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 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).**

➢ **The concept "price hedging" is explained in appendix 2.**

Hedging Prices and spot prices – 2

➢ **For each of the four slides "Hedging Prices and spot prices":**

➢ **For each year, the year'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 2012 (ENOYR-12):

   ✓ The Hedging Price is the average of the daily Closing Prices during the period October–December 2011

      • This gives a Hedging Price of 42.24 EUR/MWh, as can be seen from the slide on the System Price in appendix 1.
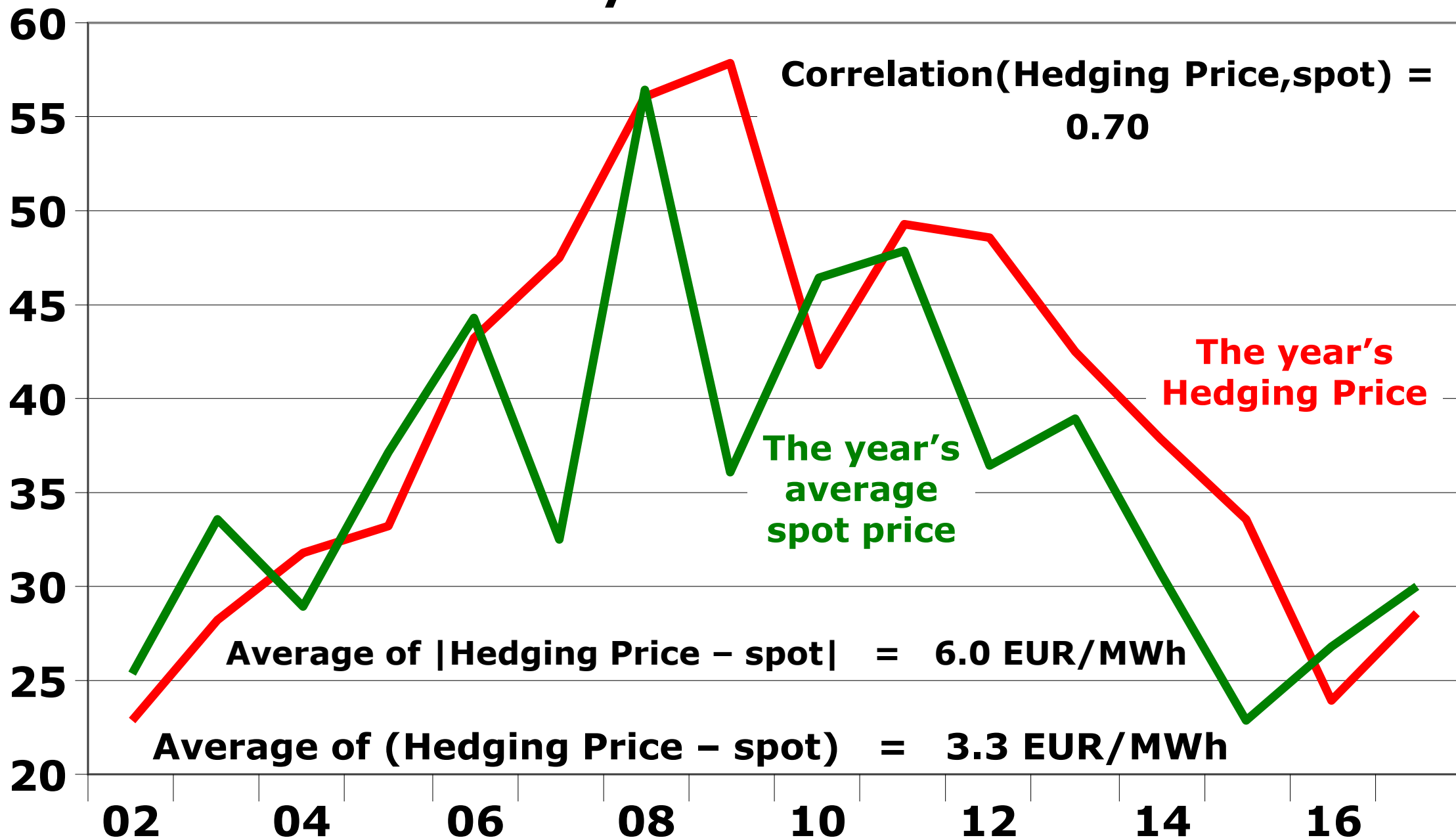
Hedging Prices and spot prices – 3

