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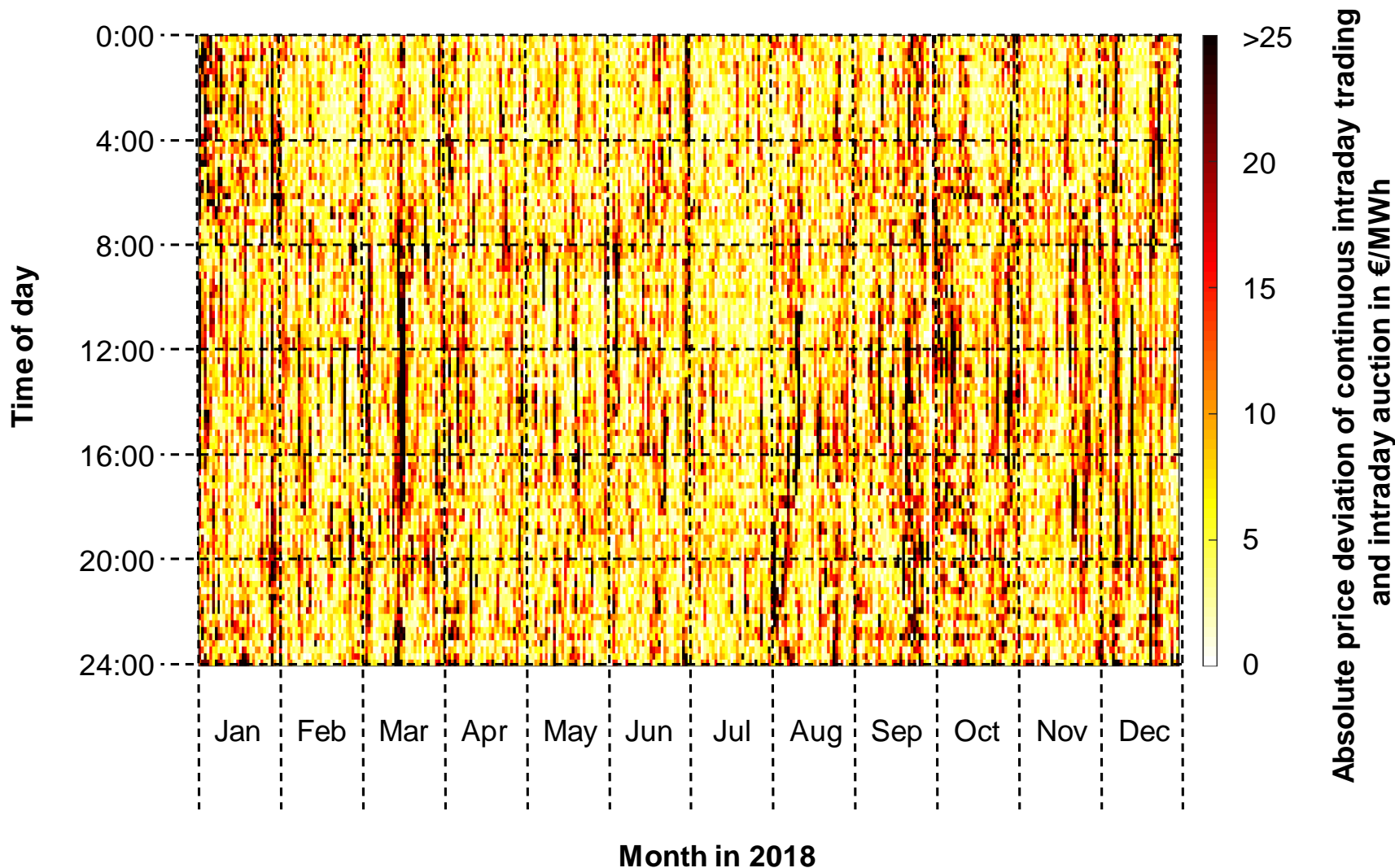
**The value of
intraday electricity trading –
Evaluating situation-dependent
opportunity costs of flexible assets**

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28.08.2019

2019

Analysis of Intraday Trading in 2018

Absolute price deviation of continuous intraday trading and intraday auction



- Representation of the absolute deviation from mean continuous intraday price (ID3) and intraday auction price in 2018
- Hardly any seasonal or hourly dependency can be recognized

Are the average revenues in continuous intraday market situation-dependent?

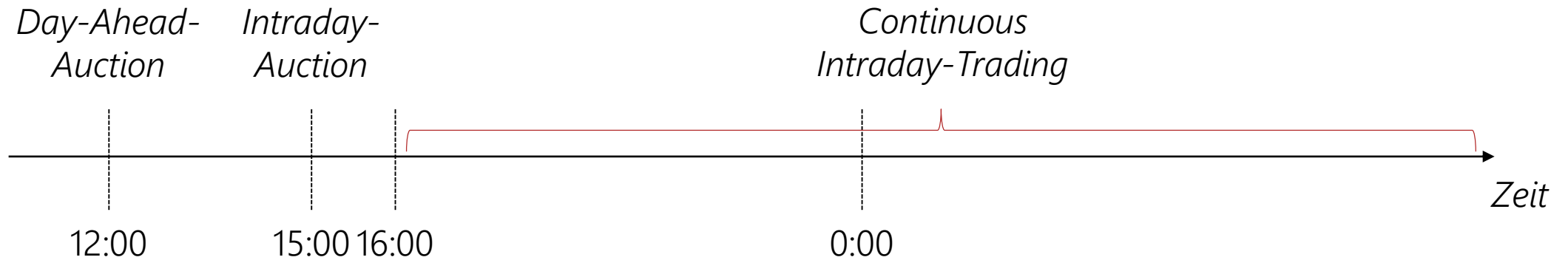
Outline

Methodology for determining average revenues in the continuous intraday market

Factors influencing the level of intraday revenue opportunities

Conclusion and use of the findings

When is an electricity offering decision made in which market?



- Research topic:
What revenue opportunities arise from continuous intraday trading?

Methodology for determining revenue opportunities in the continuous intraday market

Approach according to Weber et al.*:
Prices in the continuous intraday market develop according to a stochastic process and price changes are normally distributed.

