	283

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

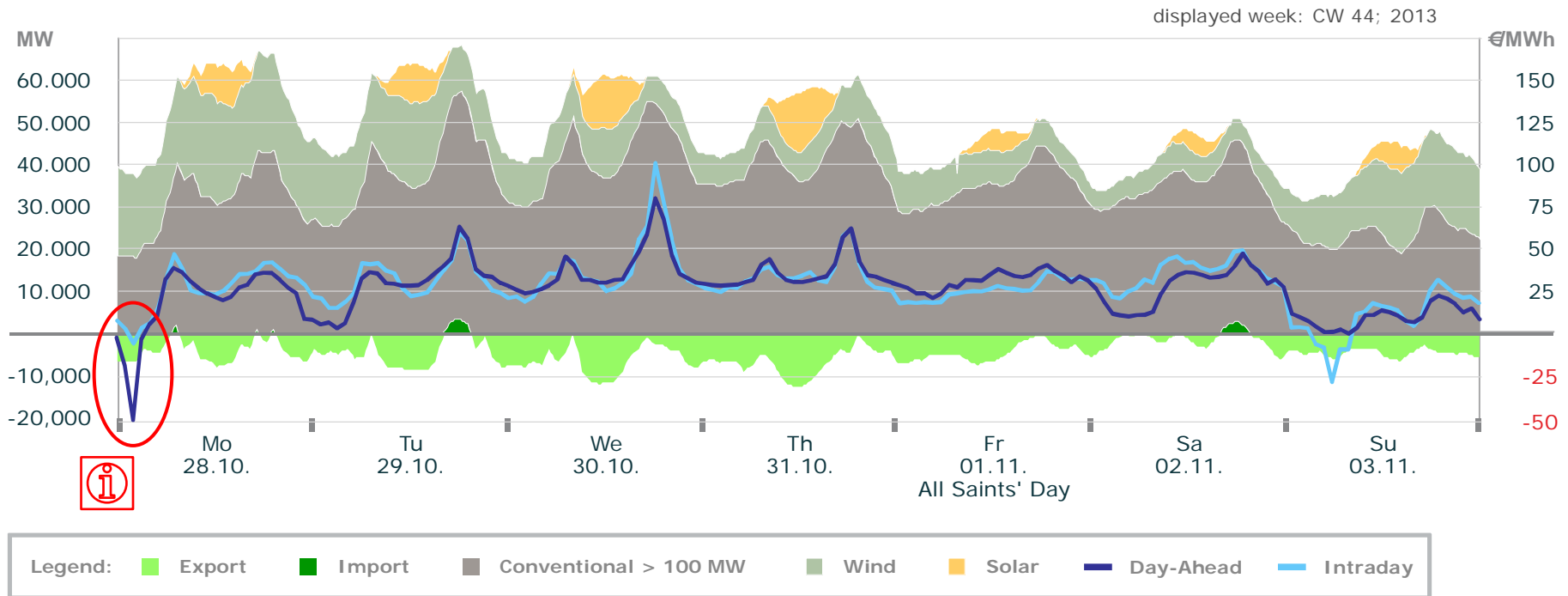
Electricity Production and Spot-Prices: CW 43 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.61	7.00	84.90	5 037
Intraday	33.31	- 11.20	79.00	340

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

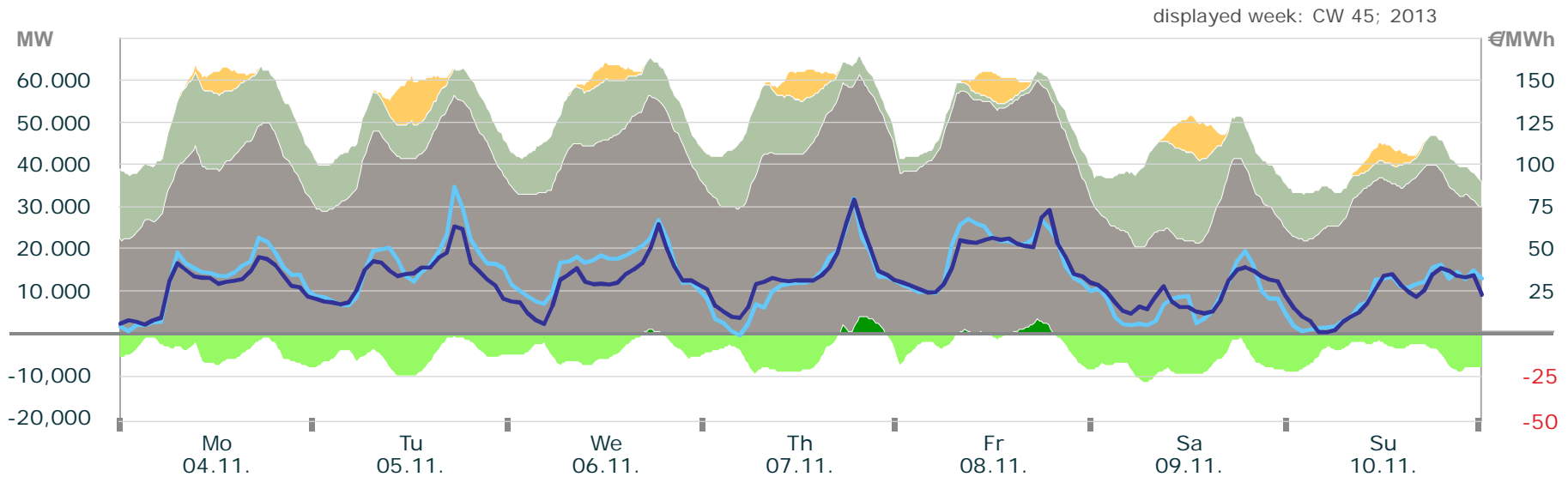
Electricity Production and Spot-Prices: CW 44 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	28.48	- 49.10	80.70	5 229
Intraday	30.86	- 26.90	101.20	376

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 45 2013

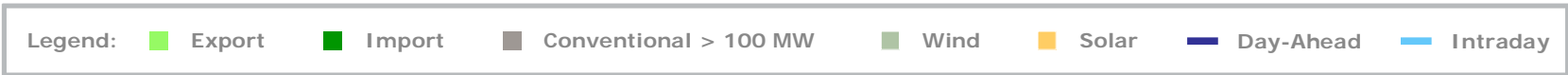
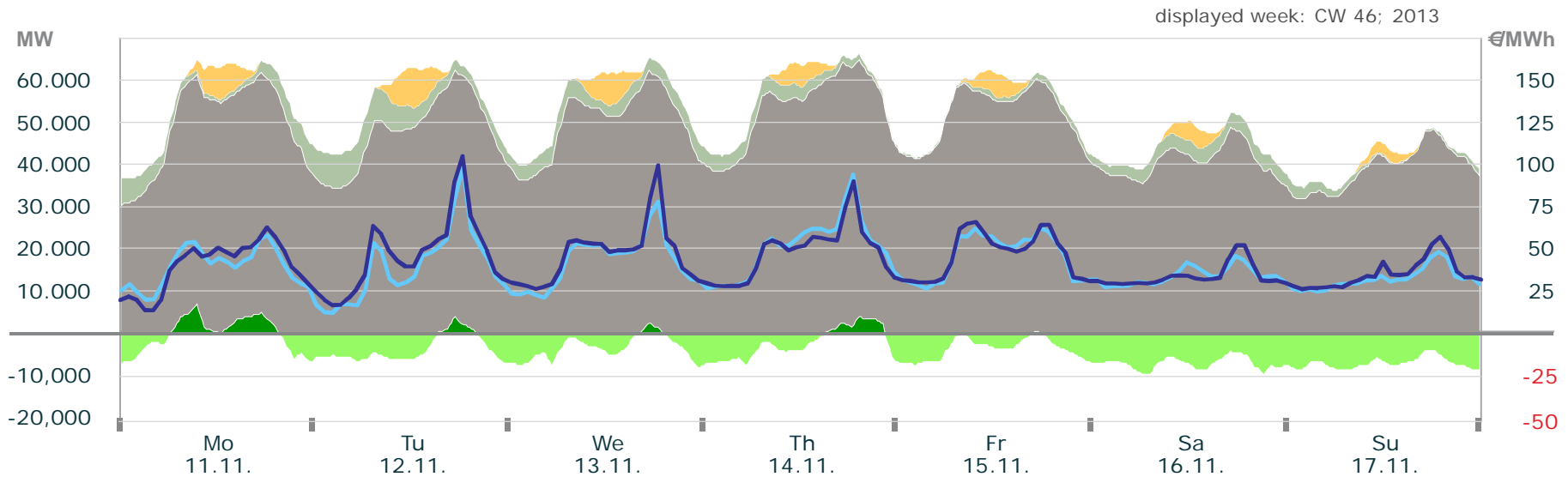


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	32.23	2.00	79.90	5 169
Intraday	38.88	0.70	87.60	428

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

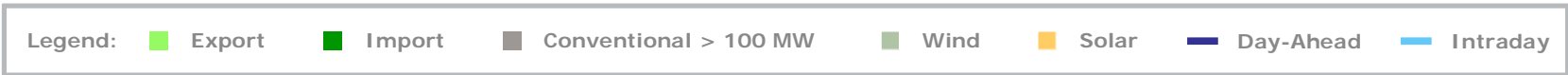
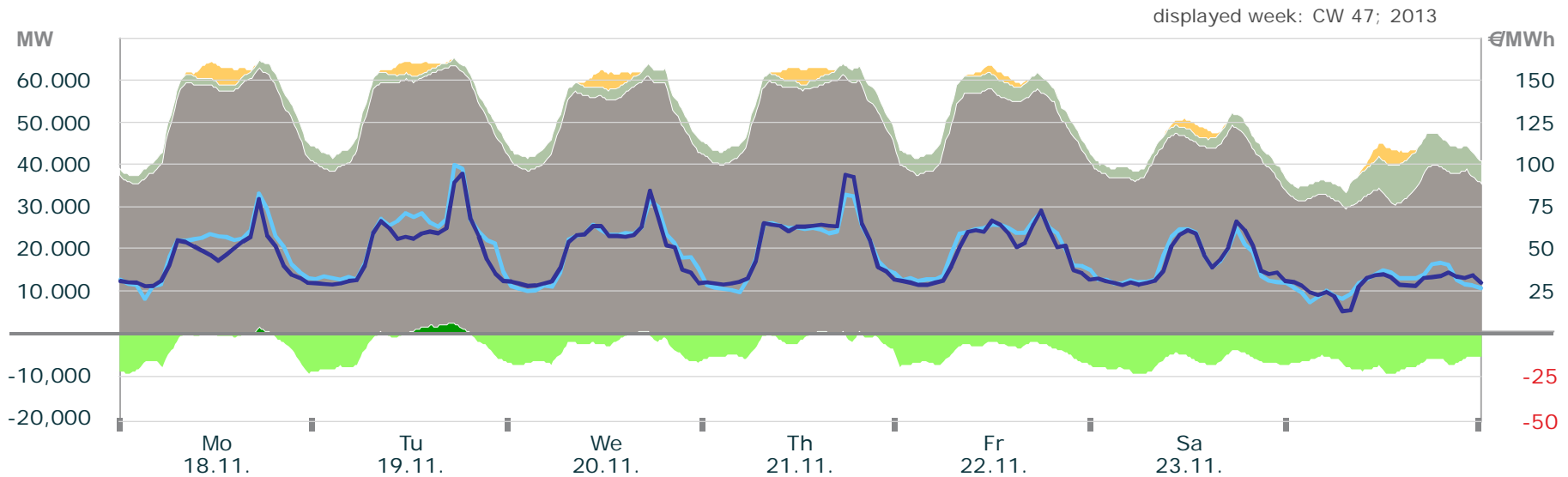
Electricity Production and Spot-Prices: CW 46 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	44.02	14.80	105.30	4 589
Intraday	45.72	13.50	98.90	232