➢ **For each of the following 4 slides:**

   ✓ **For each year, the year's average spot price is compared with the year'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**

    |Hedging Price – spot|

illustrates the average distance between the slides' two curves.

➢ **The mean of the difference**

    (Hedging Price – spot)

is the consumers' average Risk Premium.

Western Denmark: Hedging Prices and spot prices
The 16 years 2002-2017

EUR/MWh

Correlation(Hedging Price,spot) = 0.70

The year's Hedging Price

The year's average spot price

Average of |Hedging Price – spot| =   6.0 EUR/MWh

Average of (Hedging Price – spot)   =   3.3 EUR/MWh

Sources: Syspower and Nord Pool

6

Eastern Denmark: Hedging Prices and spot prices
The 16 years 2002-2017

EUR/MWh

Correlation(Hedging Price,spot) = 0.65

The year's Hedging Price

The year's average spot price

Average of |Hedging Price – spot| =   7.3 EUR/MWh

Average of (Hedging Price – spot)   =   2.9 EUR/MWh

Sources: Syspower and Nord Pool

Copyright Houmoller Consulting ©

Southern Sweden: Hedging Prices and spot prices
The 6 years 2012-2017

EUR/MWh

Correlation(Hedging Price,spot) = 0.50

Average of |Hedging Price – spot| = 7.8 EUR/MWh

The year's Hedging Price

The year's average spot price

Average of (Hedging Price – spot) = 5.8 EUR/MWh

8
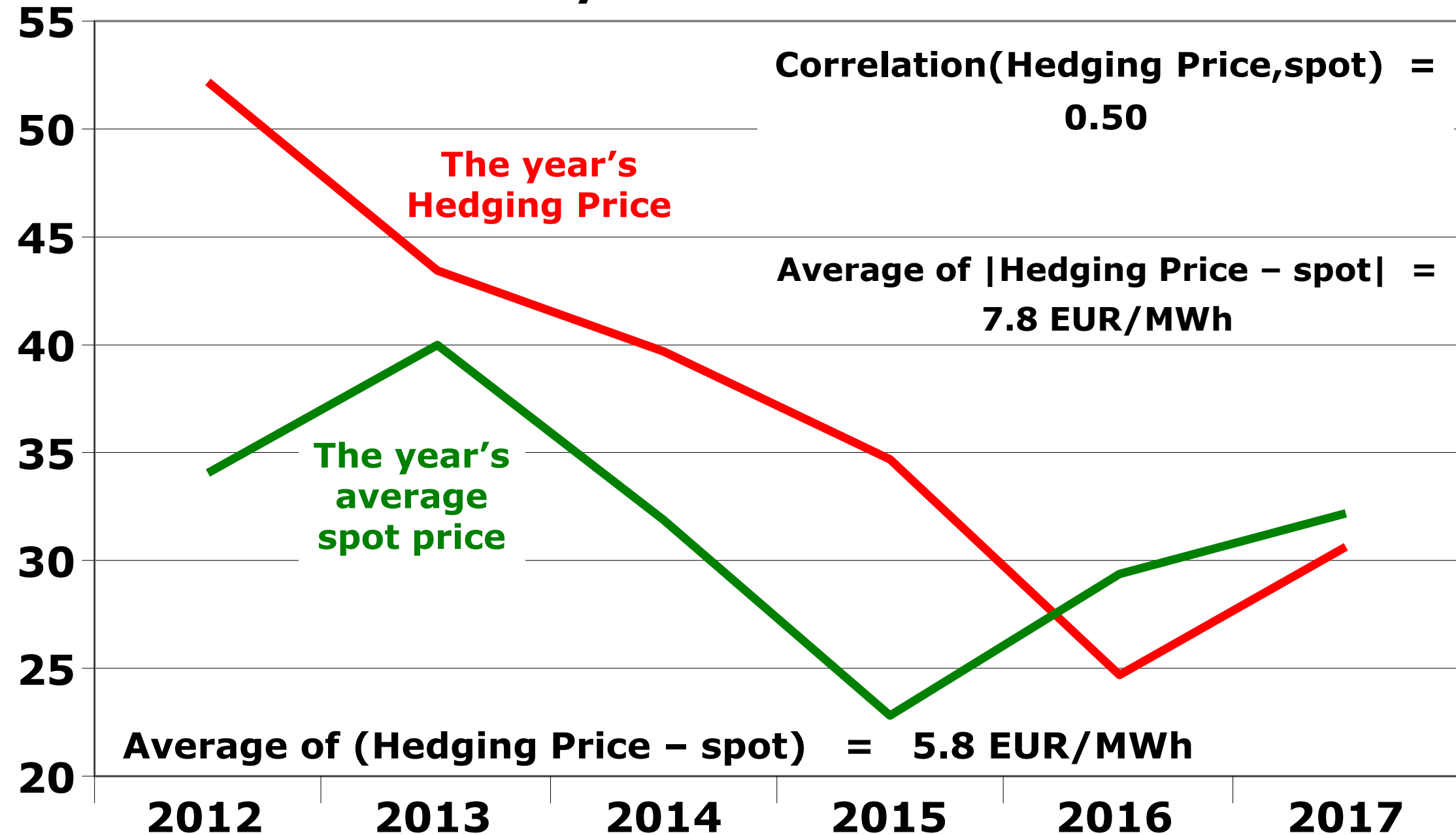
Nordic System Price: Hedging Prices and spot prices

