

Introduction

- **In Appendix 1, you'll find slides giving examples of how the Closing Prices for financial contracts can change during the contracts' trading period.**
- **In appendix 2, you'll find a list of the terms and acronyms used in this presentation.**
- **Concerning the documents referred to in this presentation:**
 - ✓ **At *houmollerconsulting.dk*, you can download the documents from the sub-page *Facts and findings*.**
- **This PowerPoint presentation is animated**
 - ✓ **It's recommended to run the animation when viewing the presentation.**
- **On most computers, you can start the animation by pressing F5.**
 - ✓ **Now the presentation moves one step forward, when you press Page Down. It moves one step backward, when you press Page Up.**

Hedging prices and spot prices – 1

- **This PowerPoint presentation compares the spot prices and the financial contracts' hedging prices**
 - ✓ **The comparison is made for the German-Austrian Phelix spot price.**
 - ✓ **And for the spot prices for the bidding zones Southern Sweden (SE4), Western Denmark (DK1) and Eastern Denmark (DK2).**
 - ✓ **Further, the comparison is made for the Nordic System Price (a virtual spot price).**

- **In this presentation, for Southern Sweden, Western Denmark and Eastern Denmark, the "hedging price" is the hedging price of the System Price forward plus the hedging price of the EPAD forward:**
 - ✓ **(hedging price) = (hedging price of System Price forward) + (hedging price of EPAD forward).**

Conclusion from the analysis: price hedging is expensive for consumers

- **As can be seen: compared with the spot prices, the hedging prices have a strong tendency to overshoot**
 - ✓ **Hence, in the choice between spot and hedging, on the average you get the highest prices by choosing hedging.**
 - ✓ **Consequently, on the average, price hedging is expensive for consumers (and advantageous for producers).**
- **For all the investigated bidding zones (Germany, DK1, DK2 and SE4), there is a statistically significant difference between the quarterly Hedging Prices and the quarterly averages of the spot prices**
 - ✓ **For SE4: with only 24 observations in the SE4 sample, it's remarkable it's possible to prove statistical significance.**
- **The concept "price hedging" is explained in appendix 2.**

Hedging prices and spot prices – 2

- **For each of the five slides “Hedging Prices and spot prices”:**
- **For each quarter, the quarter’s Hedging Price is the average of the daily Closing Prices during the last quarter, where the contract was traded.**
- **Example for the Nordic System Price forward for Q3-2012 (ENOQ3-12):**
 - ✓ **The Hedging Price is the average of the daily Closing Prices during the period April–June 2012**
 - **This gives a Hedging Price of 42.24 EUR/MWh, as can be seen from the slide on the System Price in appendix 1.**

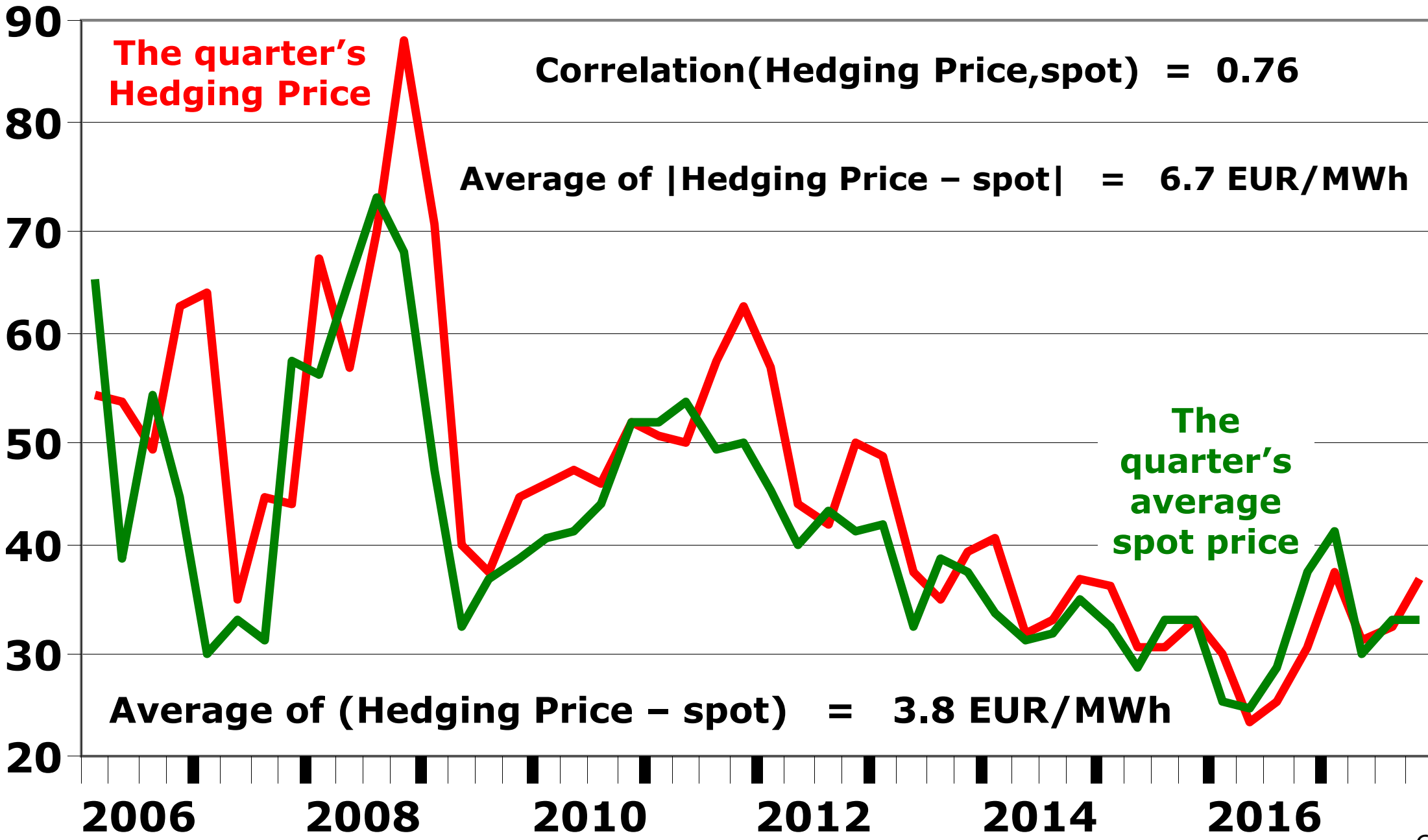
Hedging Prices and spot prices – 3

- **For each of the following five slides:**
- **For each quarter, the quarter's average spot price is compared with the quarter's Hedging Price.**
 - ✓ **For each spot price, this gives a number of points indicating how well the Hedging Price forecasted the spot price.**
- **The mean of the numerical difference**
 $| \text{Hedging Price} - \text{spot} |$
illustrates the average distance between the slides' two curves.
- **The mean of the difference**
 $(\text{Hedging Price} - \text{spot})$
is the consumers' average Risk Premium.