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

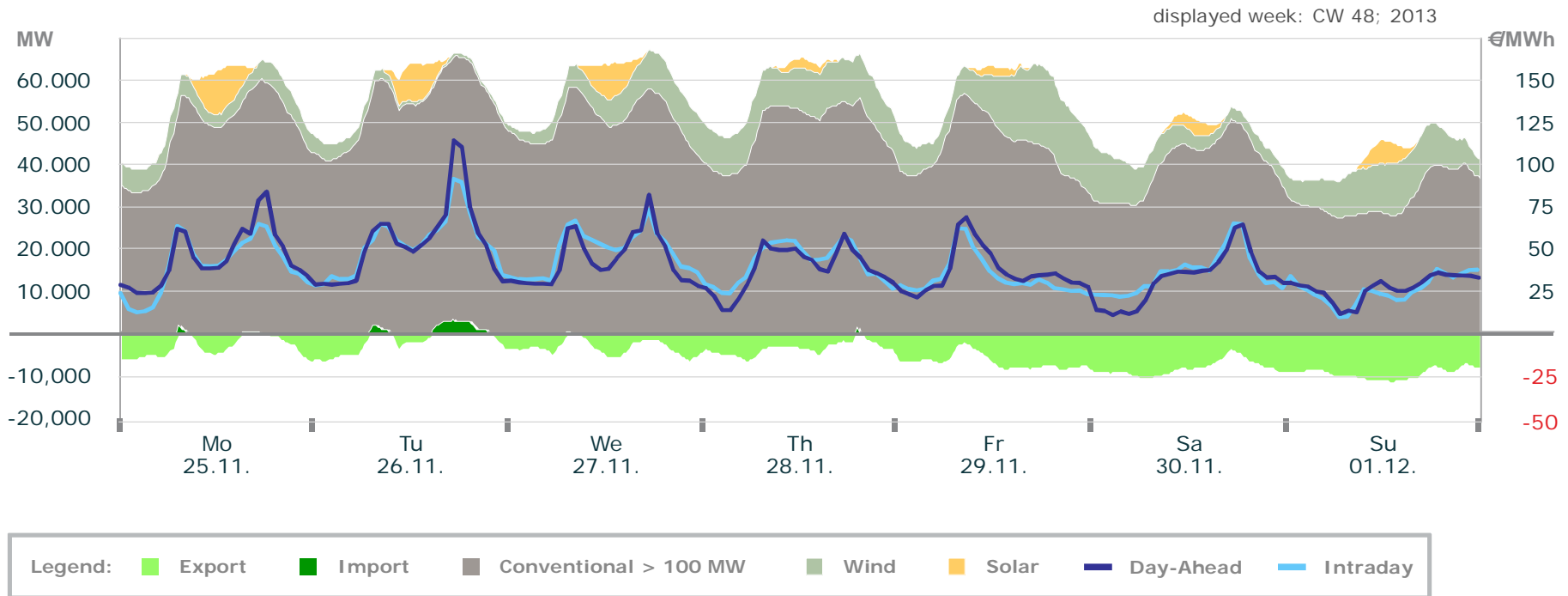
Electricity Production and Spot-Prices: CW 47 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	46.92	14.40	95.00	4 237
Intraday	52.55	19.60	100.00	239

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

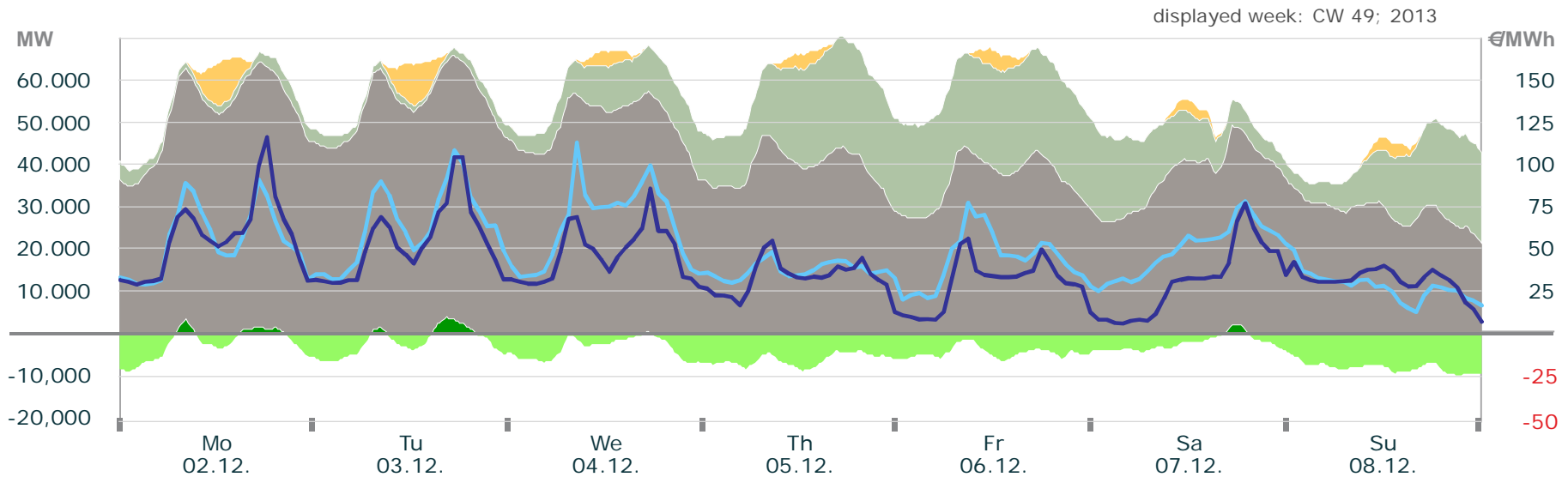
Electricity Production and Spot-Prices: CW 48 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	40.97	11.90	114.30	4 620
Intraday	41.56	11.20	92.00	292

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 49 2013

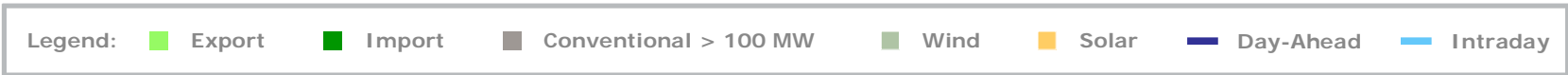
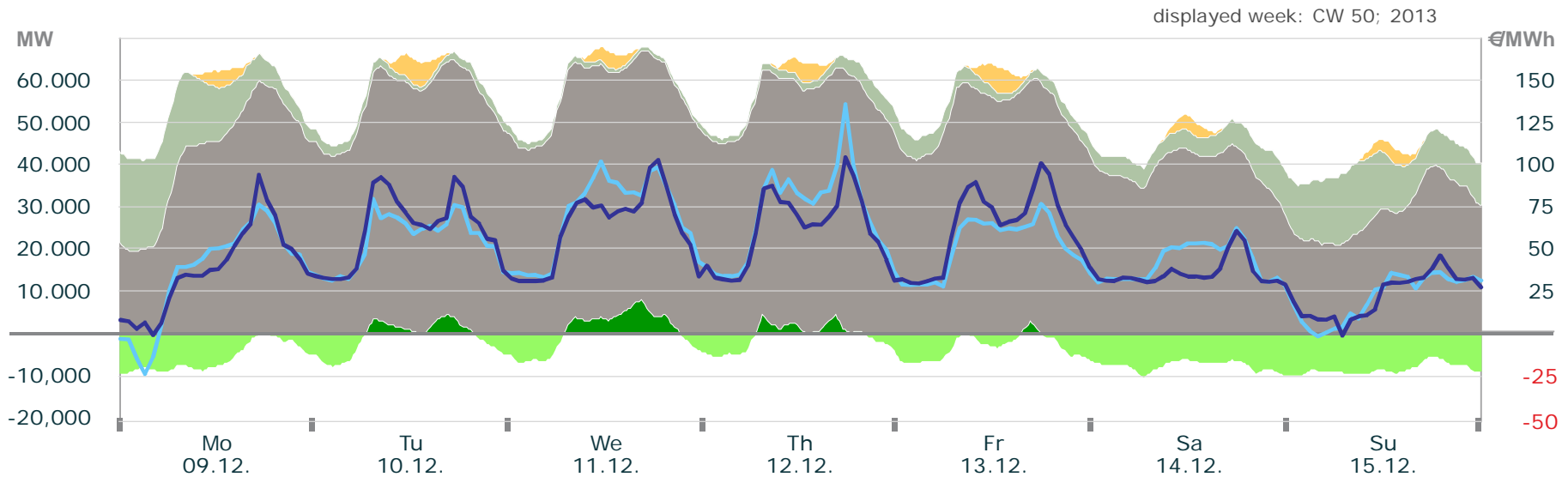


Legend: ■ Export ■ Import ■ Conventional > 100 MW ■ Wind ■ Solar — Day-Ahead — Intraday

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	41.57	7.60	116.50	5 119
Intraday	51.70	13.90	113.20	462

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

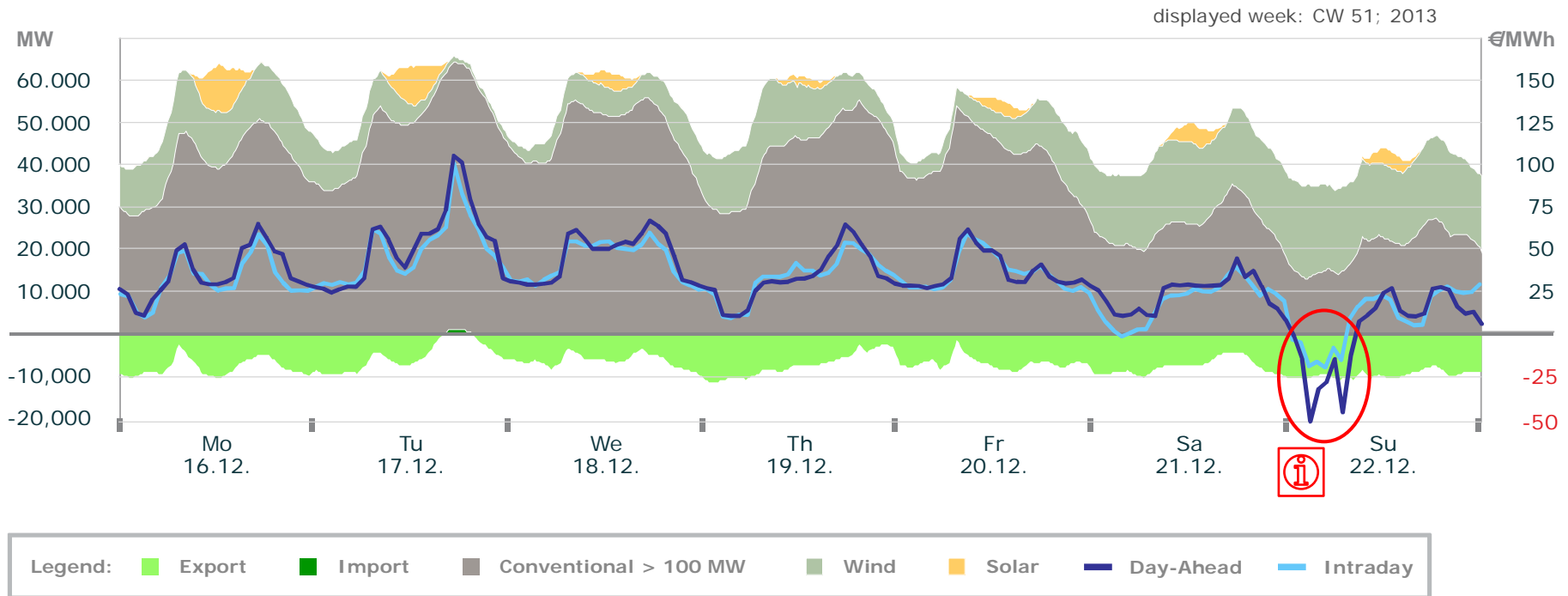
Electricity Production and Spot-Prices: CW 50 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	49.67	0.10	116.50	4 680
Intraday	59.41	- 20.40	104.50	360