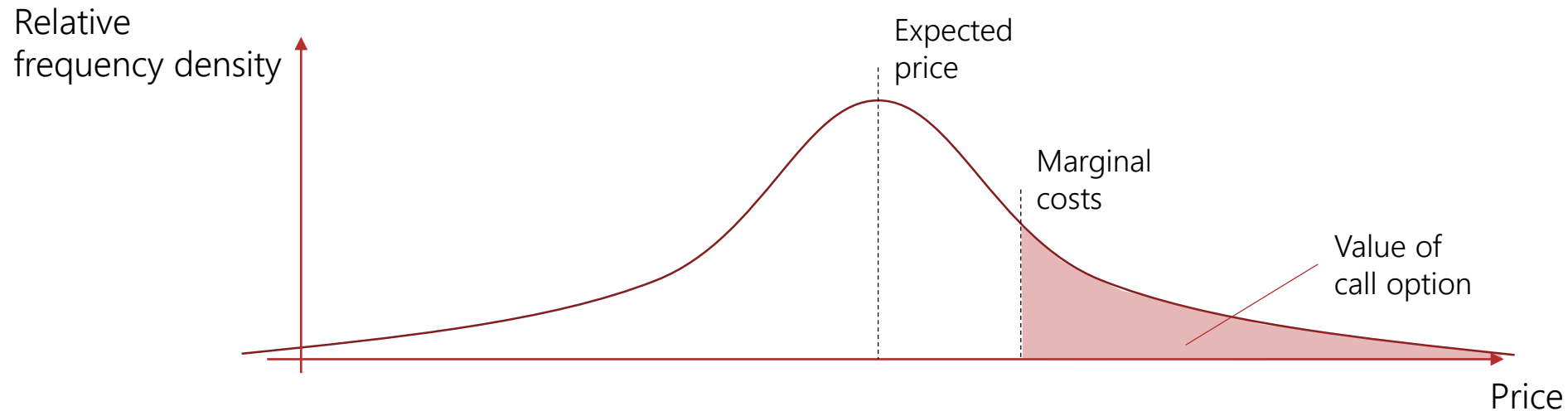


Approach
according to
Weber et al.*:

Determination of the value of the intraday revenues by five parameters:

1. Distribution function of price changes (in Weber et al. Normal distribution)
2. The standard deviation σ the distribution
3. The expected value of the intraday price p at the time of evaluation
4. The marginal costs X
5. The amount of electricity offered

Methodology for determining revenue opportunities in the continuous intraday market

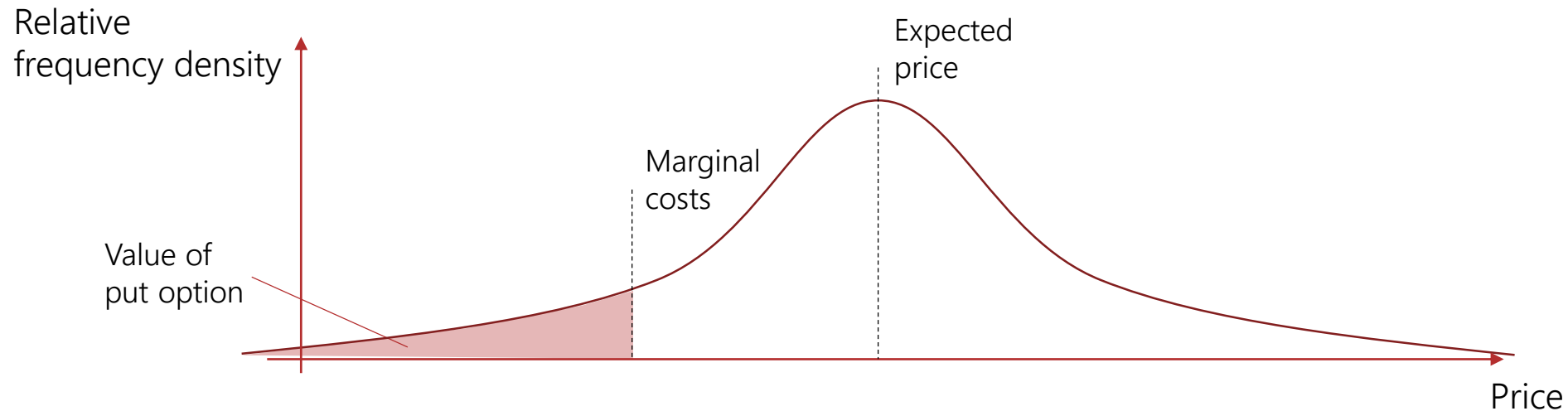


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Methodology for determining revenue opportunities in the continuous intraday market