Germany: Hedging Prices and spot prices

EUR/MWh

The 48 quarters from Q1-2006 to Q4-2017

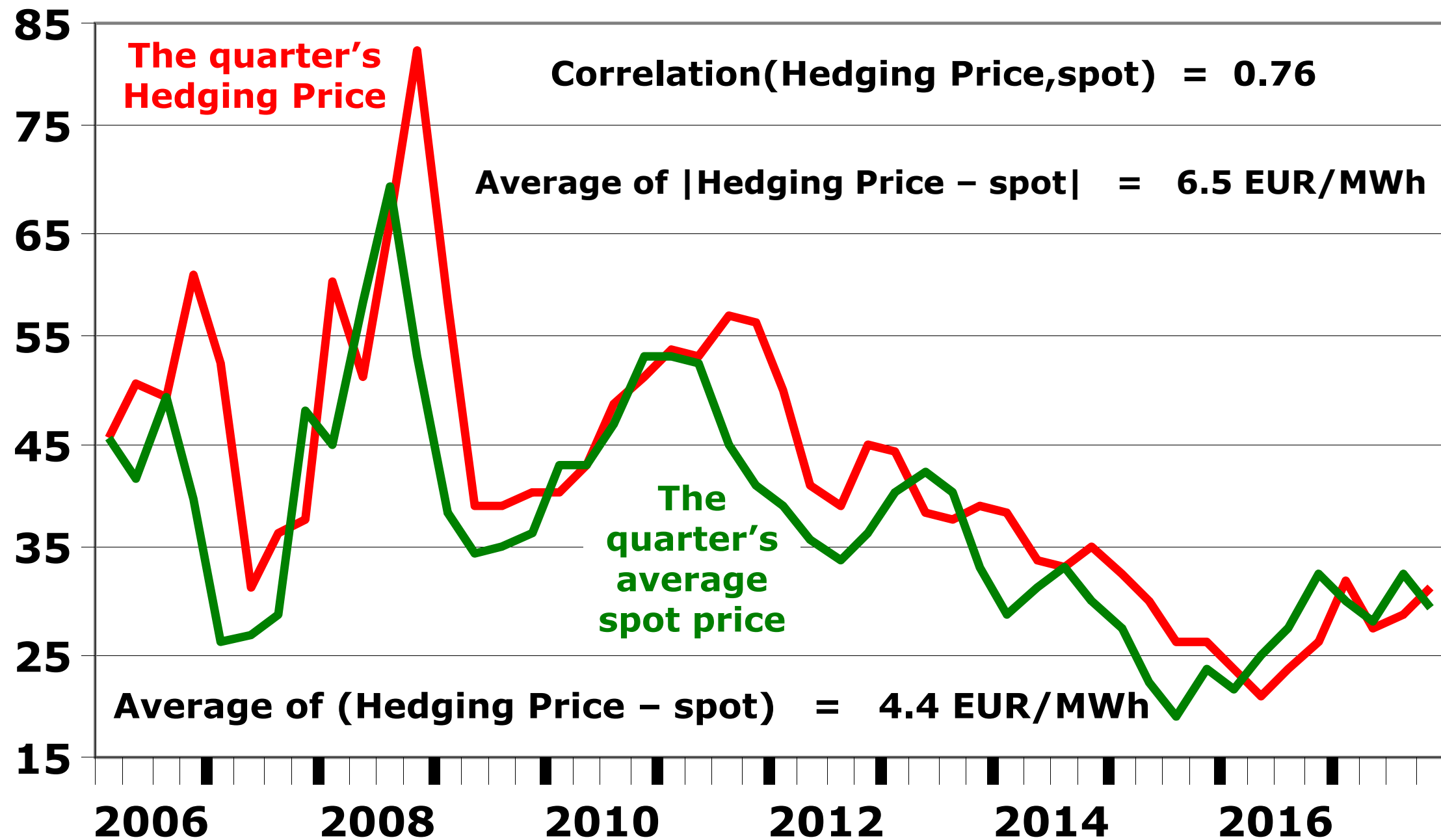


Sources: EEX and EPEX Spot

Western Denmark: Hedging Prices and spot prices

EUR/MWh

The 48 quarters from Q1-2006 to Q4-2017

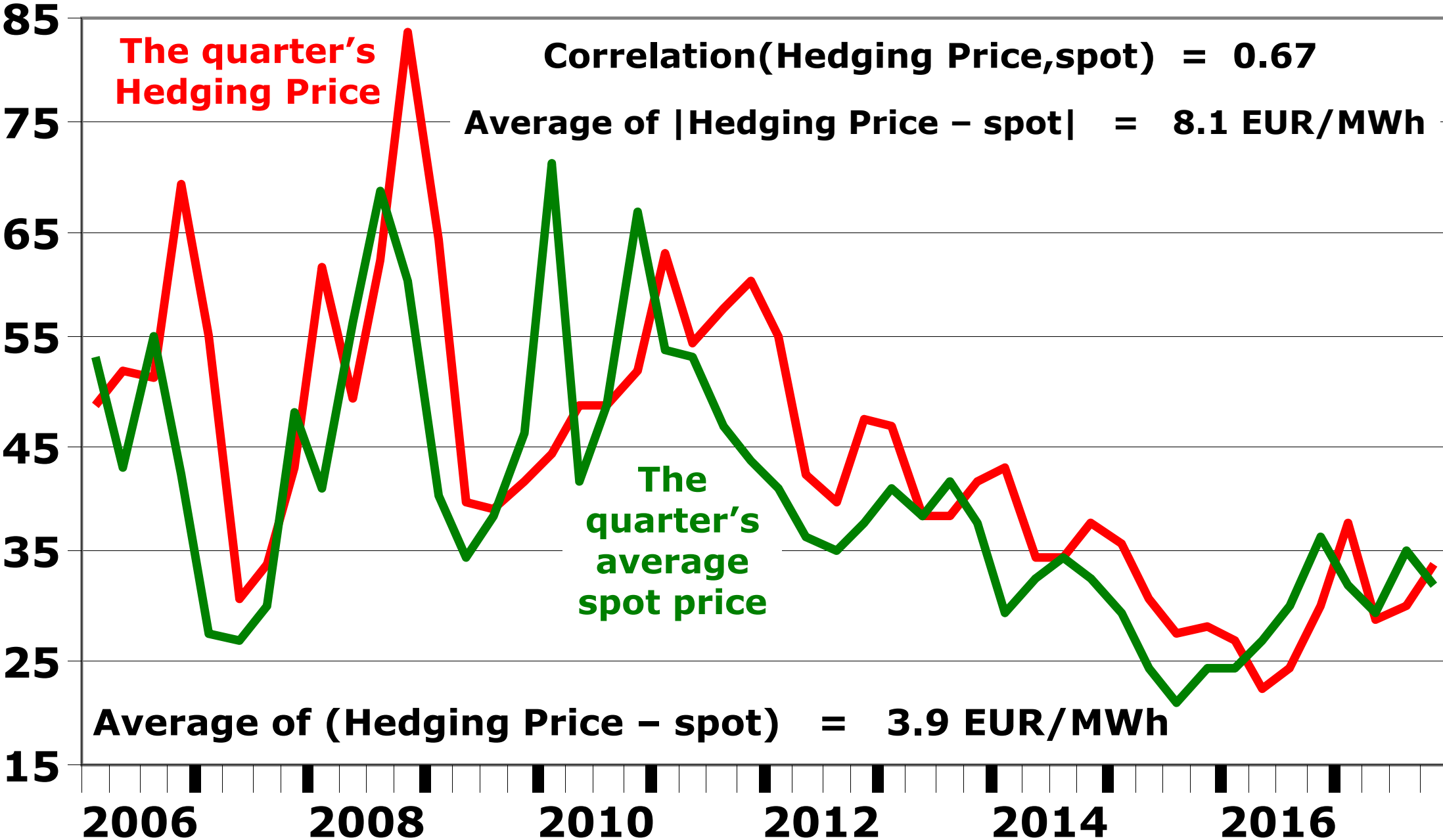


Sources: Syspower and Nord Pool

Eastern Denmark: Hedging Prices and spot prices

EUR/MWh

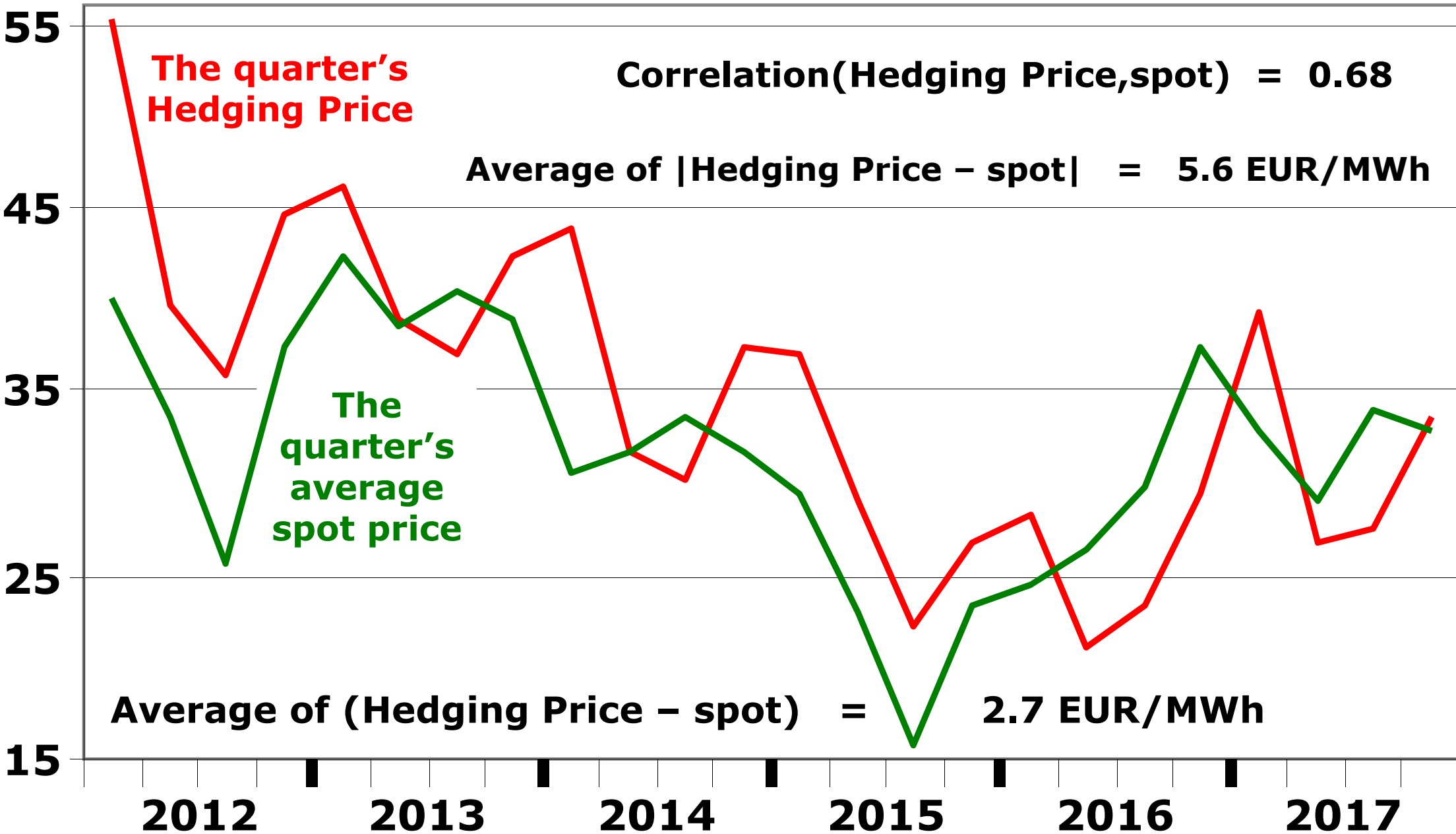
The 48 quarters from Q1-2006 to Q4-2017



Southern Sweden: Hedging Prices and spot prices

EUR/MWh