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

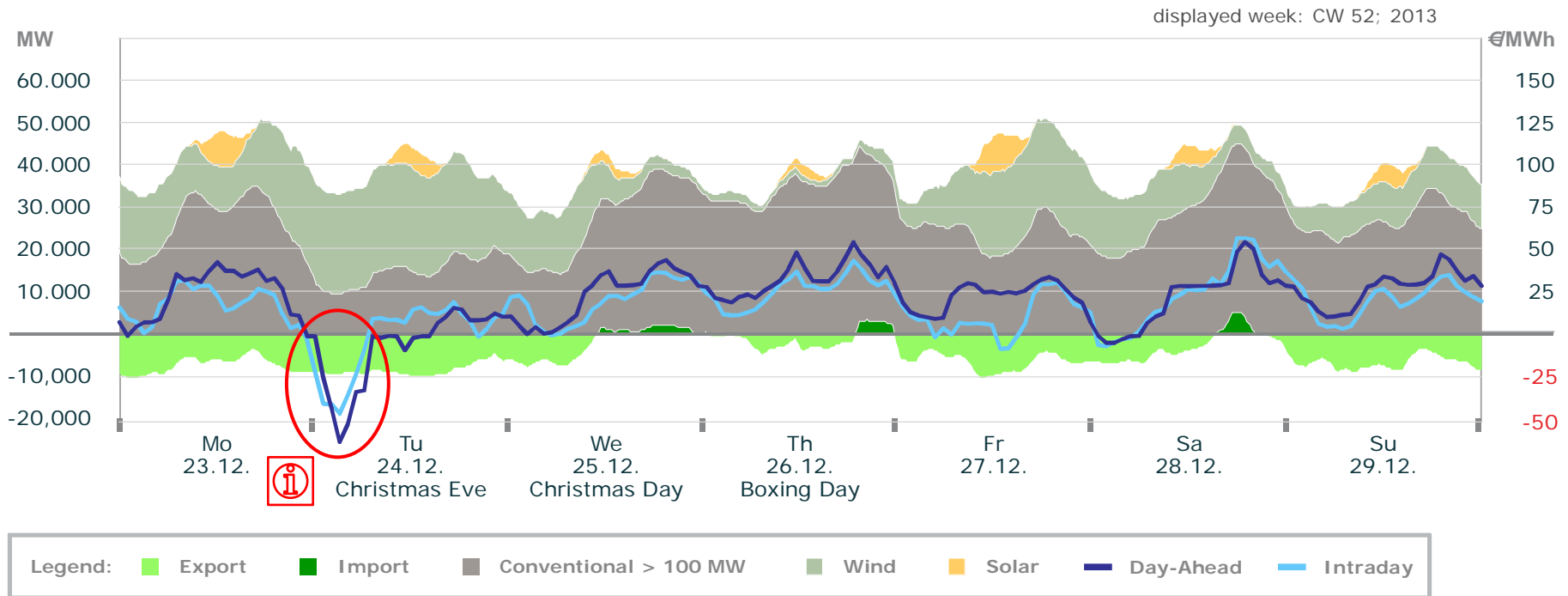
Electricity Production and Spot-Prices: CW 51 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	33.57	- 50.00	105.60	5 414
Intraday	34.30	- 18.30	101.10	339

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

Electricity Production and Spot-Prices: CW 52 2013



€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead	20.61	-62.00	55.00	5 031
Intraday	18.61	- 45.40	57.40	493

Source: Johannes Mayer, Bruno Burger, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-e

AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer

Analysis of Spot-Price Extremes



- On the following slides we try to give explanations for extreme price events based on public available data:
 - forecast versus actual production of solar and wind
 - load projection errors
 - total load in the grid
 - utilization ratio and total power output of conventional power plants

- There are also effects like strategic bidding and certain technical constraints (grid-stability, must-run generation, etc.) that are not transparently available.

Analysis of the Negative Spot-Prices on 24.03.2013



- The following table provides detailed data about the negative price period in calendar week 12 on the Spot-market:

€/MWh	11:00 – 12:00	12:00 – 13:00	13:00 – 14:00	14:00 – 15:00	15:00 – 16:00
Day-Ahead	7.20	- 0.10	- 10.07	- 50.00	- 10.01
Trade Vol (€)	274 611	- 4 021	- 417 428	- 1 875 620	- 349 957
Intraday	- 27.90	- 28.10	- 48.40	- 83.20	- 13.10
Trade Vol (€)	- 57 452	- 76 567	- 151 356	- 246 705	- 22 773

- The cumulated trade volume with negative prices was about **2.6 Mio. €** in the Day-Ahead market and **0.55 Mio. €** in the Intraday market.
- The Day-Ahead trade volume with positive prices was **174 Mio. €** in calendar week 12 and **2 511 Mio. €** in the first quarter 2013.

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

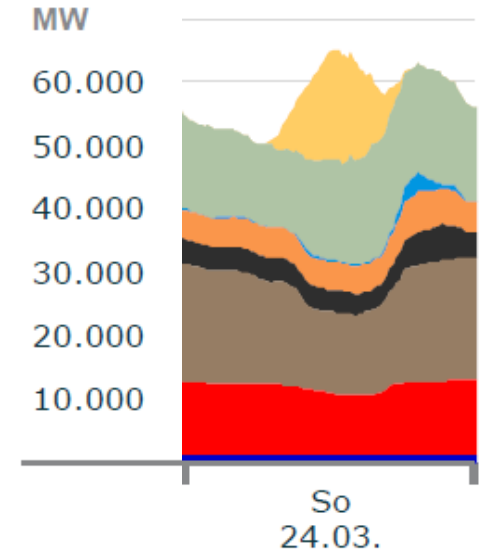
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Negative Spot-Prices on 24.03.2013



- Solar and wind produced more than 30 GW of power around noon.
- The actual load was up to 10 GW lower than projected the day before, resulting in oversupply.
- The actual production from solar and wind combined was up to 5 GW higher than it was projected the day before (see following slide).
- Utilization ratio of power plants (14:00 – 15:00):



24.03. 14:00-15:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,2 GW	9,3 GW	12,0 GW	3,1 GW	4,7 GW	0,3 GW	16,6 GW	14,1 GW
Plant Utilization*	32,4 %	77,3 %	63,0 %	15,2 %	20,5 %	2,8 %	54,9 %	42,4 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

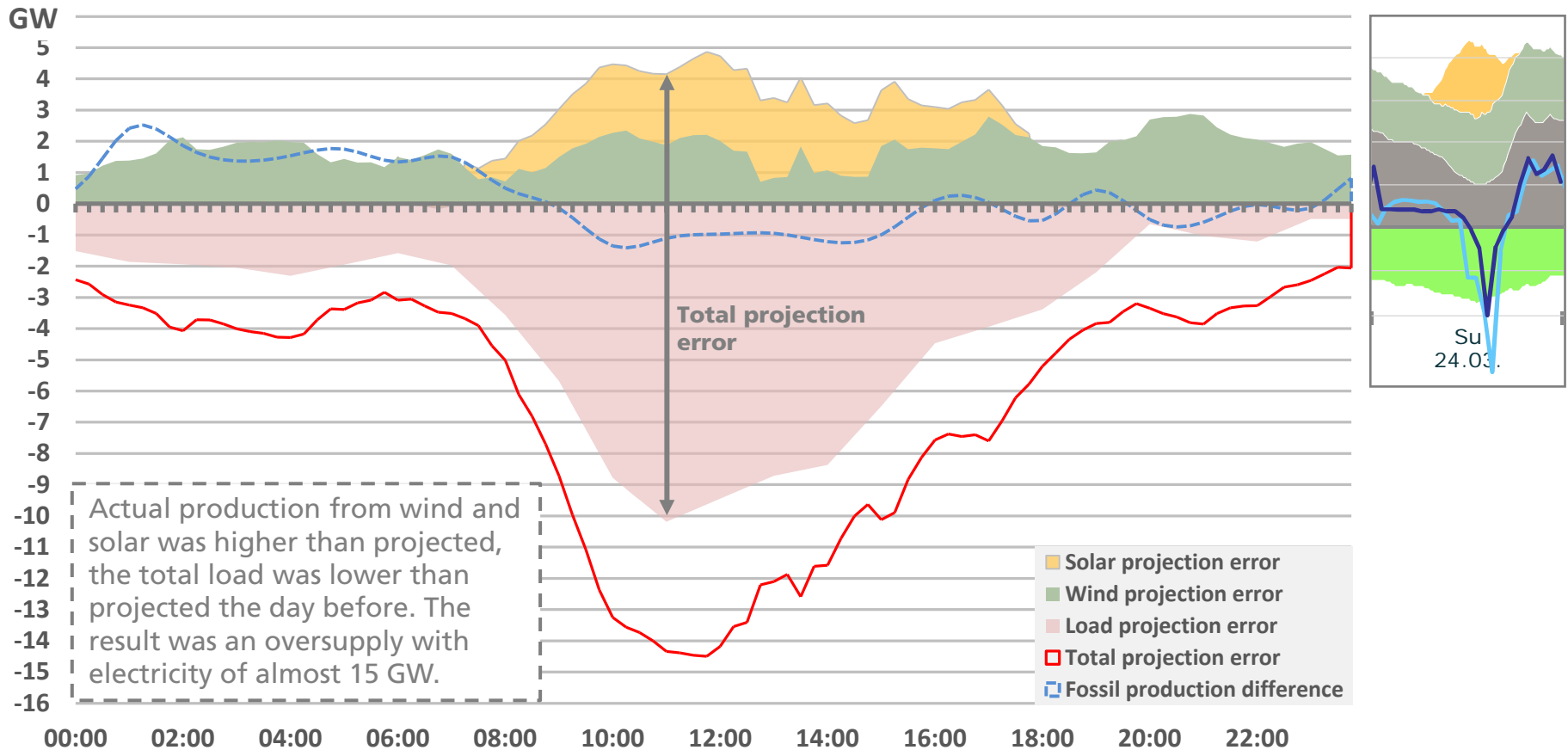
Back to month chart

Back to week chart

Analysis of the Negative Spot-Prices on 24.03.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