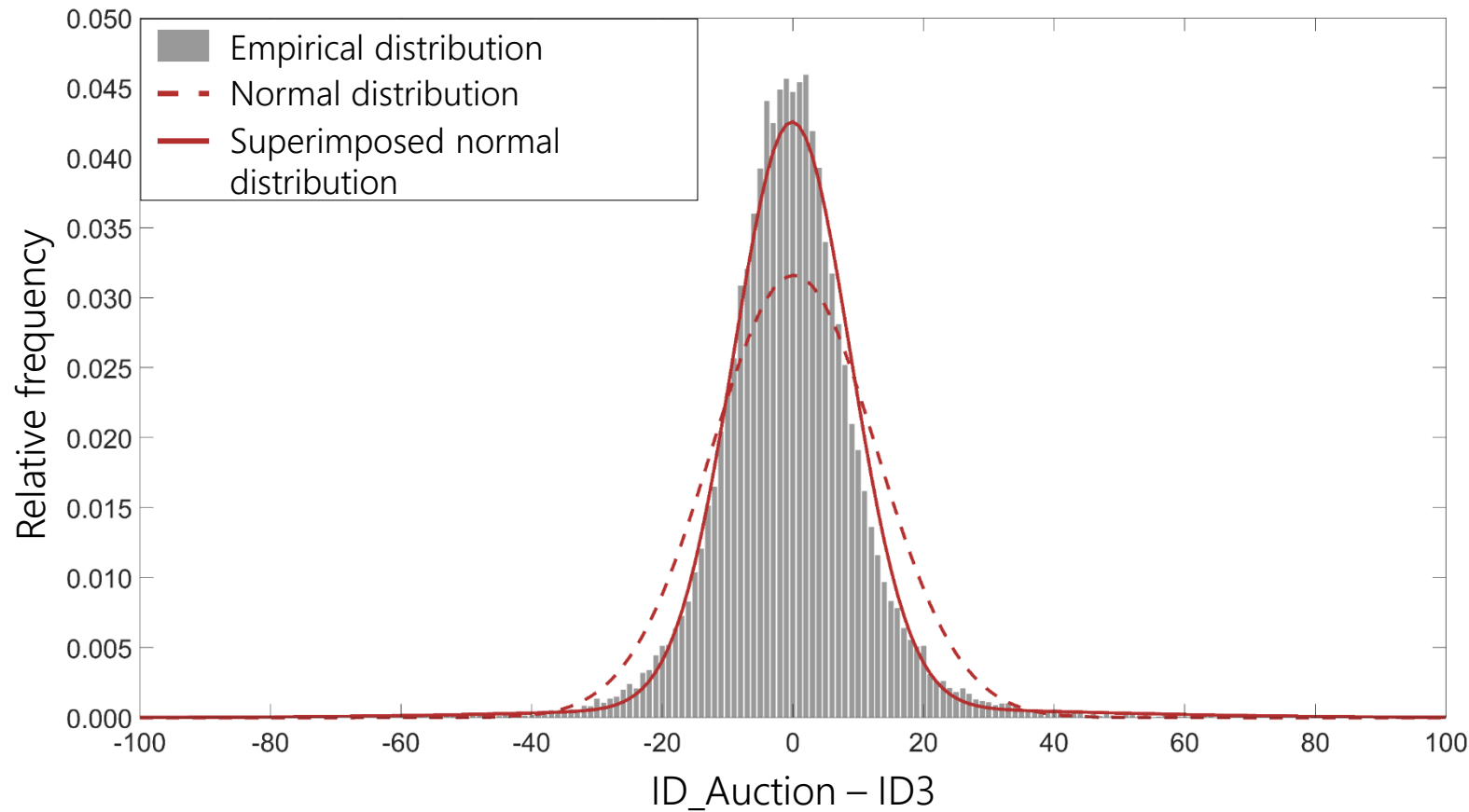
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Assumption Weber et al.:
Price changes are distributed normally

Distribution of price changes from intraday auction to continuous intraday trading



Consideration of all quarter-hours of the year 2018

- Price differences show normal distributed characteristics only in strongly simplified assumption
- Distribution function from two superimposed normal distributions represents empirical distribution much better

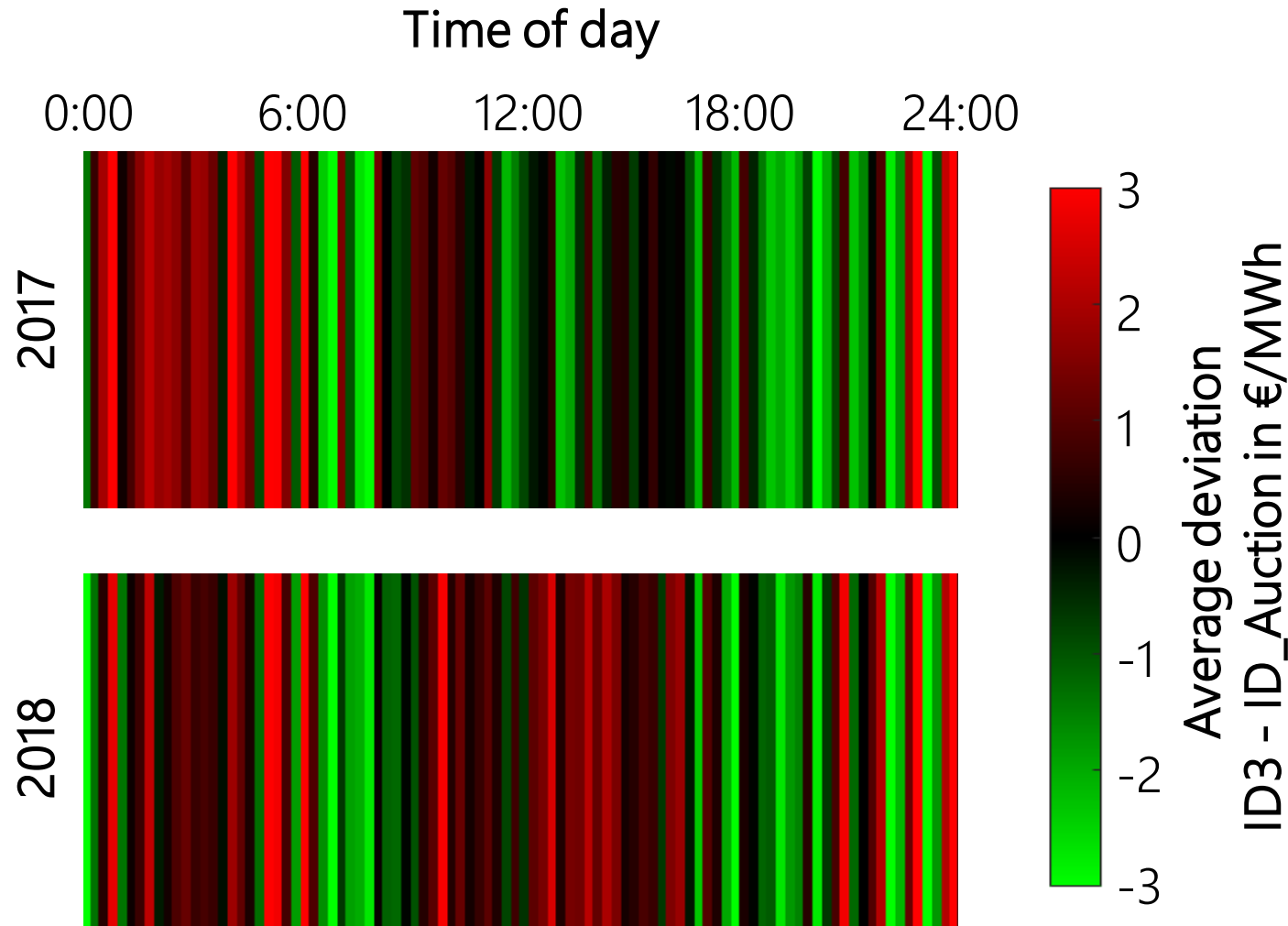
➔ Use of the superimposed normal distribution function

ID_Auction = Price intraday auction

ID3 = volume weighted average price of the last three hours in continuous intraday trading

Assumption Weber et al.:
The expected value of continuous intraday trading
corresponds to the intraday auction value*.