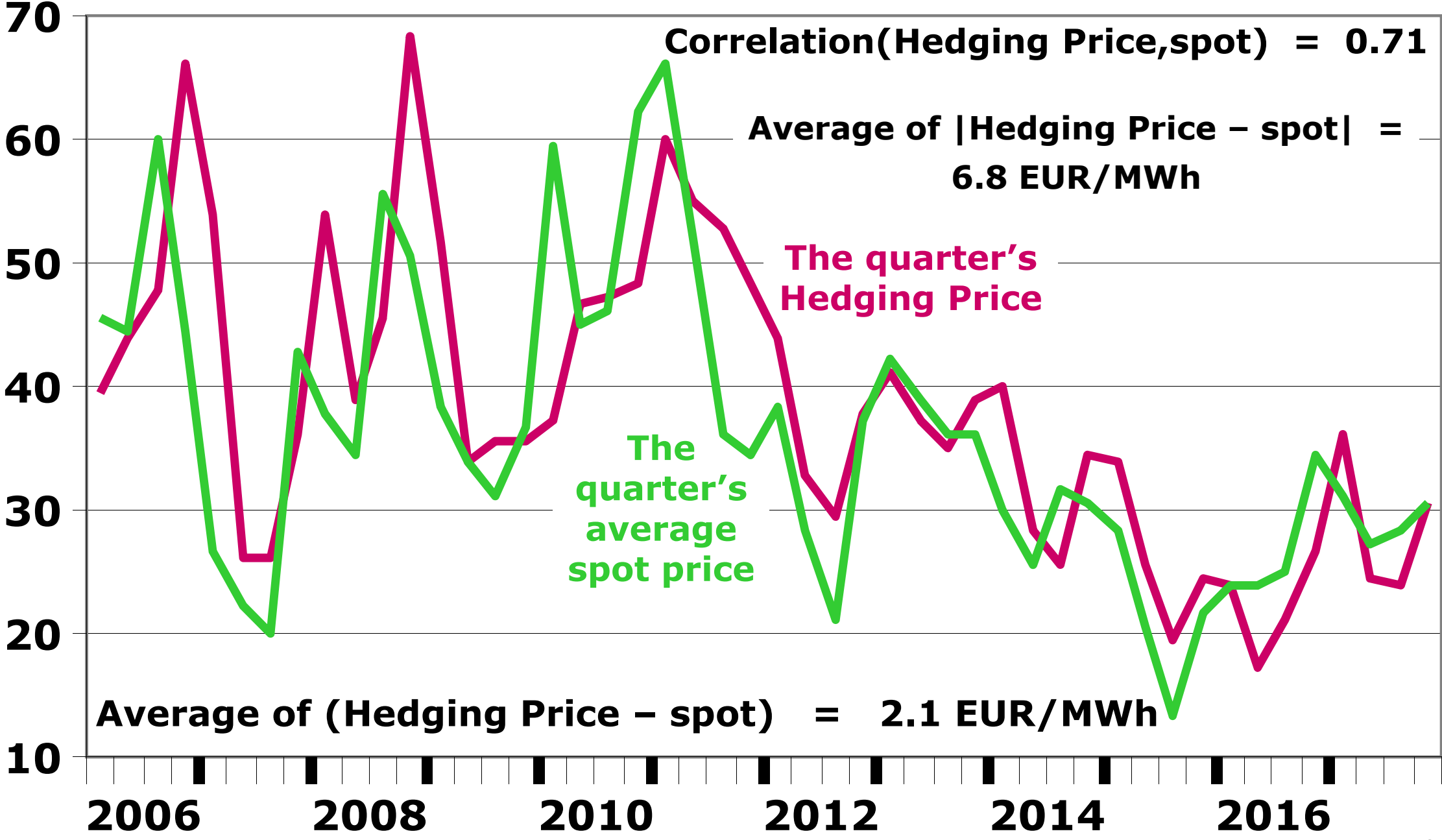
The 24 quarters from Q1-2012 to Q4-2017



System Price: Hedging Prices and spot prices

EUR/MWh

The 48 quarters from Q1-2006 to Q4-2017



Sources: Syspower and Nord Pool

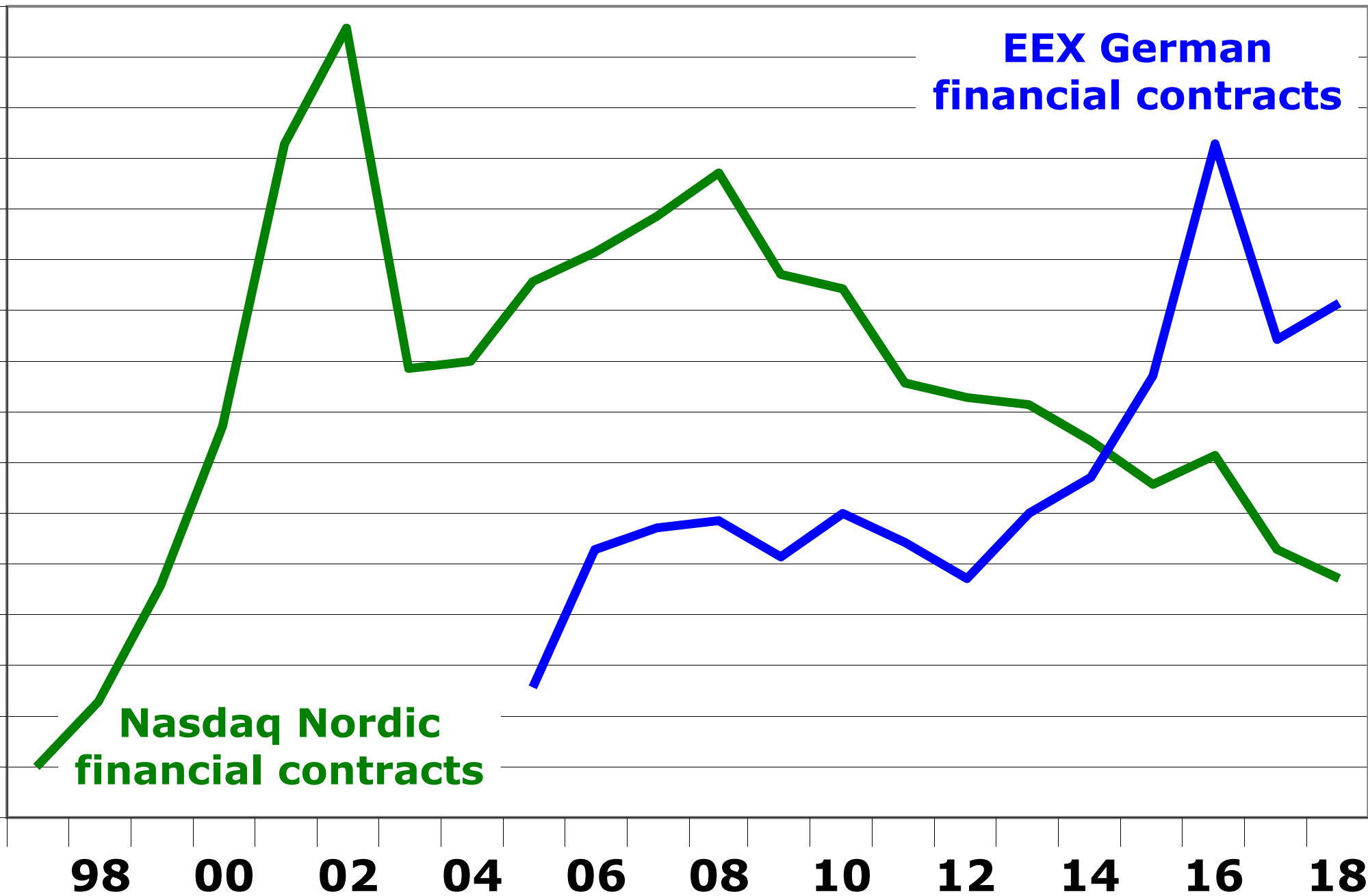
Liquidity

- **At the two following slides, for EEX and Nasdaq OMX, the blue and the green curves illustrate the cleared volume:**
 - ✓ (contracts traded off-exchange and subsequently cleared) + (contracts traded at the exchange).
- **Concerning the volume for “German financial contracts”:**