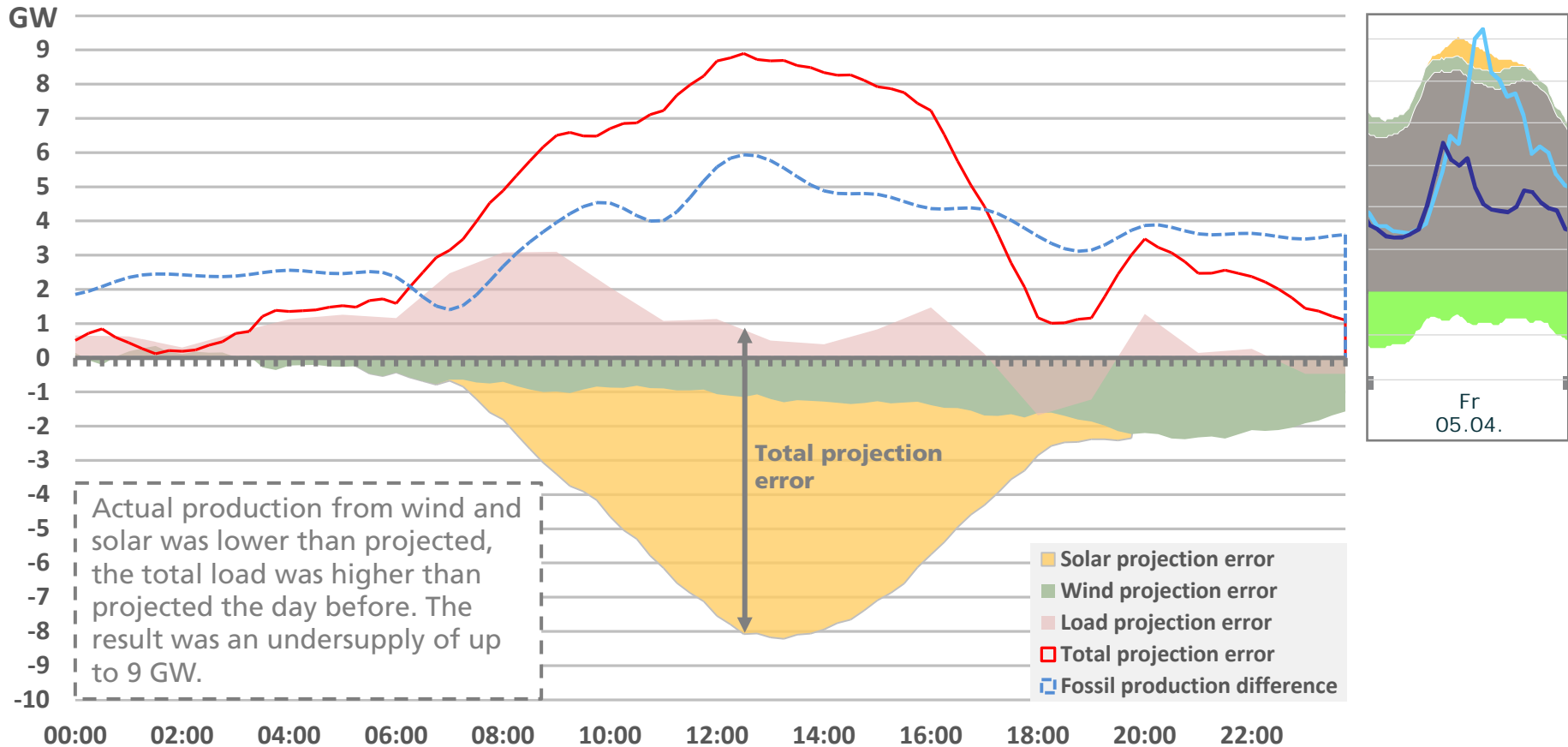
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Spot-Price Difference on 05.04.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

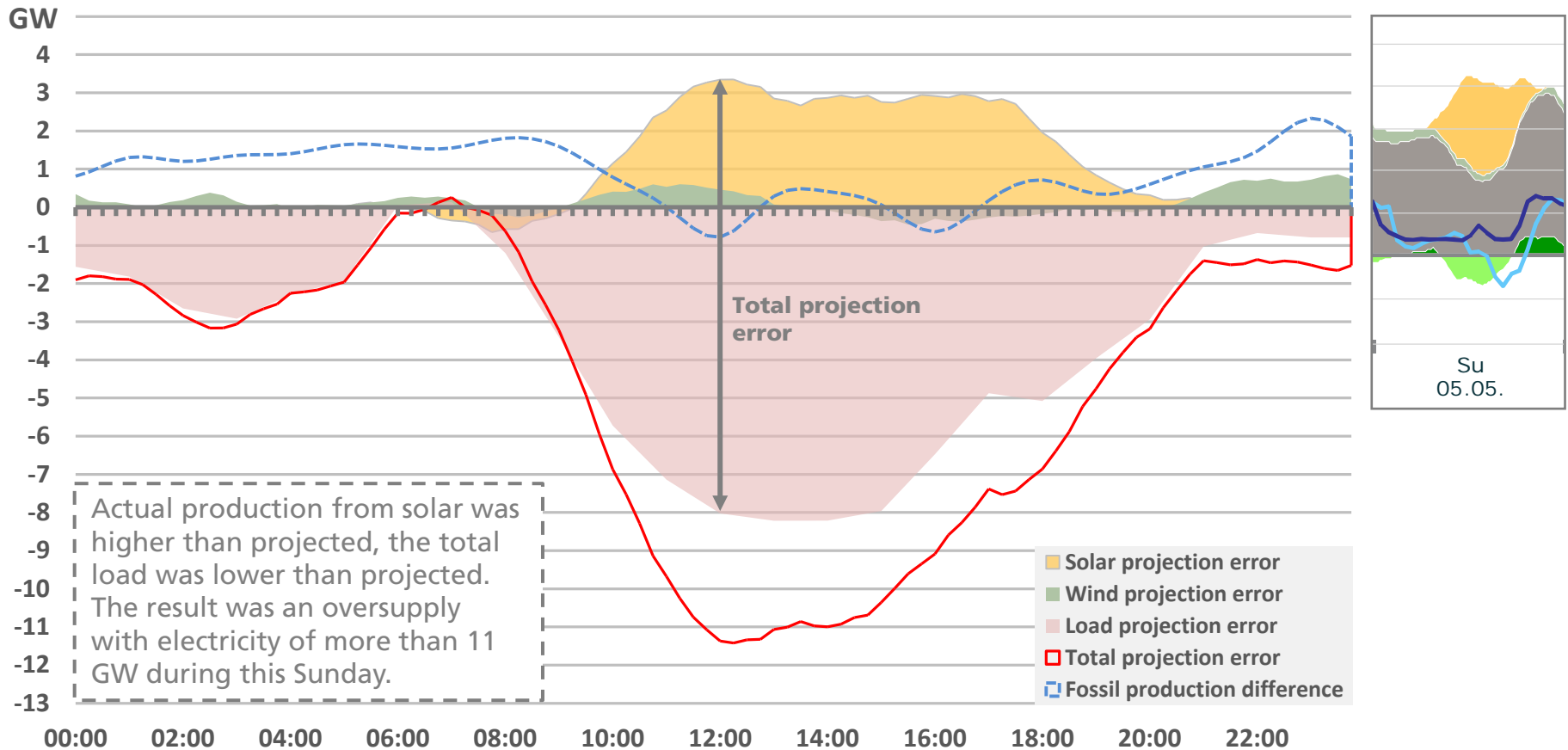
Back to month chart

Back to week chart

Analysis of the Negative Intraday-Prices on 05.05.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

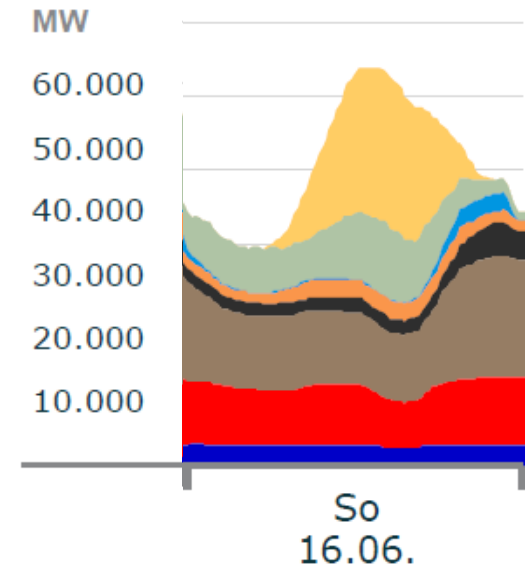
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Negative Spot-Prices on 16.06.2013



- Solar and wind produced app 29 GW of power between 2 and 3 pm during this Sunday.
- The total grid load was about 45 GW at this time.
- Conventional baseload power plants (Uranium, Brown Coal) were not able to reduce their production below 53% of the installed capacity.
- Utilization ratio of power plants (14:00 – 15:00):



16.06. 14:00-15:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	2,0 GW	6,3 GW	9,1 GW	2,2 GW	2,6 GW	0,1 GW	8,8 GW	20,1 GW
Plant Utilization*	53,8 %	67,1 %	53,9 %	10,8 %	12,2 %	1,0 %	29,1 %	60,2 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

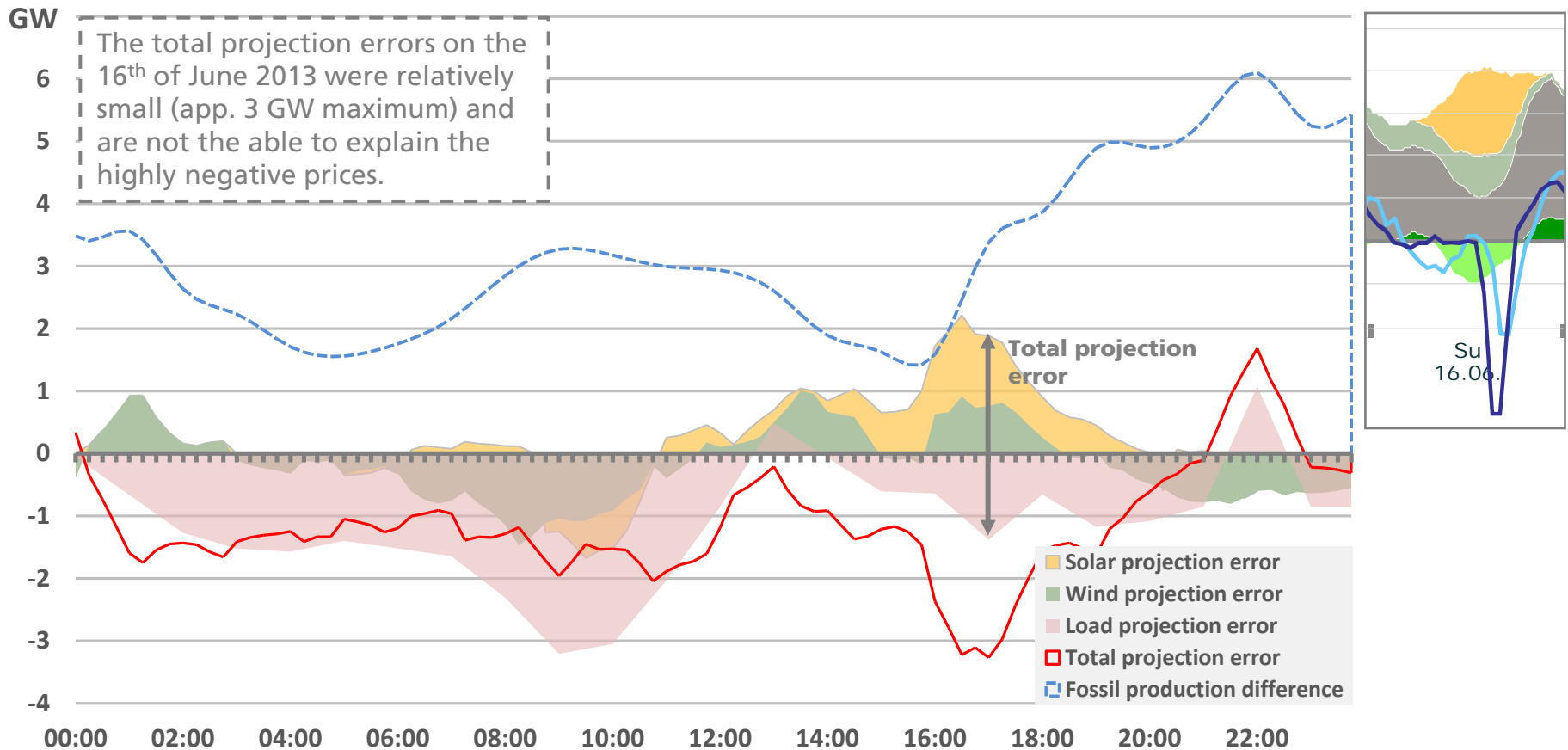
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Negative Spot-Prices on 16.06.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