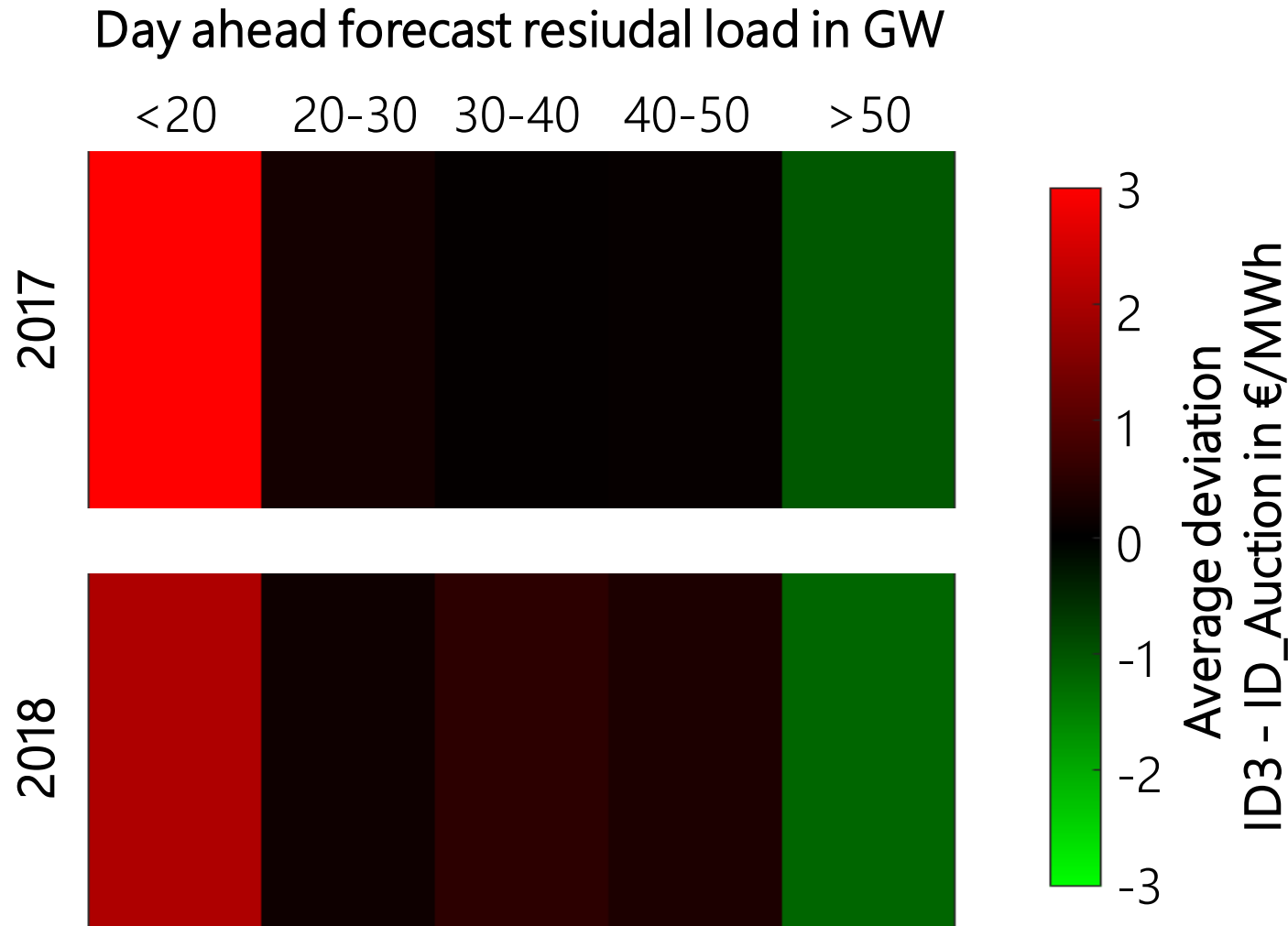
Impact of daytime on expectation of intraday prices



Consideration of all quarter-hours of the year 2018

- Slight day/night price dependence can be assumed
- When looking at individual quarter-hours, it is difficult to identify dependencies
- ➔ Average, expected price deviation of zero seems to be reasonable