 - ✓ For 2006-2016, this is Phelix futures.
 - ✓ For 2017, this is (Phelix DE/AT futures) + (Phelix DE futures).
 - ✓ For 2018, this is (Phelix DE/AT futures) + (Phelix DE futures) + (Phelix AT futures).
- **The LEBA curve includes all physical forward contracts for power arranged by the LEBA OTC brokers**
 - ✓ The LEBA curve illustrates the total OTC bilaterally settled volume.
 - ✓ The LEBA curve does not include financially settled contracts.

Cleared volume

TWh

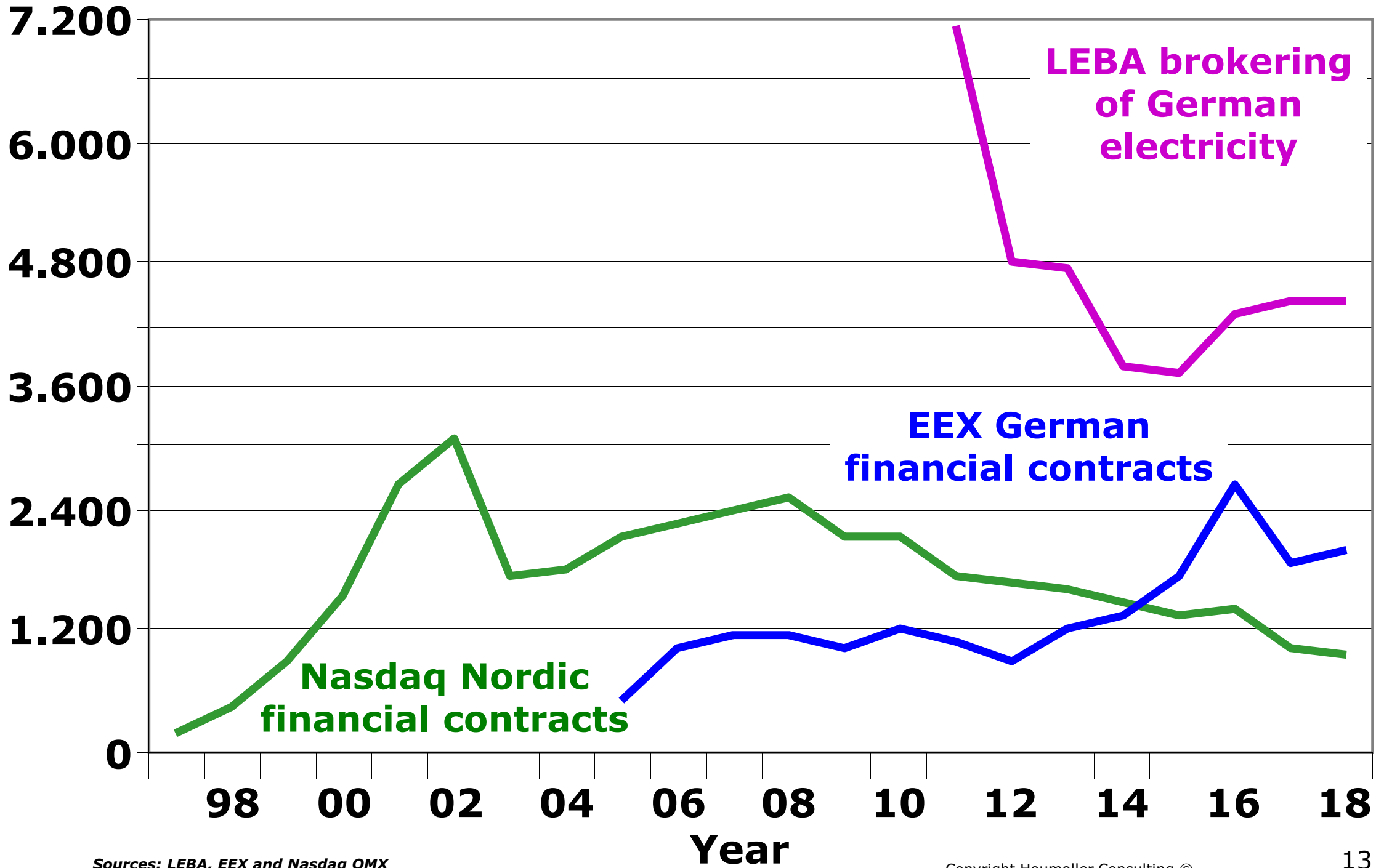
3.200
2.800
2.400
2.000
1.600
1.200
800
400
0