EUR/MWh   The 16 years 2002-2017

Correlation(Hedging Price,spot) = 0.49

Average of |Hedging Price – spot| = 7.5 EUR/MWh

The year's average spot price

The year's Hedging Price

Average of (Hedging Price – spot) = 1.5 EUR/MWh

Sources: Syspower and Nord Pool
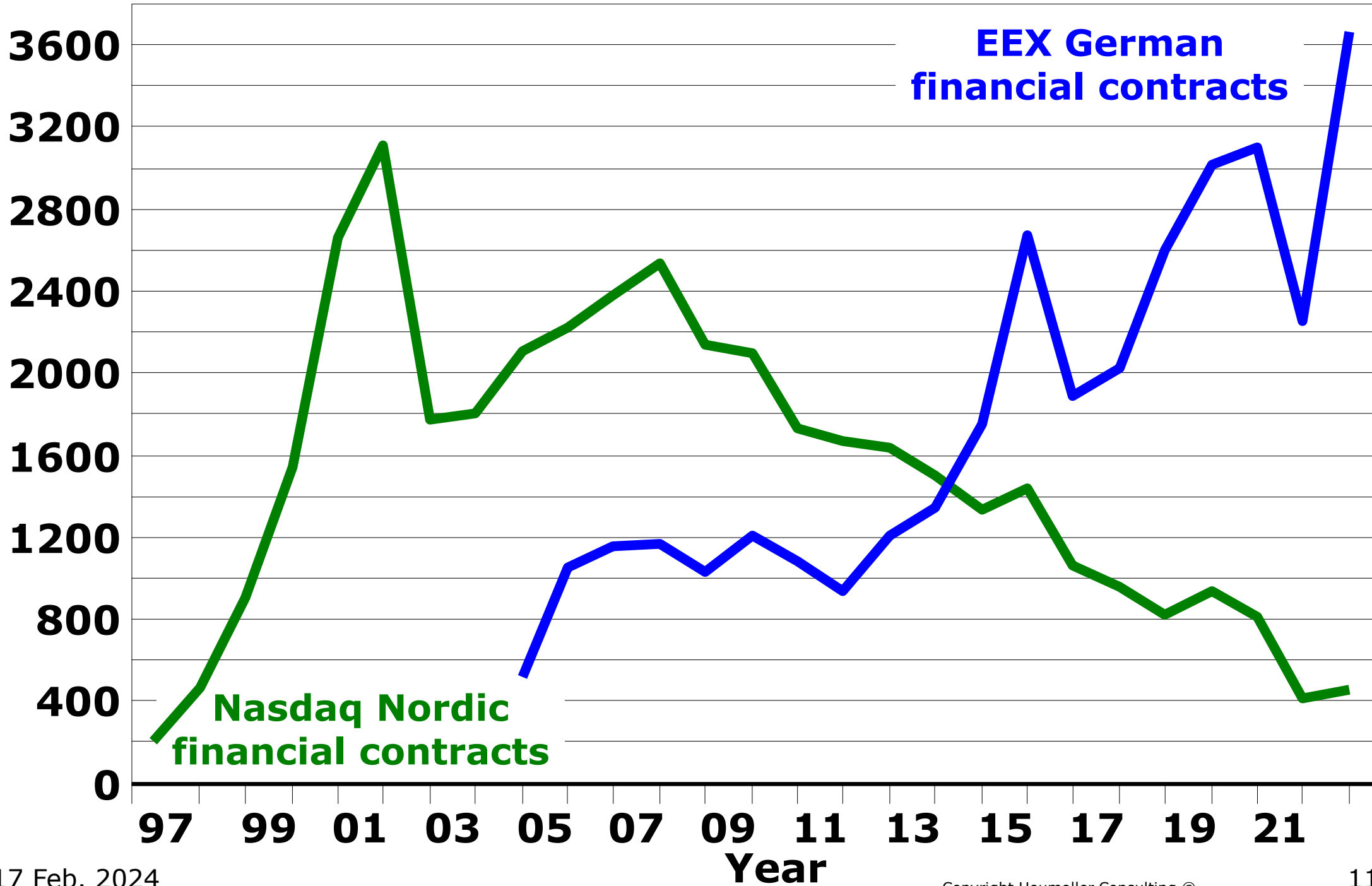
Copyright Houmoller Consulting ©