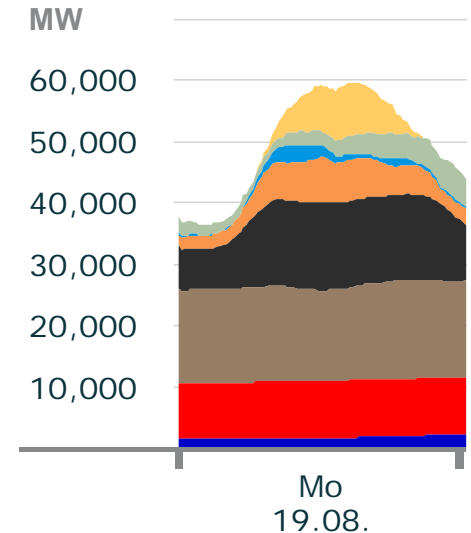
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Day-Ahead Price on 19.08.2013



- The Day-Ahead Spot-Price reached 130 €/MWh between 11am and noon.
- Solar and wind produced app 9 GW of power during this time.
- The total grid load was about 70 GW.
- Projection errors don't explain Day-Ahead Price.
- Utilization ratio of power plants (11:00 – 12:00):



19.08. 11:00-12:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,7 GW	9,1 GW	14,6 GW	13,8 GW	8,6 GW	1,9 GW	1,7 GW	7,3 GW
Plant Utilization*	43,9 %	98,4 %	92,0 %	95,6 %	30,0 %	20,6 %	5,5 %	21,0 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

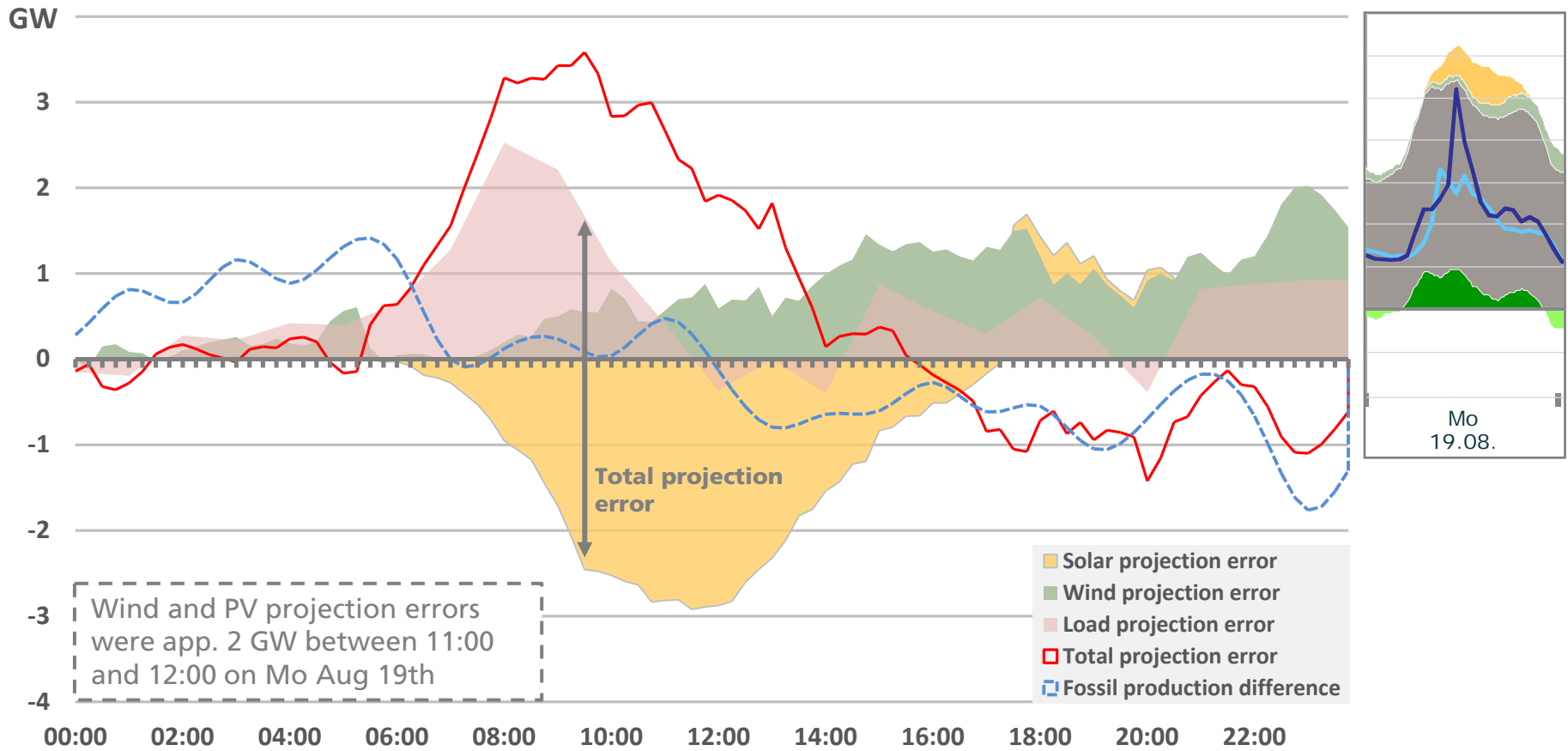
Back to month chart

Back to week chart

Analysis of the Day-Ahead Price on 19.08.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

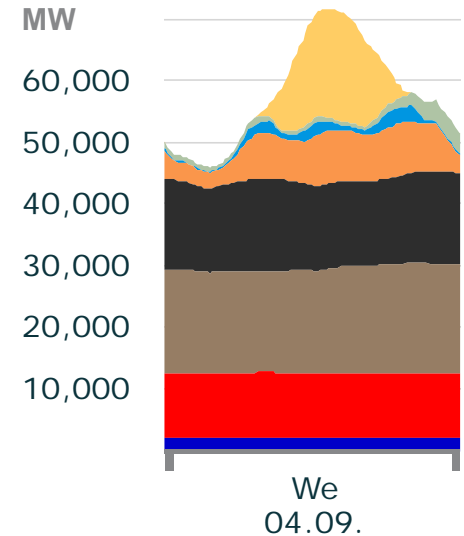
Back to month chart

Back to week chart

Analysis of the Intraday Price on 04.09.2013



- The Intraday Spot-Price reached 154 €/MWh between 9pm and 10pm.
- Wind produced 2,7 GW during this time.
- The total grid load was about 61 GW.
- Projection errors don't explain Intraday Price.
- Utilization ratio of power plants (21:00 – 22:00):



04.09. 21:00-22:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,9 GW	10,4 GW	17,6 GW	14,4 GW	9,2 GW	0,4 GW	2,7 GW	0 GW
Plant Utilization*	48,6 %	98,7 %	97,0 %	84,0 %	34,0 %	4,8 %	8,8 %	0 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

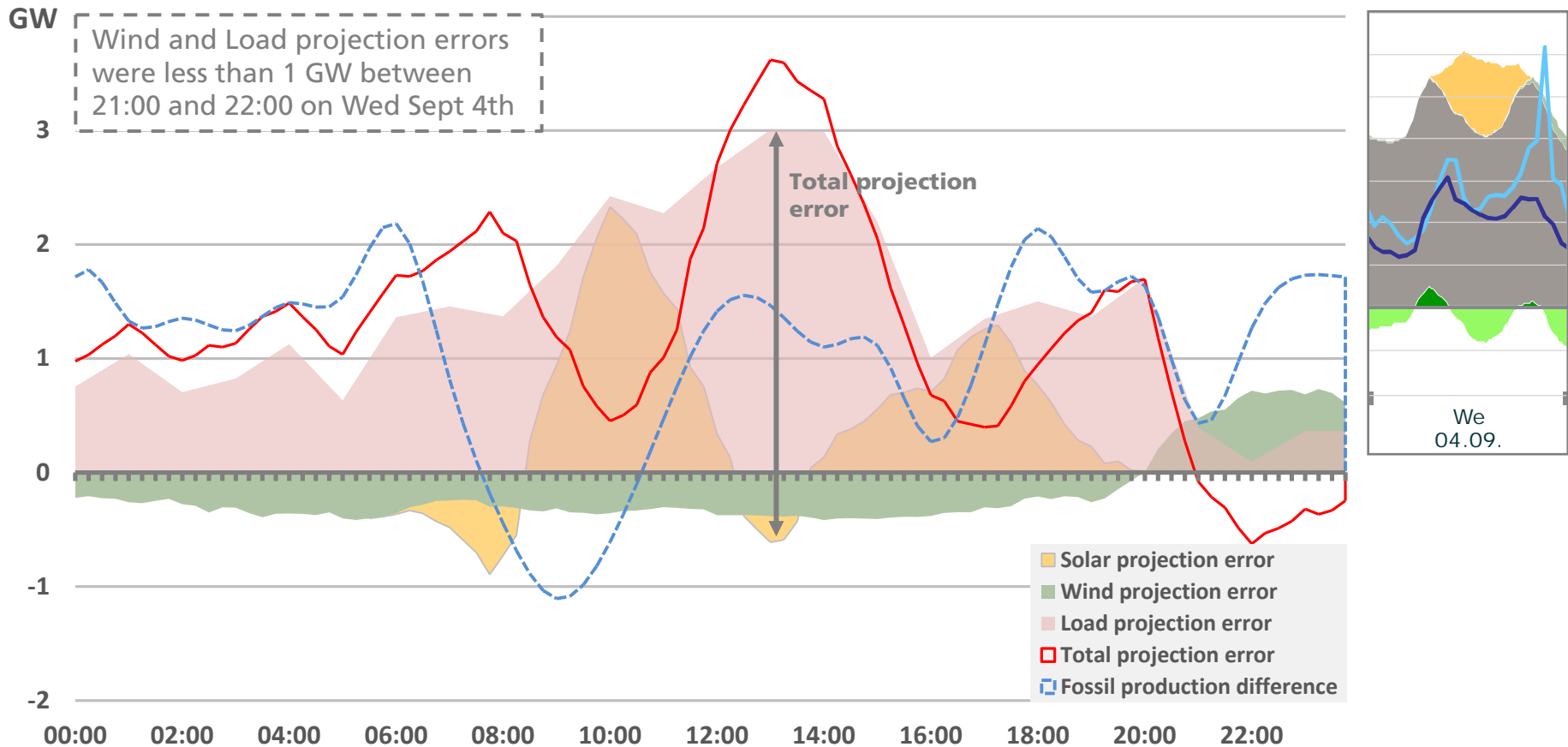
Back to month chart

Back to week chart

Analysis of the Intraday Price on 04.09.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