**EEX German
financial contracts**

**Nasdaq Nordic
financial contracts**

TWh Cleared volume and LEBA OTC trading



Risk Premium R

- For the consumers, the Risk Premium R_C is the difference between the financial contracts' hedging prices and the spot prices.
- For the producers, the Risk Premium R_p has the opposite sign.
- For a balanced hedging system, the two Risk Premiums are equal:
 - ✓ $R_C = R_p = 0$.
- In this presentation, R_C is calculated by using the Hedging Price defined previously:
 - ✓ $R_C = (\text{Hedging Price}) - (\text{spot price})$.
 - *You get R_p by just reversing the sign:*
 $R_p = (\text{spot price}) - (\text{Hedging Price})$.
- For the Nordic financial contracts, the Risk Premium can be calculated as the sum of the Risk Premium R_{SYS} from the System Price contracts and the Risk Premium R_{EPAD} from the EPAD contracts:
 - ✓ $R_C = R_{C,SYS} + R_{C,EPAD}$

Consumers' Risk Premiums in EUR/MWh

	$R_{C,EPAD}$	$R_{C,SYS}$	Risk Premium $R_C =$ (Hedging Price) – (spot price) $= R_{C,EPAD} + R_{C,SYS}$
DK1 Averages for the years 2006-2017	2.3	2.1	4.4
DK2 Averages for the years 2006-2017	1.9	2.1	3.9
SE4 Averages for the years 2012-2017	1.6	1.1	2.7
Germany Average for the years 2006-2017	Not applicable	Not applicable	3.8

For DK2, rounding errors cause the apparent discrepancy

Consumers' Risk Premiums in Danish øre/kWh

	<p>Risk Premium $R_C =$ (Hedging Price) - (spot price) $= R_{C,EPAD} + R_{C,SYS}$</p>
<p>DK1 Average for the years 2006-2017</p>	<p>3.3</p>
<p>DK2 Average for the years 2006-2017</p>	<p>2.9</p>
<p>SE4 Average for the years 2012-2017</p>	<p>2.0</p>
<p>Germany Average for the years 2006-2017</p>	<p>2.8</p>

Correlation between Hedging Prices and spot prices

- **Note that higher liquidity for a financial contract does not necessarily imply stronger correlation between the contract's hedging prices and the underlying spot prices.**
- **Among the Nordic financial contracts, the Nordic System Price forwards have been the most liquid during the period investigated**
 - ✓ **At the same time, the System Price forwards' Hedging Prices have only modest correlation to the System Prices.**

Appendix 1

Closing Prices

**Variation during the last nine months
of the financial contract's trading period**

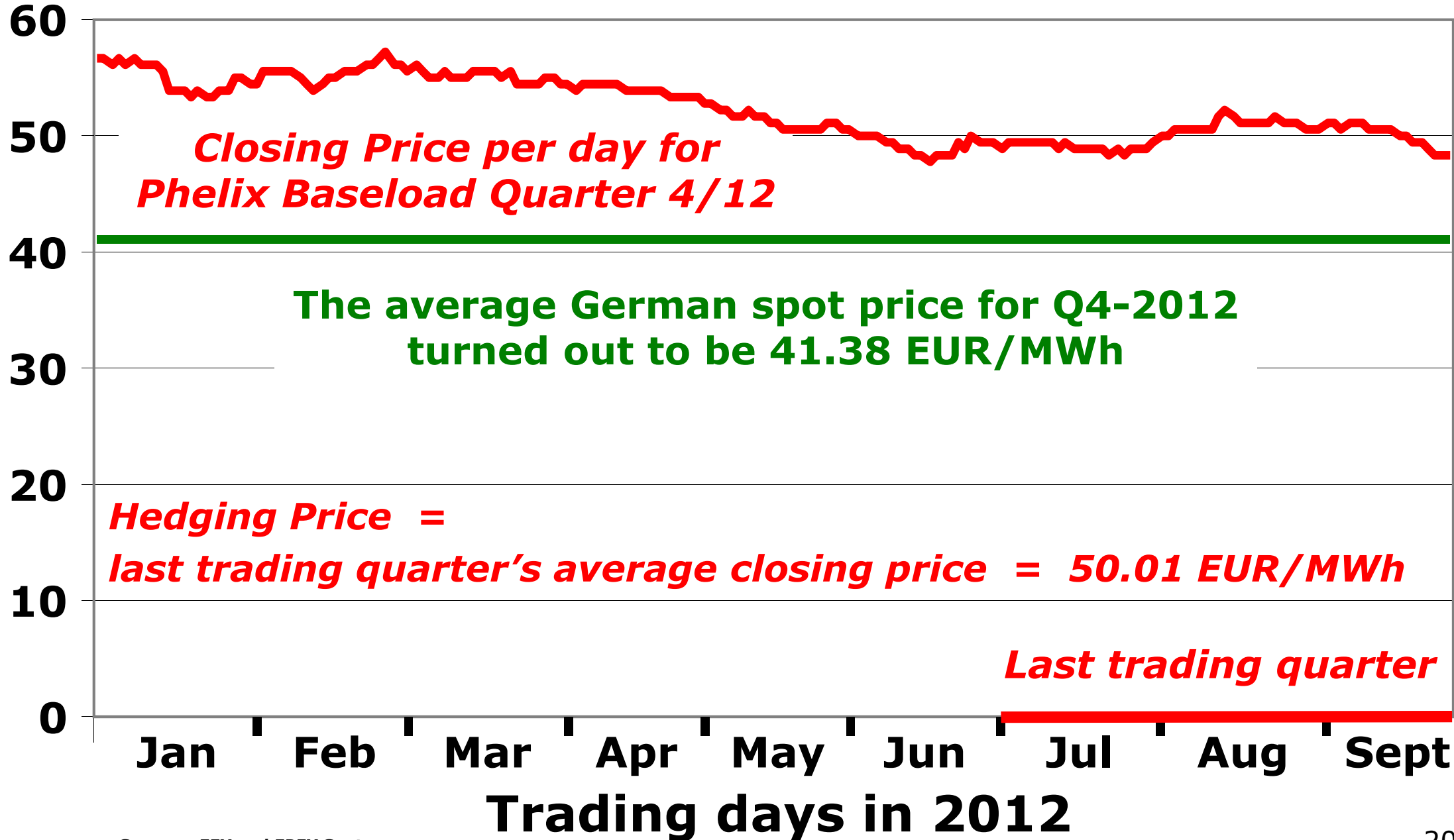
Closing Prices

- **Please refer to appendix 2: at the end of each trading day, both Nasdaq OMX and EEX set a Closing Price for each of their financial contacts.**
- **As examples of how the Closing Prices vary:**
- **The following five slides show the daily Closing Prices for five financial contracts.**
- **For each contract, the daily Closing Price is shown during the last nine months, where the contract was traded.**
- **The four Nordic contracts hedged against the Q3-2012 spot price for respectively**
 - ✓ **Western Denmark (DK1).**
 - ✓ **Eastern Denmark (DK2).**
 - ✓ **Southern Sweden (SE4).**
 - ✓ **The Nordic System Price.**
- **The German contract hedged against the German Q4-2012 spot price.**