9
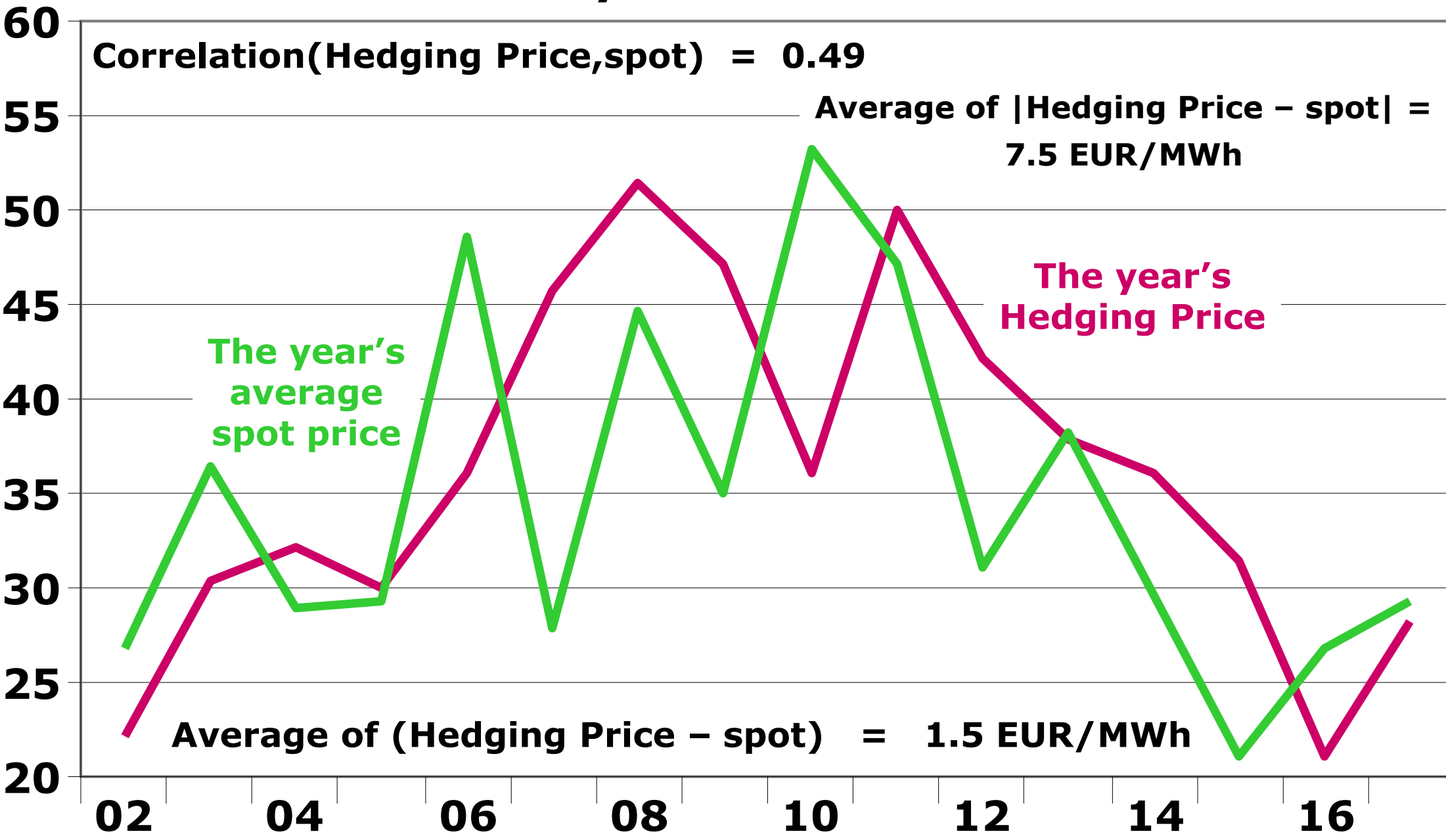
Liquidity

- ➢ **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":**
  - ✓ **Please refer to *Cleared volume* in appendix 2.**