Impact of day ahead residual load forecast on expectation of intraday prices



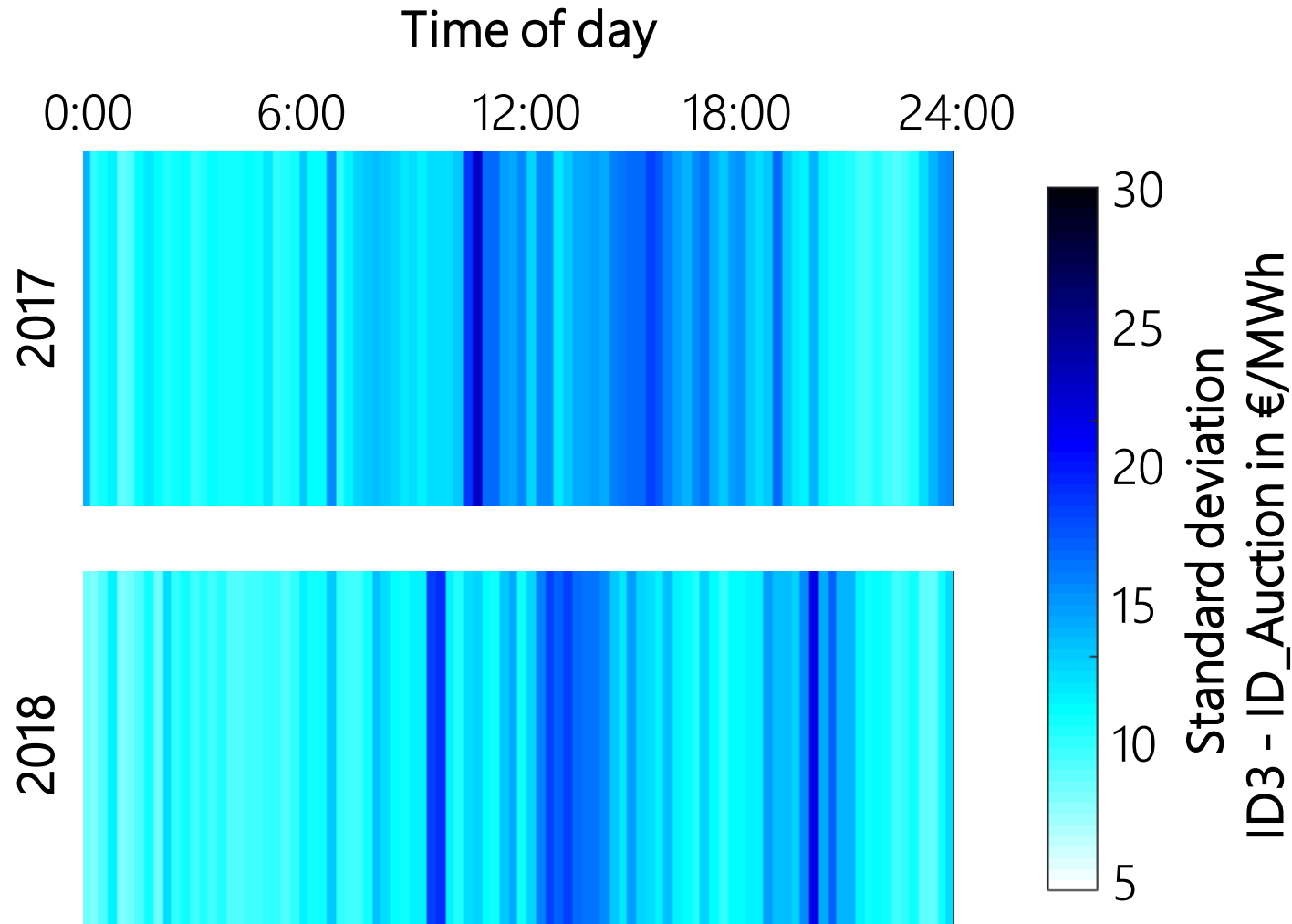
Consideration of all quarter-hours of the year 2018

- Higher expected continuous intraday prices for low residual load forecast
 - Lower expected continuous intraday prices for high residual load forecast
- ➔ Residual load dependent average price deviation has impact on expected revenues of continuous intraday trading

Assumption Weber et al.:
The standard deviation* for each quarter-hour product
should be calculated once a month

* Of the deviation between the volume-weighted prices of the last three hours before close of trading and the prices of the intraday opening auction

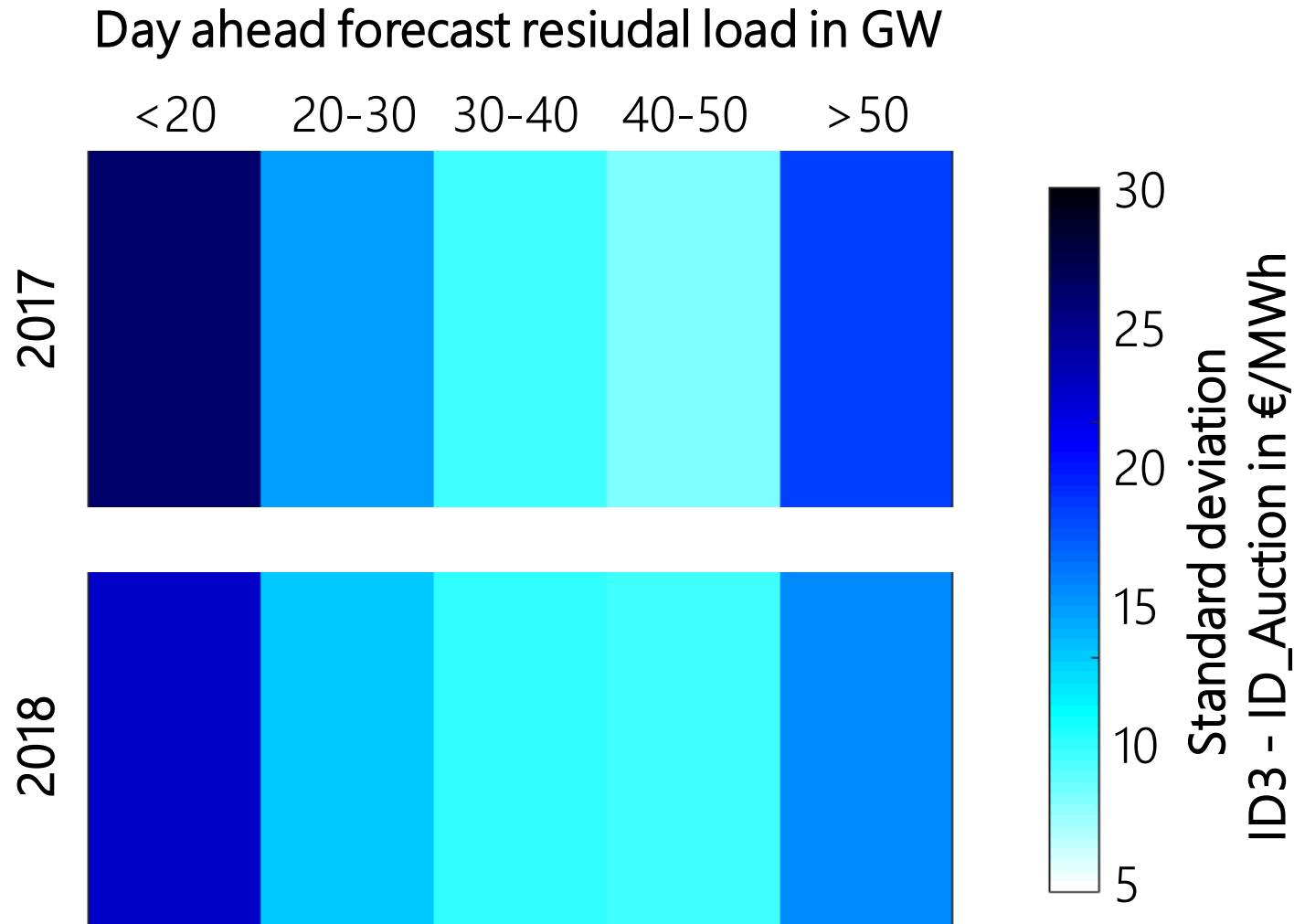
Impact of daytime on standard deviation of intraday prices