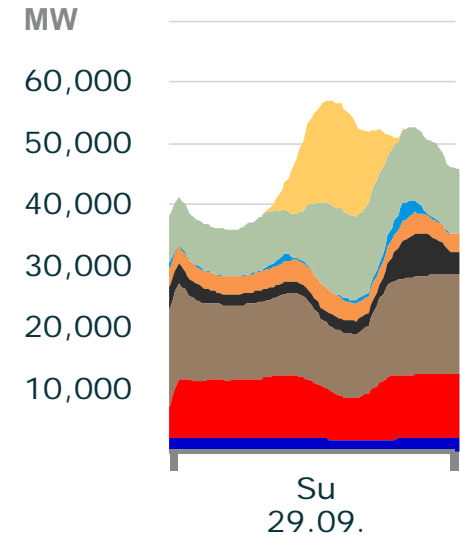
Back to month chart

Back to week chart

Analysis of the Intraday Price on 29.09.2013



- Negative Intraday Spot-Prices occurred between 2 and 6pm, reaching – 48.9 €/MWh (16:00 – 17:00)
- Wind and PV produced app. 25 GW during this time
- The total grid load was about 54 GW
- The total projection error was about 3 GW during this time
- Utilization ratio of power plants (16:00 – 17:00):



29.09. 16:00-17:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,8 GW	8,4 GW	12,6 GW	2,0 GW	3,2 GW	0,8 GW	14,6 GW	8,7 GW
Plant Utilization*	46,0 %	78,0 %	69,0 %	15,5 %	11,2 %	8,6 %	48,0 %	25,2 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

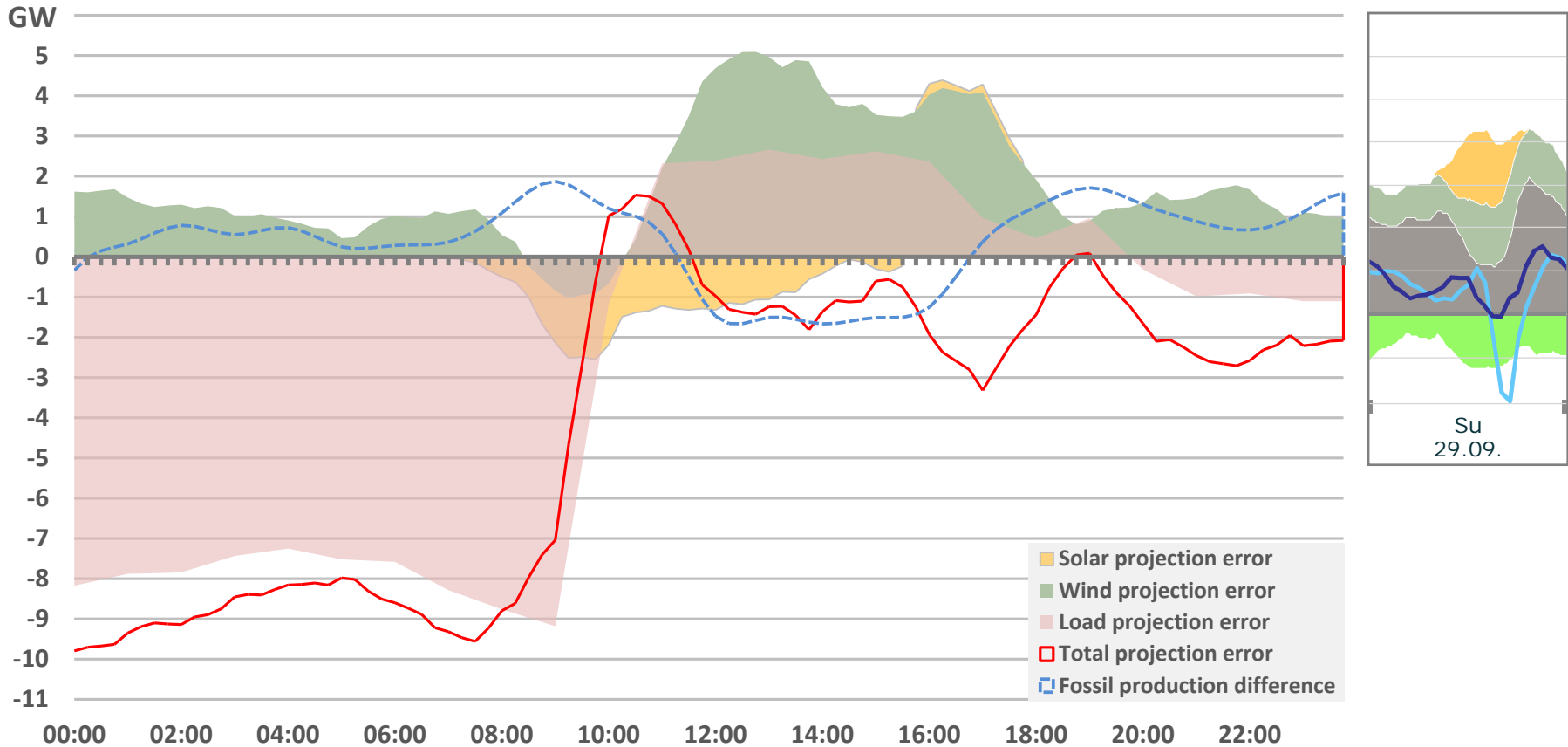
Back to month chart

Back to week chart

Analysis of the Intraday Price on 29.09.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

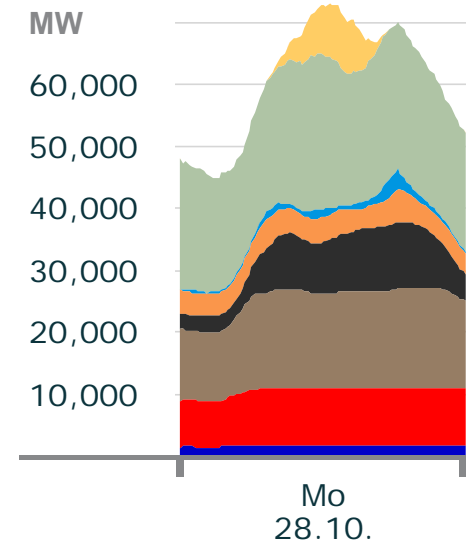
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Day-Ahead Price on 28.10.2013



- Negative Day-Ahead Spot-Prices occurred in the night from Sunday to Monday between 11pm and 4am, reaching – 49.1 €/MWh (02:00 – 03:00)
- Wind produced app. 18 GW during this time
- The total grid load was about 50 GW
- The total projection error was about 2 GW during this time



- Utilization ratio of power plants (16:00 – 17:00):

28.10. 02:00-03:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,6 GW	7,2 GW	11,2 GW	2,5 GW	4,4 GW	0,08 GW	18,4 GW	0 GW
Plant Utilization*	40,6 %	67,6 %	60,6 %	12,2 %	15,6 %	0,9 %	60,2 %	0,0 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

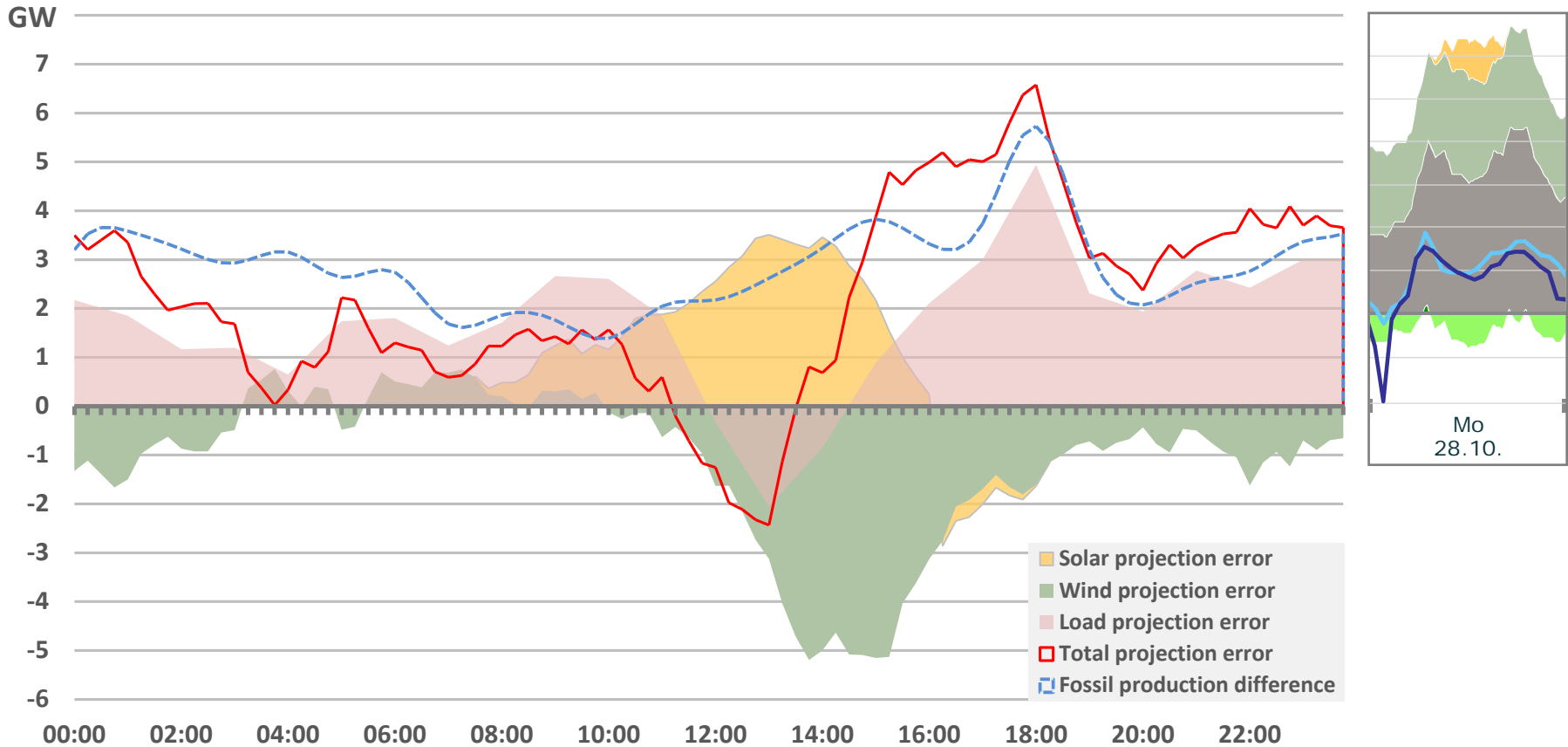
Back to month chart

Back to week chart

Analysis of the Day-Ahead Price on 28.10.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

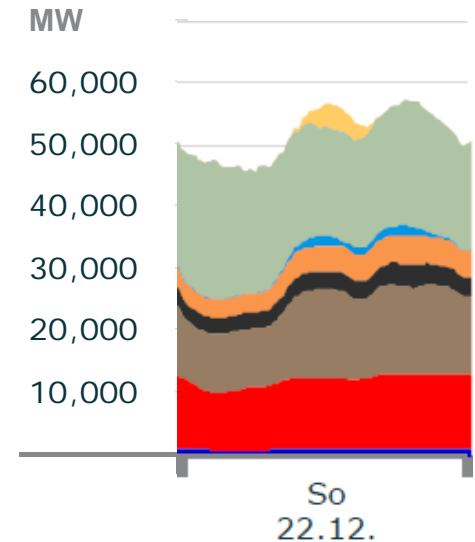
[Back to month chart](#)

[Back to week chart](#)

Analysis of the Day-Ahead Price on 22.12.2013



- Negative Spot-Prices occurred in the night from Sunday to Monday between midnight and 8am, reaching Day-Ahead prices of – 44.7 €/MWh (06:00 – 07:00)
- Wind produced app. 20 GW during this time
- The load projection error is not yet available in the data set of entsoe.net
- Utilization ratio of power plants (06:00 – 07:00):