Germany: Q4-2012

EUR/MWh

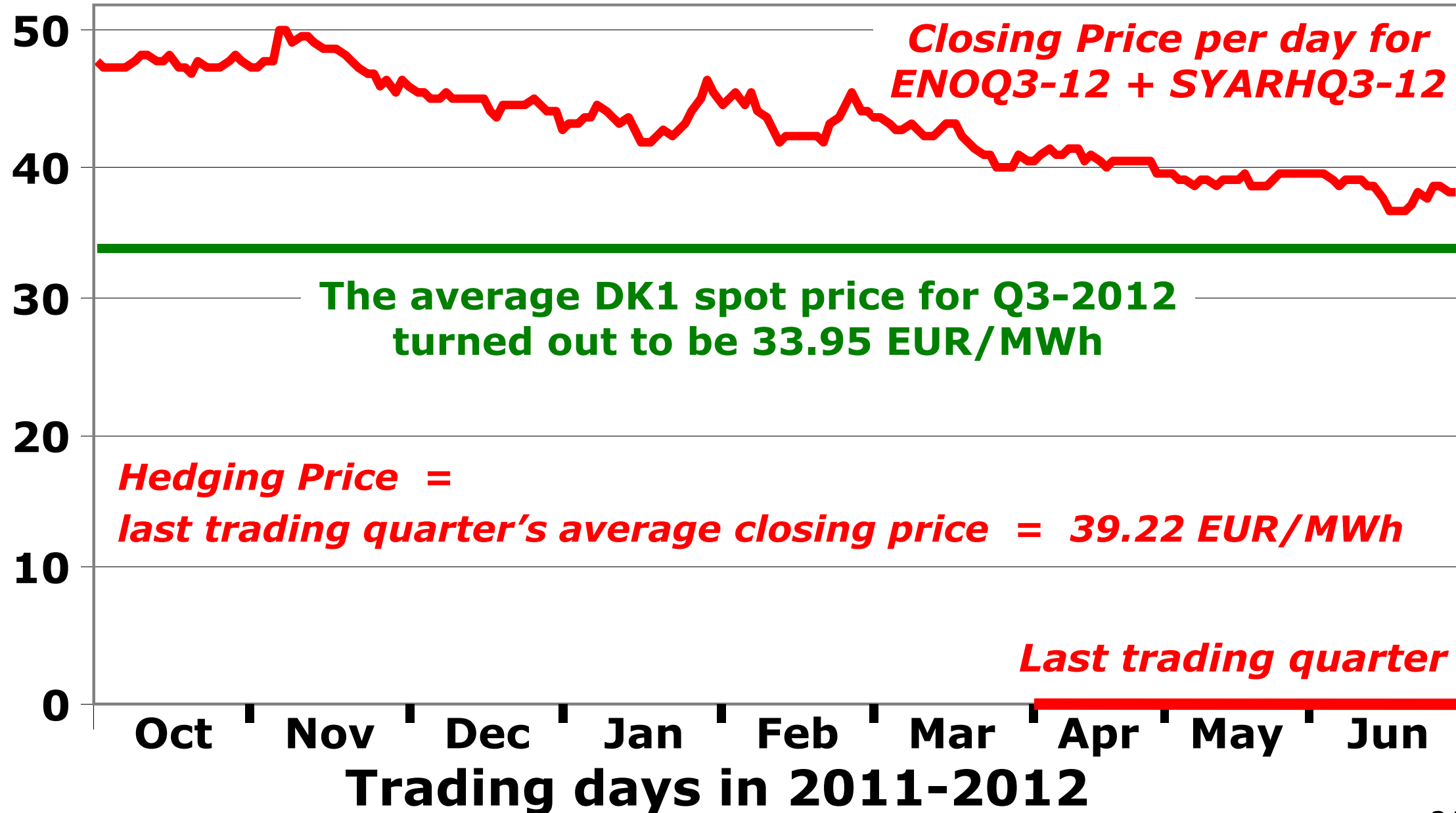
Closing prices and the quarter's average spot price