Consideration of all quarter-hours of the year 2018

- Slight day/night price uncertainty can be assumed
 - When looking at individual quarter-hours, it is difficult to identify specific uncertainties of prices
- ➔ From empirical data it is not reasonable to use specific standard deviations for specific day times

Impact of day ahead residual load forecast on standard deviation of intraday prices



Consideration of all quarter-hours of the year 2018

- High price uncertainty for very low and high residual load forecasts
 - Low price uncertainty for moderate residual load forecasts
- ➔ Residual load forecast has huge impact on price uncertainty of continuous intraday prices

Evaluation of situation-dependent revenues at continuous intraday trading

Exemplary investigation

- Biogas plant
- Marginal costs: 60 €/MWh
- Electricity price in the intraday auction: 59 €/MWh

High residual load forecast

1 Expectation value: 59 €/MWh
Standard deviation: 18 €/MWh



Average expected revenues in continuous intraday trading

6,7 €/MWh

Low residual load forecast

2 Expectation value: 61 €/MWh
Standard deviation: 23 €/MWh



10,2 €/MWh

Moderate residual load forecast

3 Expectation value: 59 €/MWh
Standard deviation: 9 €/MWh



3,1 €/MWh

Expected revenues at continuous intraday trading vary strongly in dependence of residual load forecast!