22.12. 06:00-07:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,0 GW	10 GW	9,5 GW	2,6 GW	3,1 GW	0,09 GW	19,9 GW	0 GW
Plant Utilization*	27,5 %	83 %	54,6 %	14,6 %	12,2 %	0,9 %	65,1 %	0,0 %

*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

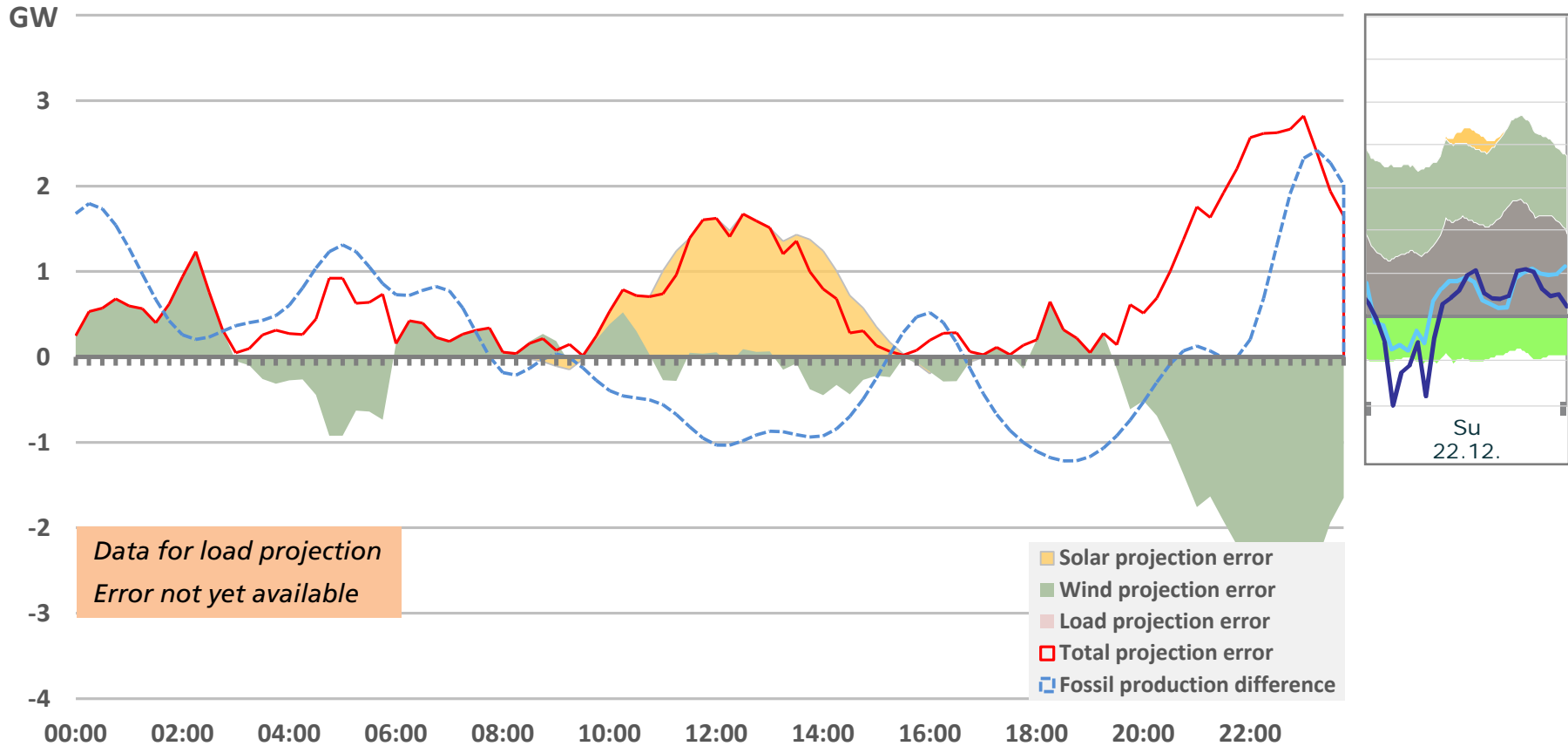
Back to month chart

Back to week chart

Analysis of the Day-Ahead Price on 22.12.2013



Actual production/load minus projected production/load (from day before)



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

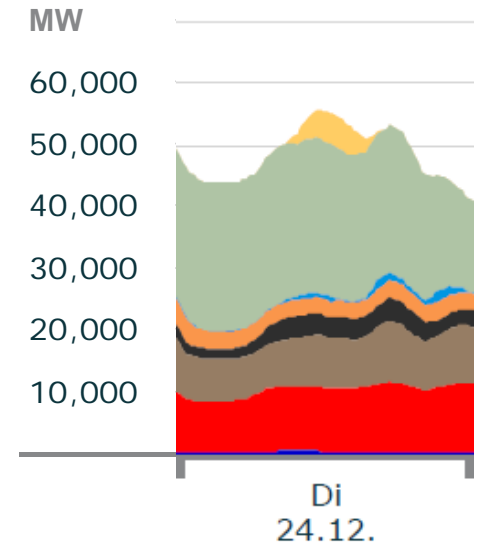
Back to month chart

Back to week chart

Analysis of the Day-Ahead Price on 24.12.2013



- Zero and negative Spot-Prices occurred in the night of Christmas Eve between midnight and 2pm, reaching – 51.5 €/MWh (04:00 – 05:00)
- Wind produced app. 24 GW during this time
- The load projection error is not yet available in the data set of entsoe.net
- Utilization ratio of power plants (04:00 – 05:00):



24.12. 04:00-05:00	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production	1,0 GW	8,2 GW	6,7 GW	1,7 GW	2,7 GW	0,05	23,7 GW	0 GW
Plant Utilization*	25,5 %	68,8 %	38,3 %	7,9 %	10,2 %	0,6 %	77,6 %	0,0 %

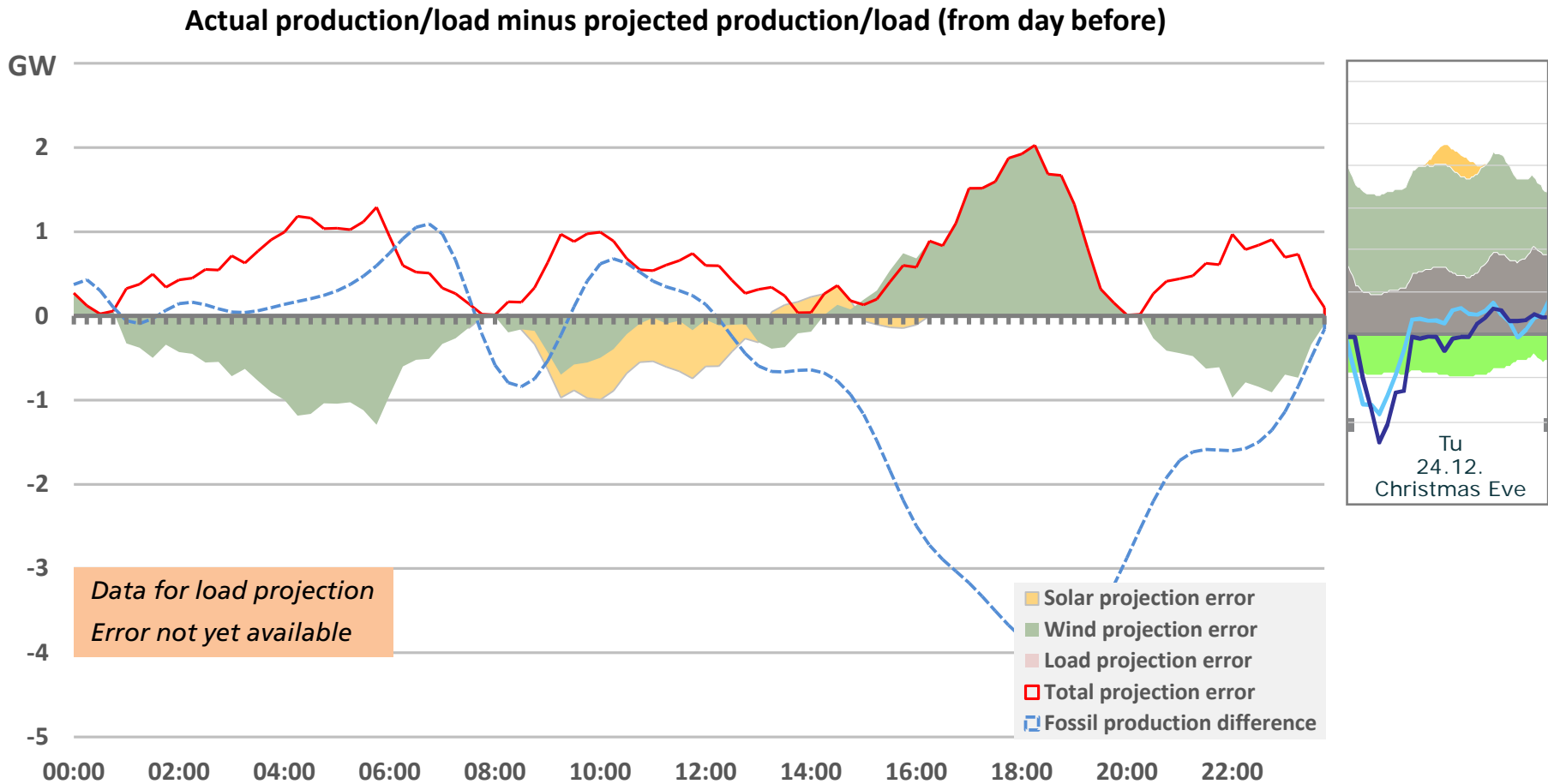
*compared to available capacity

Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX

Back to month chart

Back to week chart

Analysis of the Day-Ahead Price on 24.12.2013



Source: Johannes Mayer, Fraunhofer Institute for Solar Energy Systems; Data: EEX, Entso-E

[Back to month chart](#)

[Back to week chart](#)

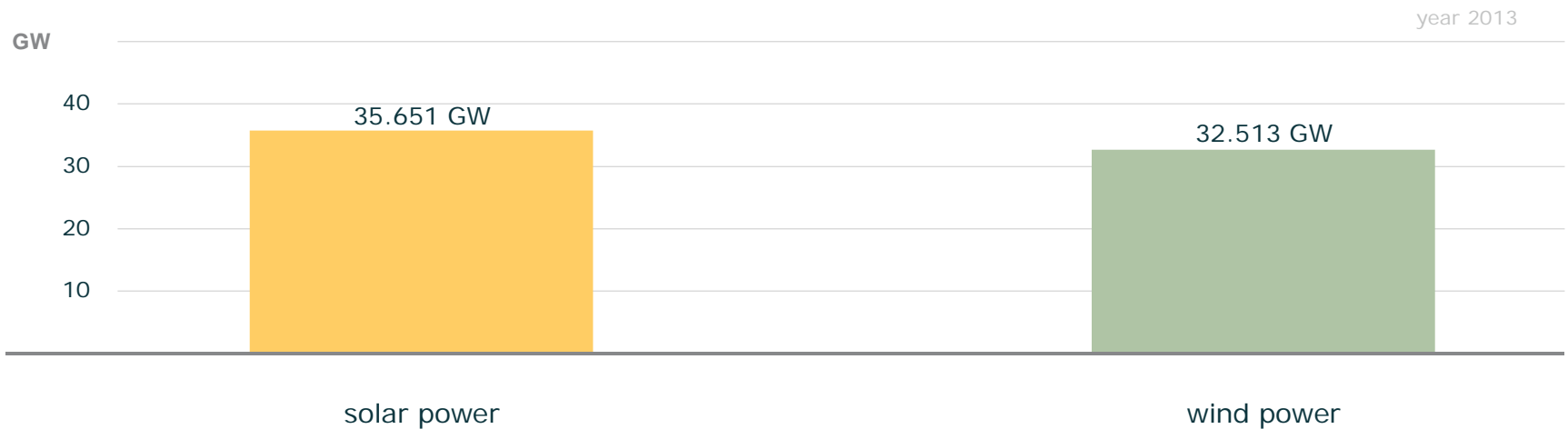
AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer

Installed solar and wind power, 16.10.2013



Installed solar and wind power

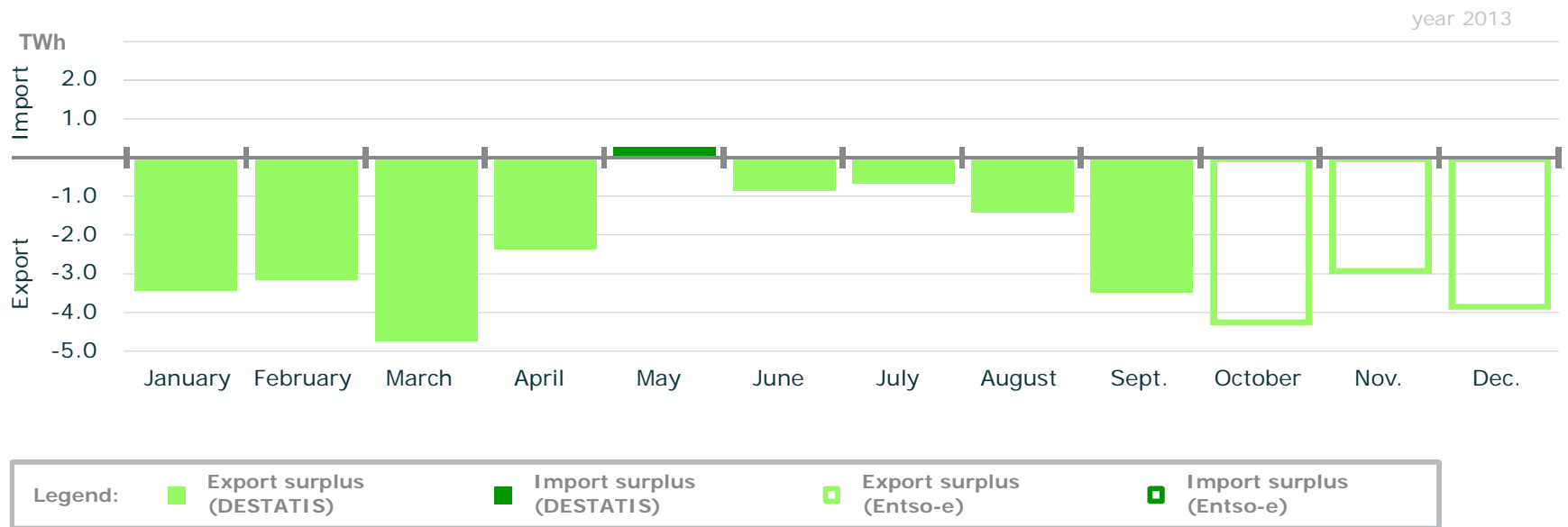


Source: Bruno Burger, Fraunhofer ISE, Data: Bundesnetzagentur

Electricity Import-Export-Balance



Electricity Export and Import Balance

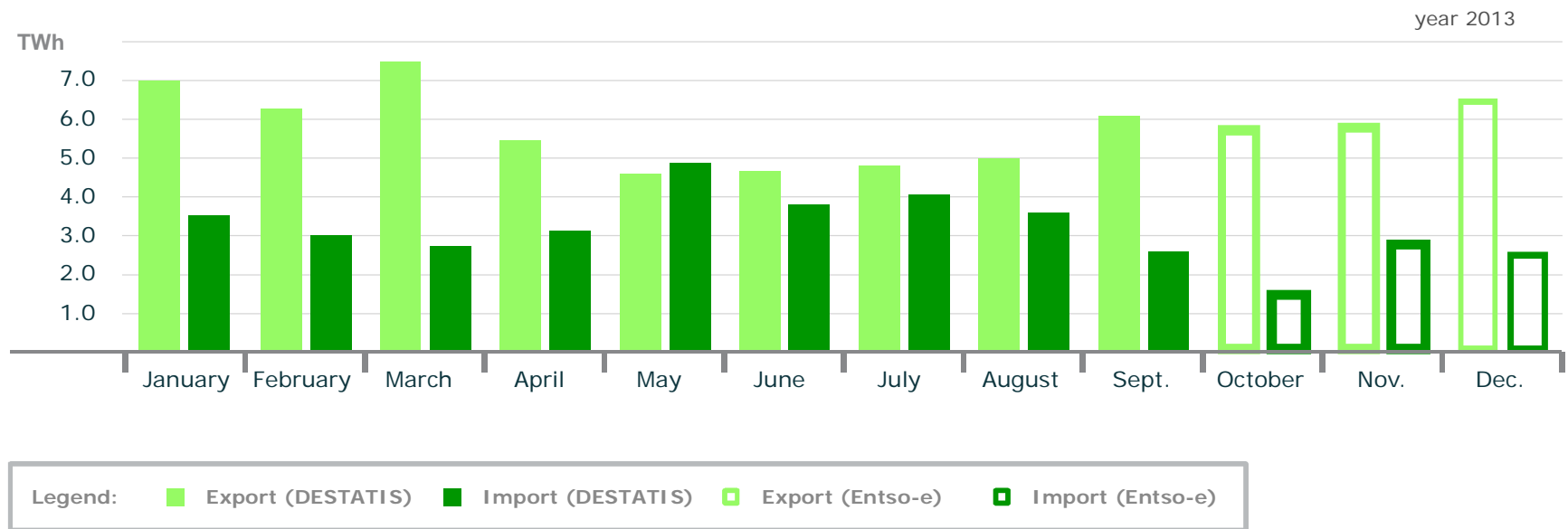


Source: Bruno Burger, Fraunhofer ISE, Data: BMWi Energiedaten (-2011); DESTATIS (2012); Entso-e (2013, skaliert)

Electricity Import-Export-Balance



Electricity Export and Import



Source: Bruno Burger, Fraunhofer ISE, Data: BMWi Energiedaten (-2011); DESTATIS (2012); Entso-e (2013, skaliert)

AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer



- The presentation is designed to provide an overview of the German electricity market by visualization of important market parameters (electricity production from conventional and renewable sources, import-export data and electricity spot market prices).
- Basis: Legal obligation for utility companies to publish production and consumption data since 2003 (European regulation EG 1228/2003)

Instructions



- The production time series of conventional power sources in this presentation refer to the net production of power plants greater 100 MW. Self consumption of the power plants and transfer losses are not included. Hence the total sum of conventional production differs from the gross electricity production listed by other sources (i.e. dSTATIS).
- The period mean value is calculated as volume weighted average for **Day-Ahead-Spot-Prices** and **Intraday-Spot-Prices**.

€/ MWh	Period Mean	Period Min	Period Max	Trading / GWh
Day-Ahead				
Intraday				

Instructions



- The abbreviations in the table below represent the following energy sources:

English:

Legend:	■ Run of River	■ Uranium	■ Brown Coal	■ Hard Coal	■ Gas	■ Pumped Storage	■ Wind	■ Solar
---------	--	--	---	--	---	--	---	---

German:

Legende:	■ Laufwasser	■ Kernenergie	■ Braunkohle	■ Steinkohle	■ Gas	■ Pumpspeicher	■ Wind	■ Solar
----------	--	--	---	---	---	--	---	---

	RoR	Uran	BC	HC	Gas	PSt	Wind	Solar
Production								
Plant Utilization*								



- We are working hard on constantly improving the quality and significance of the information given in this presentation.
- Therefore we look forward to your critical comments and ideas for further analysis.

Contact:

Johannes Mayer

johannes.nikolaus.mayer@ise.fraunhofer.de

AGENDA

- General Spot-Price Analysis
- Electricity Production and Spot-Prices
 - Analysis by month
 - Analysis by Week
- Analysis of Spot-Prices Extremes
- General energy data
- Instructions
- Sources and Disclaimer



- Production Data: <http://www.transparency.eex.com/de/>
- Electricity Spot Prices: <http://www.eex.com/de/Downloads>
- Import-Export Data: <http://www.entsoe.eu/>
- Load Data: <http://www.entsoe.eu/>
- Monthly Production Data: <https://www.destatis.de>
- Total Installed Capacity by Source: <http://www.bundesnetzagentur.de>

Interested in Detailed Electricity Production Time Series?

We also publish slides with detailed time series on the electricity production by source (run-of-river, nuclear, brown coal, hard coal, gas, solar, wind, ...). The slides also show further analysis on the electricity import-export balance, supplement of PV and wind production, intraday production profiles etc.

2013:

<http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/news/electricity-production-from-solar-and-wind-in-germany-in-2013.pdf>

2012:

<http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/news/electricity-production-from-solar-and-wind-in-germany-in-2012.pdf>

2011:

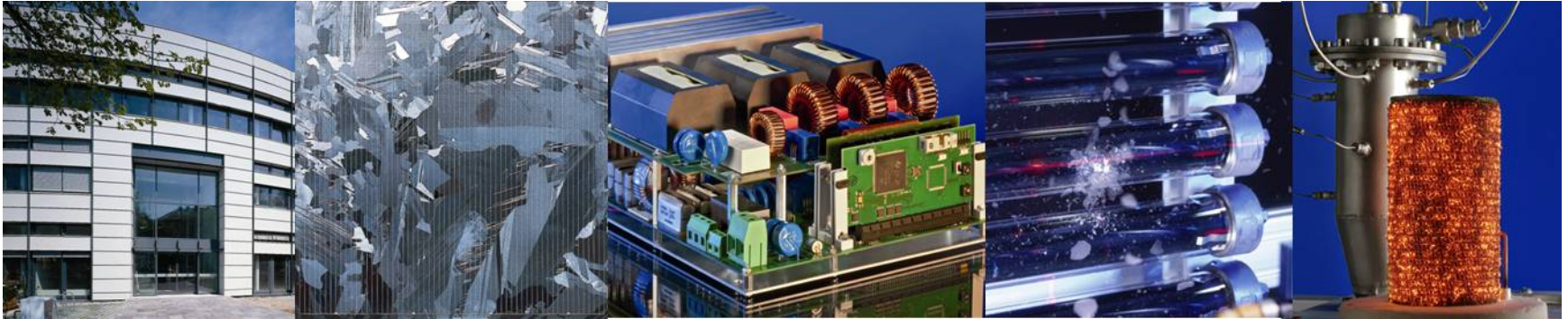
<http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/news/electricity-production-from-solar-and-wind-in-germany-in-2011.pdf>

Disclaimer of Liability



The content of this slides has been carefully prepared and reviewed. However, the Fraunhofer Institute of Solar Energy Systems (ISE) does not guarantee the accuracy, completeness or quality of the information provided, or that it is up-to-date. Liability claims against the Fraunhofer ISE in respect of material or immaterial damage caused by the use or non-use of the information offered or by inaccurate or incomplete information are in principle ruled out provided that there is no provable culpable intent or gross negligence on the institute's part.

Thank-you for your attention!



Fraunhofer Institute for Solar Energy Systems ISE

Dipl.-Phys.oec Johannes Mayer

www.ise.fraunhofer.de

Tel.: 0049 (0)761 – 4588 5949

johannes.nikolaus.mayer@ise.fraunhofer.de