Western Denmark (DK1): Q3-2012

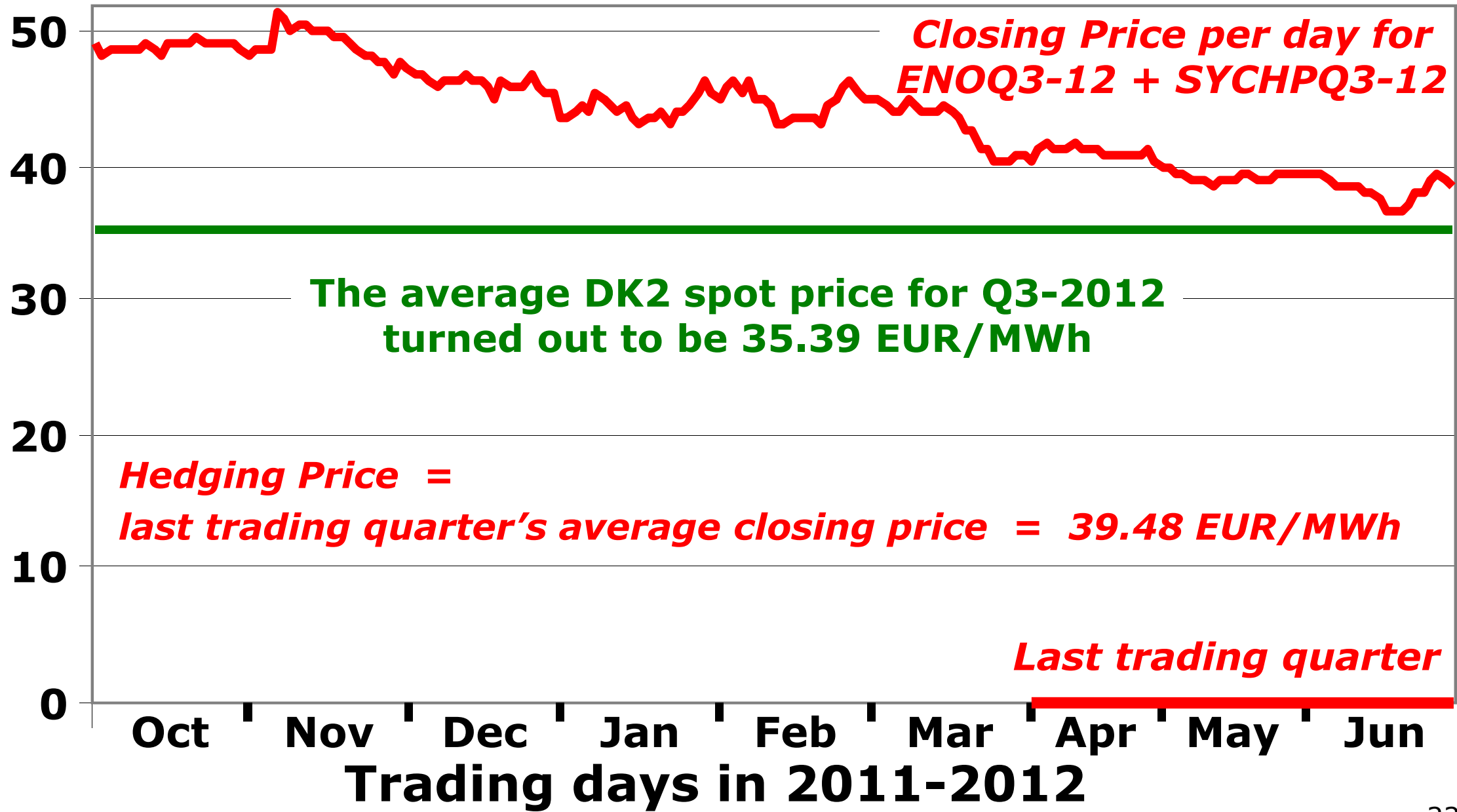
EUR/MWh

Closing prices and the quarter's average spot price



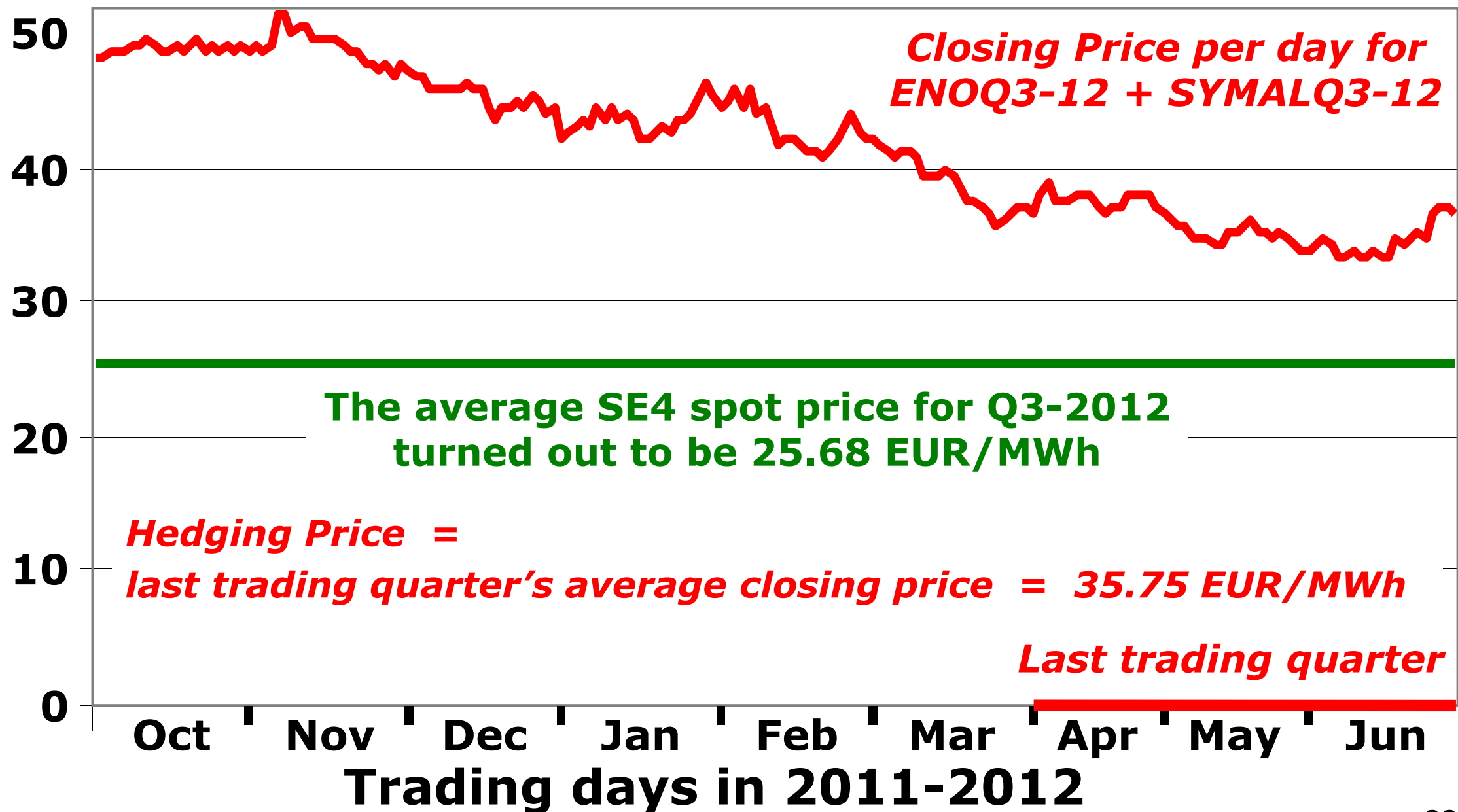
Eastern Denmark (DK2): Q3-2012

EUR/MWh Closing prices and the quarter's average spot price



Southern Sweden (SE4): Q3-2012

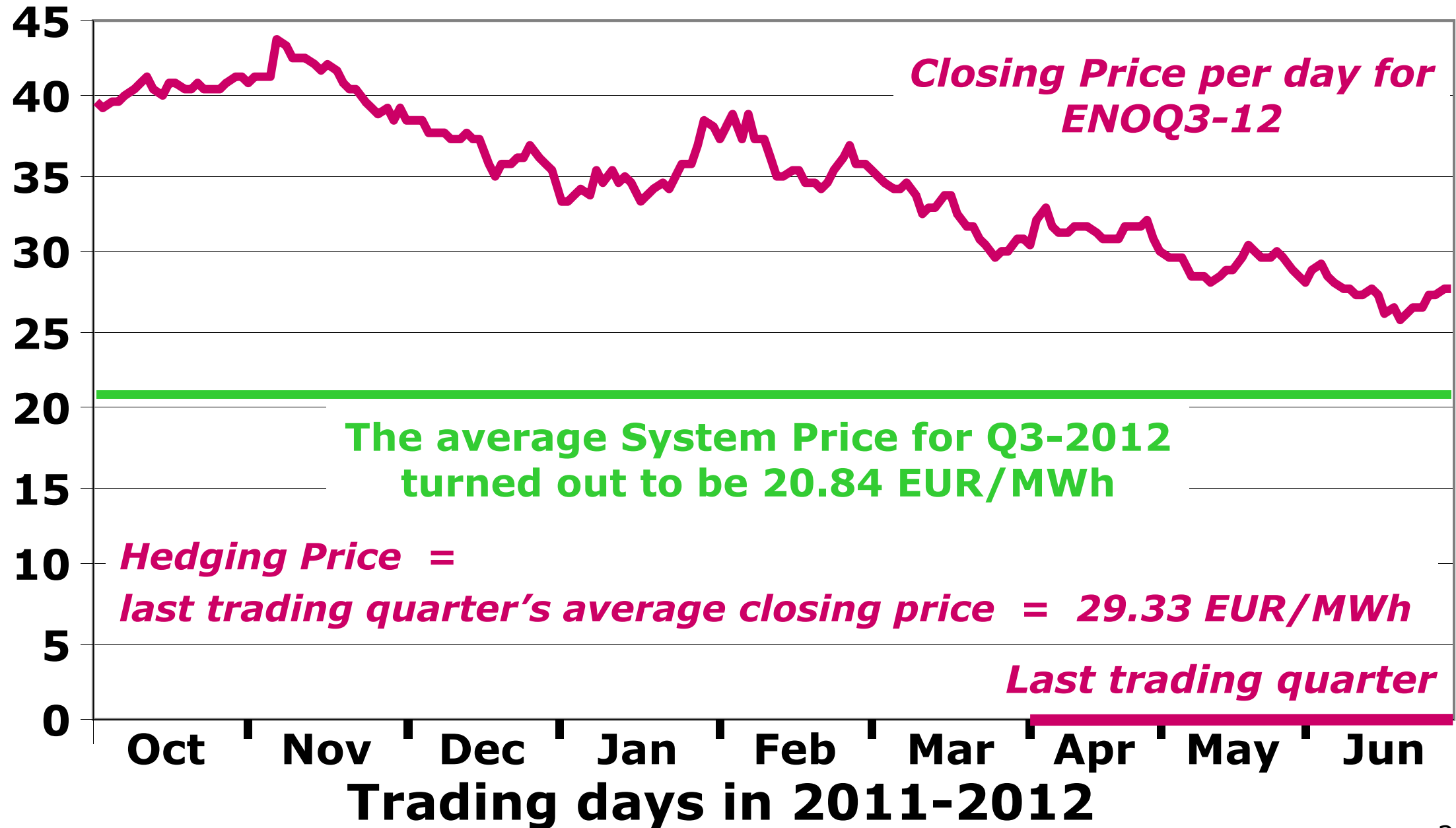
EUR/MWh Closing prices and the quarter's average spot price



System Price: Q3-2012

EUR/MWh

Closing prices and the quarter's average spot price



Appendix 2

Terminology and acronyms

Terminology and acronyms – 1

As used in this presentation

- ***Bidding zone*** A geographical area, within which the players can trade electrical energy day-ahead without considering grid bottlenecks.
- ***CfD*** Contract for Difference. A financial contract, which hedges against the risk there is a difference between the System Price and the spot price of a given Nordic bidding zone. Today, the name has been changed to EPAD contract.