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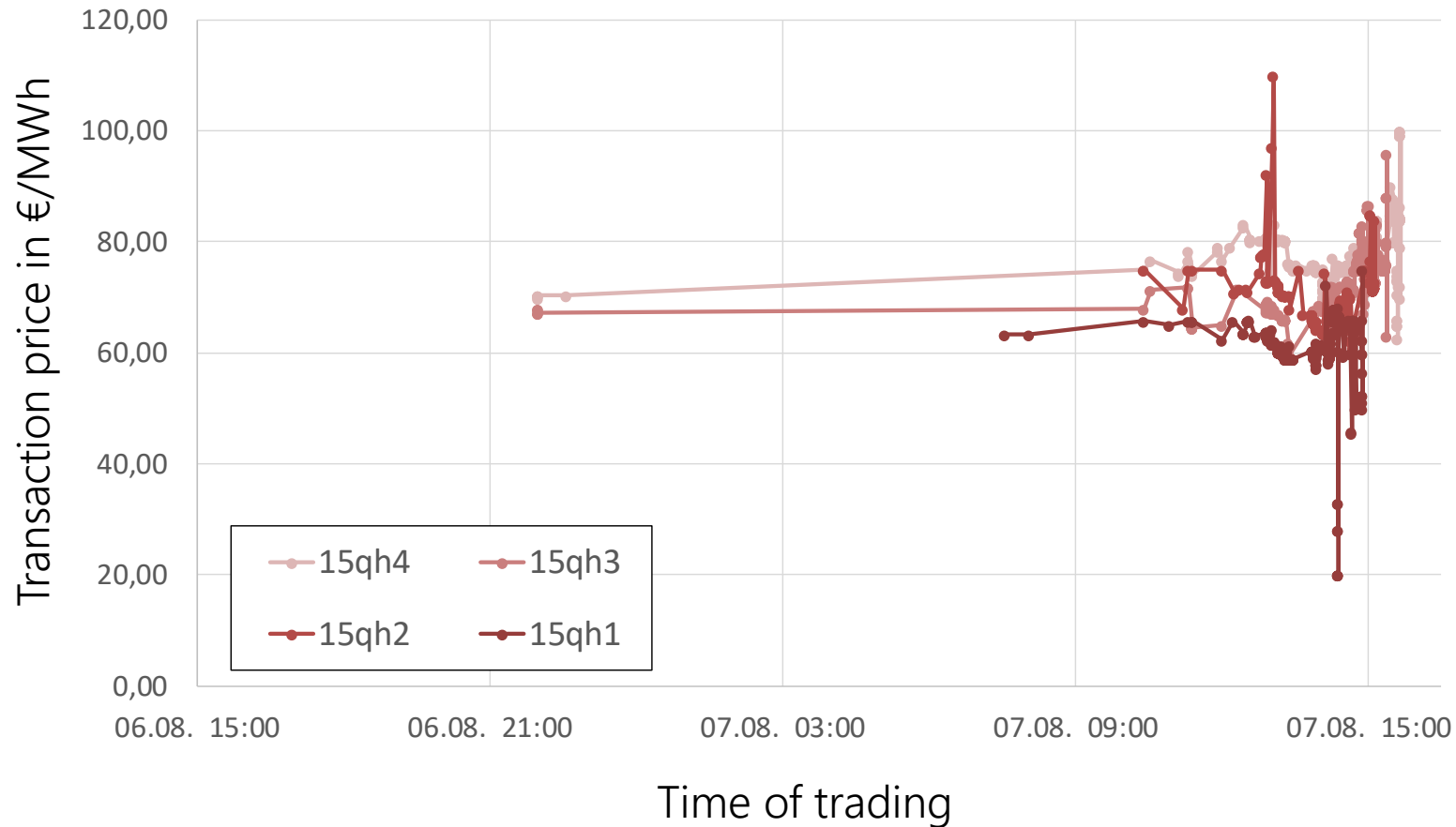
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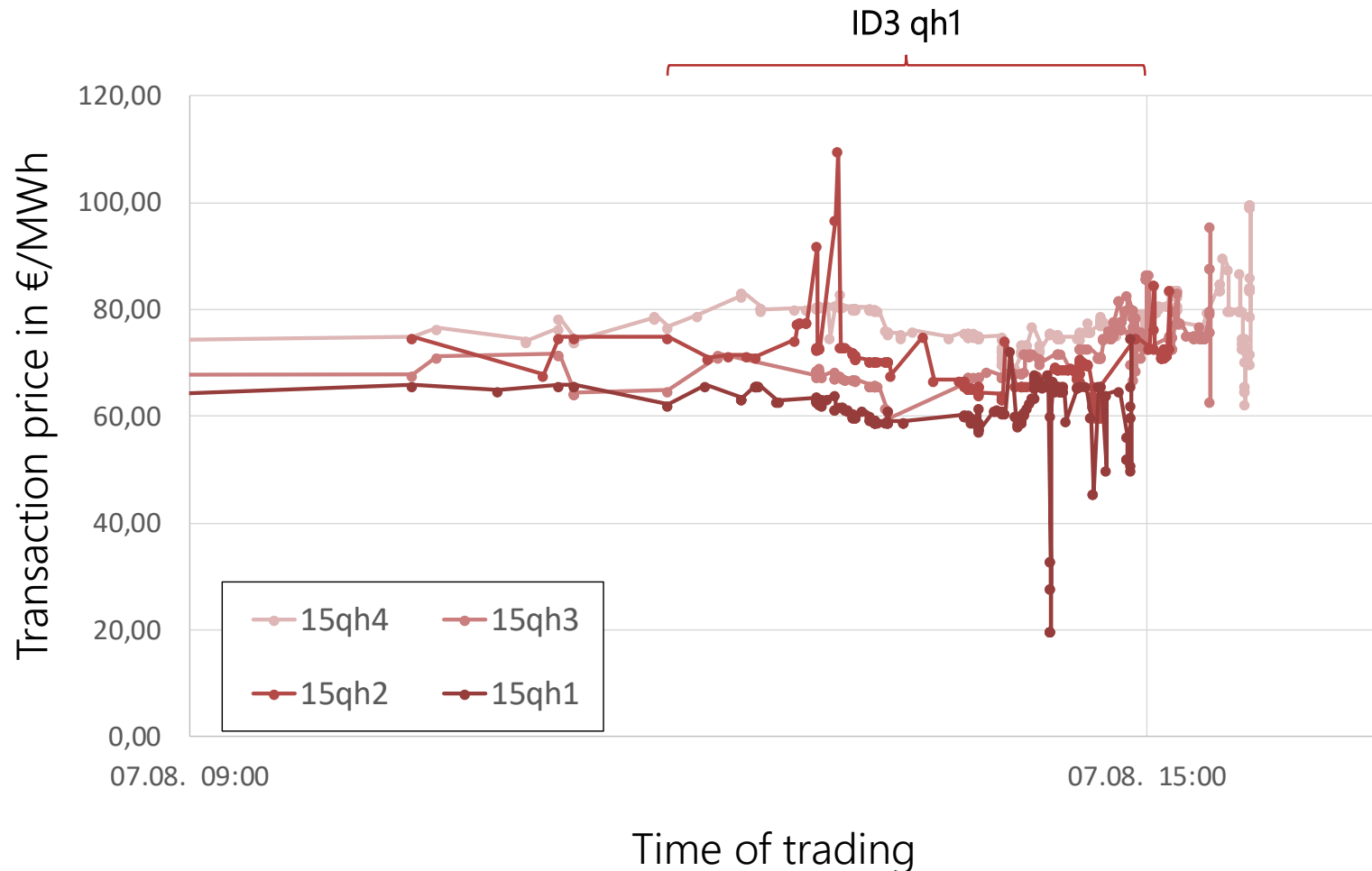
Analysis of price structures of the cont. Intraday trading



Characteristics of continuous intraday prices

- Trading takes place mainly in the three hours before delivery
- Partly high volatility

Analysis of price structures of the cont. Intraday trading

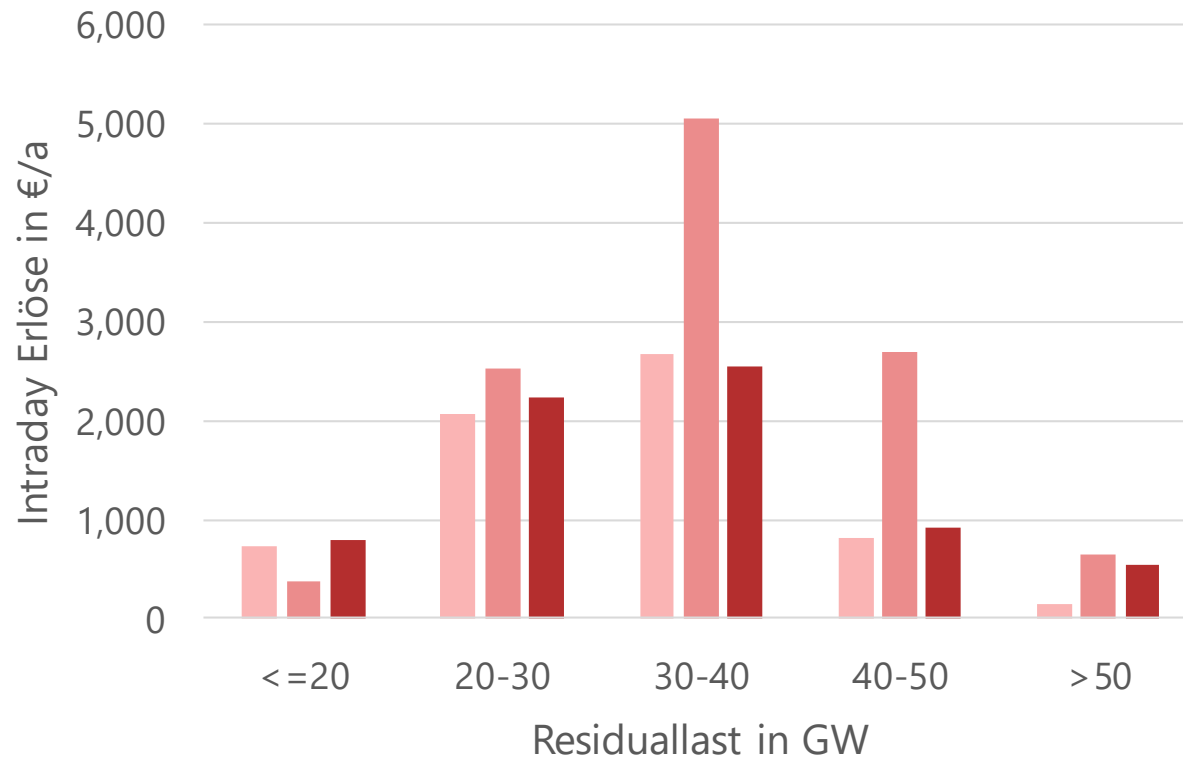


Characteristics of continuous intraday prices

- Trading takes place mainly in the three hours before delivery
- Partly high volatility
- For the analysis of continuous intraday trading, product ID3 is evaluated (volume weighted average price of the last three hours in continuous intraday trading).

Wie gut werden reale Erlöse auf dem kontinuierlichen Intraday-Markt durch Verteilungsfunktionen repräsentiert?

Reale und simulierte Erlöse im kontinuierlichen Intraday Handel in 2018



- Reale Erlöse
- Normalverteilung
- Situationsabhängige, überlagerte Normalverteilung

Exemplarische Analyse:

- Leistung: 1 MW
- Variablen Grenzkosten: 30 €/MWh
- Erstellung Verteilungsfunktionen an Daten aus 2017
- Simulation der Erlöse im Jahr 2018

Modellierte Erlöse der überlagerten, situationsabhängigen Verteilungsfunktion trifft reale Erlöse wesentlich besser als die der Normalverteilung

Fazit und Nutzung der Erkenntnisse

Welche Parameter sind für eine Intraday-Optionalität entscheidend?

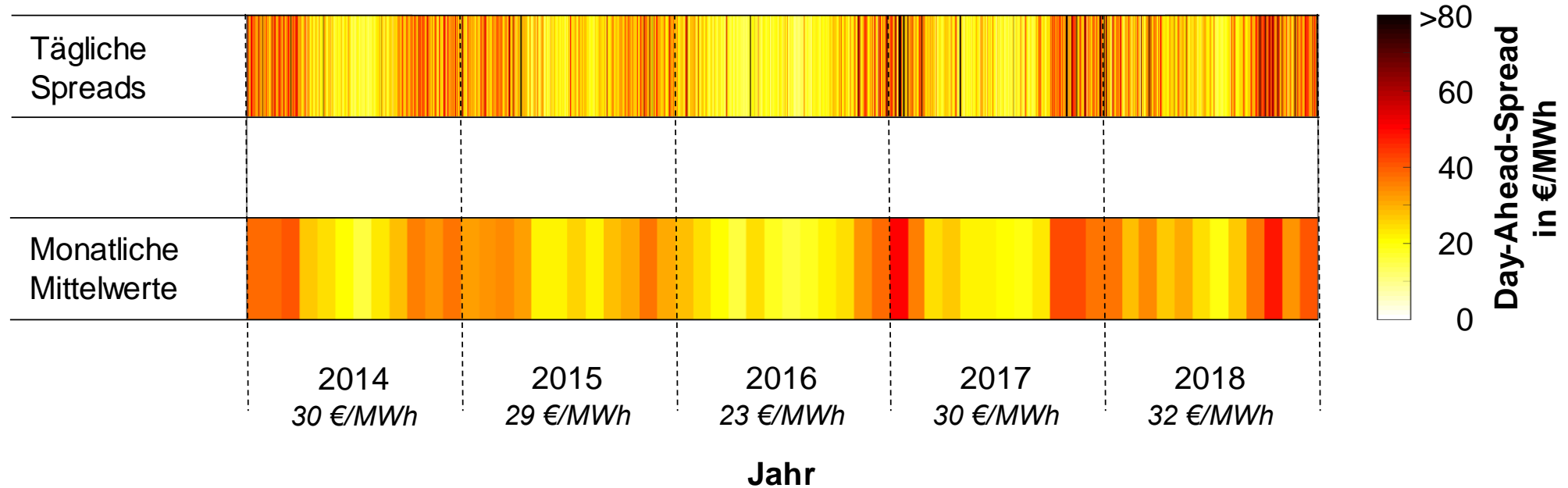
- 1) Verteilungsfunktion der Preisänderungen (in Weber et al. Normalverteilung)
- 2) Den Erwartungswert des Intraday-Preises p bei Fälligkeit der Option
- 3) Die Standardabweichung σ der noch unbekanntes Intraday-Preise
- 4) Die variablen Kosten X bei einem thermischen Kraftwerk
- 5) Die zu vergütende Leistung

Wie charakterisieren sich diese Parameter?

- Klare Abhängigkeit der Standardabweichung von Windenergieprognosen/Residuallastprognosen
 - Auch Erwartungswert des kontinuierlichen Intradayhandels mit residuallastsabhängigen Schwankungen
- Preisänderungen gut repräsentiert durch situationsabhängige, überlagerte Verteilungsfunktion

Durch das Verfahren können situationsabhängige Opportunitäten für den kontinuierlichen Intraday-Markt bestimmt werden, um die Einsatzentscheidung von Flexibilitäten auf anderen Märkten zu optimieren

Analyse der Spreads im Day-Ahead-Markt



Methodik & Erkenntnisse

- Darstellung der maximalen, täglichen Spreads der letzten 5 Jahre
- Variation der Spreads zwischen 7 und 150 €/MWh
- Saisonales Profil mit höheren Preisunterschieden in den Wintermonaten
- Schwankungen der durchschnittlichen, jährlichen Spreads wesentlich geringer als Schwankungen des Spotpreises (2017: 34,2 €/MWh; 2018: 44,5 €/MWh)