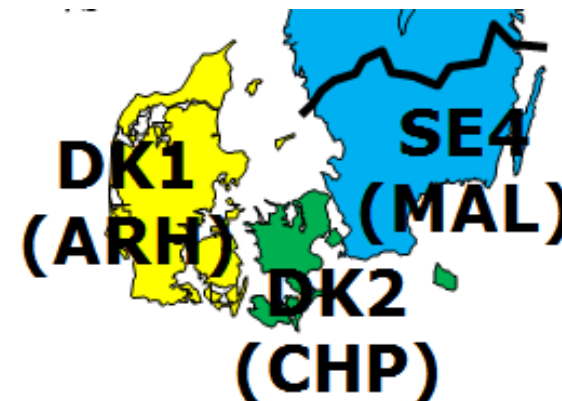
Example: the underlying reference for the EPAD/CfD for DK1 is this difference

(DK1 spot price) - (System Price).

- ***Closing Price*** At Nasdaq OMX and at EEX, for each financial contract, a Closing Price is set at the end of every trading day. In effect, at the end of the trading day, the Closing Price is the financial market's forecast of the future spot price. At Nasdaq OMX, this hedging price is called the *Daily Fix*. At EEX, it's called the *Settlement Price*. In this presentation, *Closing Price* is used as the common term.

Terminology and acronyms – 2

As used in this presentation



- **Correlation** Given two data sets, the correlation measures the degree to which the two data sets move in lockstep. Please refer to the next-to-last slide.
- **DK1 and DK2** The bidding zones of Western and Eastern Denmark as indicated at the picture.
- **Eastern Denmark** See **DK2**.
- **EEX** European Energy Exchange. Please refer to the web site eex.com.
- **EPAD** Electricity Price Area Differential. See **CfD**.
- **Financial contract** In this presentation, it's a common term for **forward contract** and **future contract**.

Terminology and acronyms – 3

As used in this presentation

- ***Forward contract*** The Nordic contracts investigated in this document are the forward contracts. You'll find a description of the contracts at the web site nasdaqomx.com/commodities. Further, please refer to the chapters 11-13 of the PDF document "The Liberalized Electricity Market".
- ***Future contract*** The German-Austrian contracts investigated in this document are the future contracts, where the underlying reference is the German spot price. You'll find a description of the contracts at the web site eex.com.
- ***German financial contract*** In this document, this is a future, where the underlying reference is the Phelix DE spot price, the Phelix DE/AT spot price or the Phelix AT spot price.
- ***German spot price*** See *Phelix DE/AT spot price*. Further, see the PowerPoint presentation "German spot prices 2002–2018".
- ***Hedging Price*** (with capital H and P) In this document, for a given financial contract, this is the average of the Closing Prices during the last quarter where the contract was traded. See also slide no. 2.

Terminology and acronyms – 4

As used in this presentation

- ***Hedging price*** (without both capital H and P) A financial contract's price. It's not a price paid from one player to another. The role of a financial contract's price is explained in the chapters 11-13 of the PDF document "The Liberalized Electricity Market".
- ***hedging price*** See *Hedging price*.
- ***LEBA*** London Energy Brokers' Association. See the web site lebaltd.com.
- ***Nasdaq OMX*** An exchange, where the players can trade Nordic financial contracts (and other contracts). Please refer to the web site nasdaqomx.com/commodities.
- ***Nordic* and *Nordic area*** In this document, this refers to the four countries Denmark, Finland, Norway and Sweden.
- ***Nordic financial contract*** In this document, this is a financial contract, where the underlying reference is a Nordic spot price or the Nordic System Price.
- ***Nordic System Price*** See *System Price*.
- ***OTC*** Over-The-Counter. Trading taking place without the supervision of an exchange. This is also called bilateral trading.

Terminology and acronyms – 5

As used in this presentation

- ***Phelix Baseload 4/12*** The EEX future, which hedged against the German spot price during Q4-2012.
- ***Phelix DE spot price*** See *Phelix DE/AT spot price*.
- ***Phelix DE/AT spot price*** The common spot price for Germany and Austria. From October 2018, there was no longer a common spot price for Germany and Austria. Hence, from October 2018, there was a Phelix DE spot price for Germany and a Phelix AT spot price for Austria.
- ***Price hedging*** As a consumer or producer of electricity in a large part of Europe: if you choose to trade at the spot price, you'll first learn your price for the next day's consumption/production of electricity after 12 o'clock Central European Time.

However, by using a financial contract, you can fix your electricity price at an earlier point in time. This early fixing of the price is called "price hedging".
- ***Risk Premium*** See the first slide on Risk Premium.
- ***SE4*** The bidding zone of Southern Sweden as indicated on the map previously shown in this appendix.

Terminology and acronyms – 6

As used in this presentation

- ***Southern Sweden*** See ***SE4***.
- ***Spot price*** Please see the PowerPoint presentation “Maximizing the economic value of market coupling and spot trading” (or the PDF document with the same name).
- ***SYARHQ3-12*** See ***ticker symbol***.
- ***SYCHPQ3-12*** ticker symbol of the CfD, which hedged against the difference between the DK2 spot price and the System Price during Q3-2012. **CPH** indicates **CoPenHagen**.
- ***SYMALQ3-12*** ticker symbol of the CfD, which hedged against the difference between the SE4 spot price and the System Price during Q3-2012. **MAL** indicates **MALmø** (the biggest town in SE4).
- ***System Price*** A virtual price. It’s the theoretical, common spot price we would have in the Nordic area, if there were no grid bottlenecks in the area covered by the four countries.

For an overview over the historical values of the System Price, please see the PowerPoint presentation “System Price 1992-2018” (or the PDF document with the same name).

Terminology and acronyms – 7

As used in this presentation

➤ ***Ticker symbol*** The name of a financial contract.

Example 1: the ticker symbol of the contract, which hedged against the System Price during Q3-2012 was ENOQ3-12

- ENO indicates Electricity Nordic
- Q3-12 indicates the third quarter of 2012.

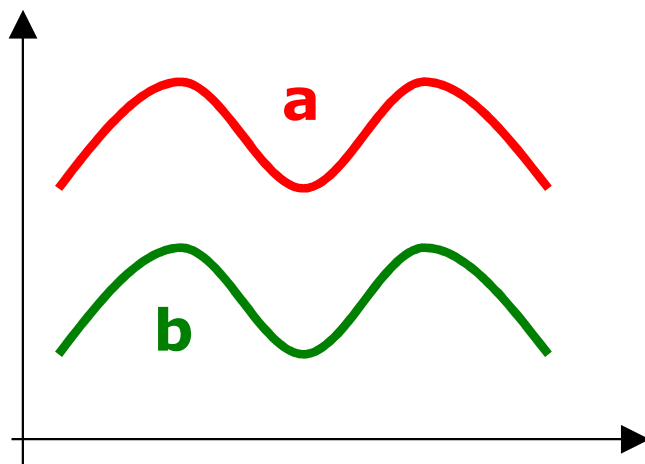
Example 2: the ticker symbol of the CfD, which hedged against the difference between the DK1 spot price and the System Price during Q3-2012 was SYARHQ3-12

- SY indicates System Price
- ARH indicates AARHus (the biggest town in Western Denmark).
- Q3-12 indicates the third quarter of 2012.

➤ ***Western Denmark*** See ***DK1***.

The correlation function

- **The correlation function measures the correlation between two variables.**
- **If the two variables move in lockstep, the value of the correlation function is 1.**
 - ✓ **A value of 0 means there is no correlation at all.**



**In this example
 Correlation(a,b) = 1
 as a and b move
 in lockstep**

Thank you for your attention!

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