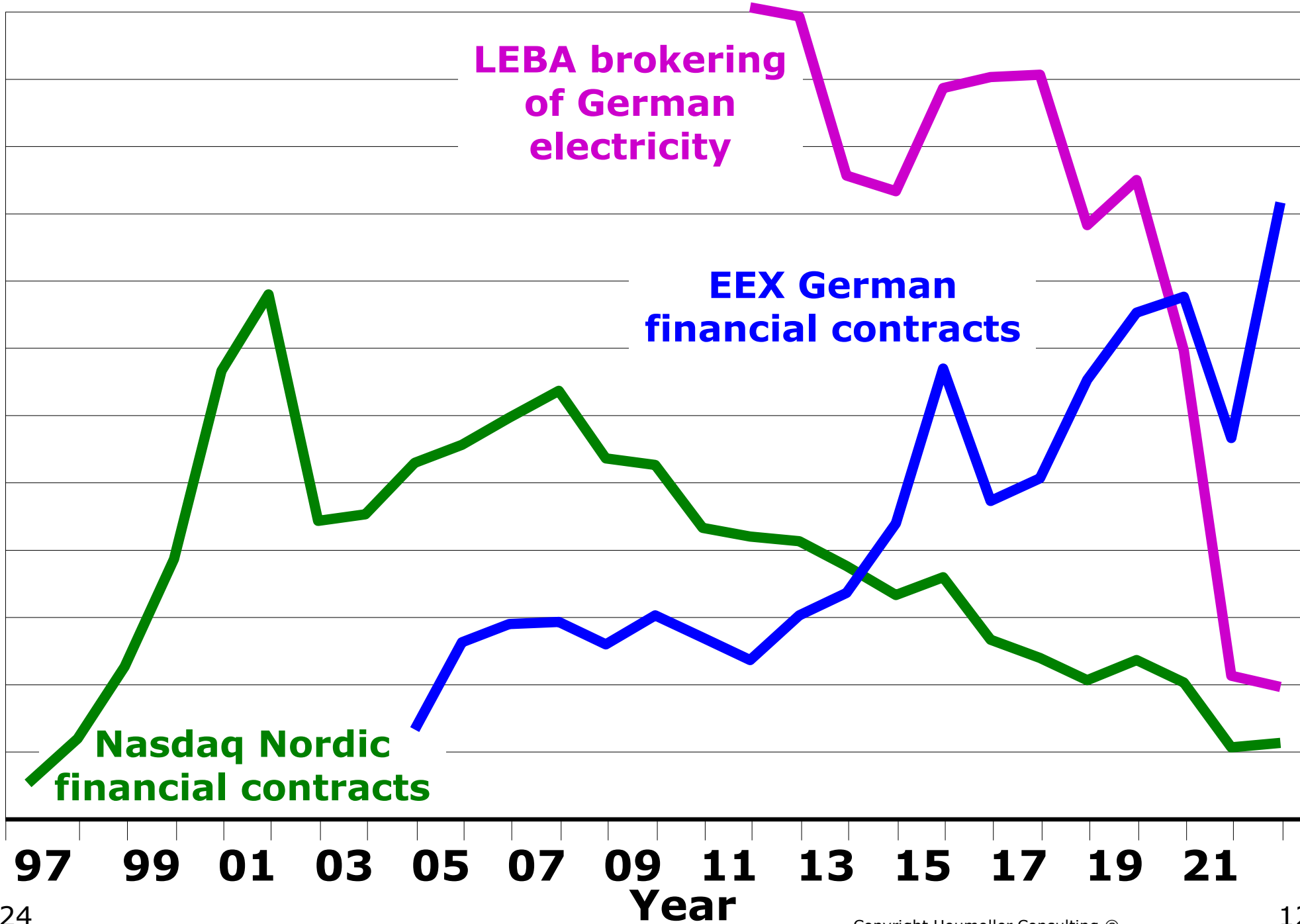- ➢ **Concerning the LEBA curve:**
  - ✓ **Please refer to *LEBA* in appendix 2.**

TWh

Cleared volume 1997–2023

HoumollerConsulting
QUALITY ADVICE

EEX German financial contracts

Nasdaq Nordic financial contracts

3600
3200
2800
2400
2000
1600
1200
800
400
0

Year

97 99 01 03 05 07 09 11 13 15 17 19 21

17 Feb. 2024

Copyright Houmoller Consulting ©

11

TWh Cleared volume and LEBA OTC trading 1997–2023

LEBA brokering of German electricity

EEX German financial contracts

Nasdaq Nordic financial contracts

Y-axis (TWh): 0, 400, 800, 1200, 1600, 2000, 2400, 2800, 3200, 3600, 4000, 4400, 4800

X-axis (Year): 97, 99, 01, 03, 05, 07, 09, 11, 13, 15, 17, 19, 21

17 Feb. 2024

Copyright Houmoller Consulting ©

12

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 = $ (Hedging Price) – (spot price).**

   - *You get R_P by just reversing the sign:*

      $R_P = $ (spot price) – (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 2002-2017	1.8	1.5	3.3
DK2 Averages for the years 2002-2017	1.4	1.5	2.9
SE4 Averages for the years 2012-2017	2.4	3.4	5.8

Consumers' Risk Premiums in Danish øre/kWh

	Risk Premium R_C = (Hedging Price) – (spot price) = $R_{C,EPAD} + R_{C,SYS}$
DK1 Average for the years 2002-2017	**2.4**
DK2 Average for the years 2002-2017	**2.2**
SE4 Average for the years 2012-2017	**4.3**

Correlation between Hedging Prices and spot prices

➢ **Note that higher liquidity for a financial contract does <u>not</u> 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 low correlation to the System Prices.**
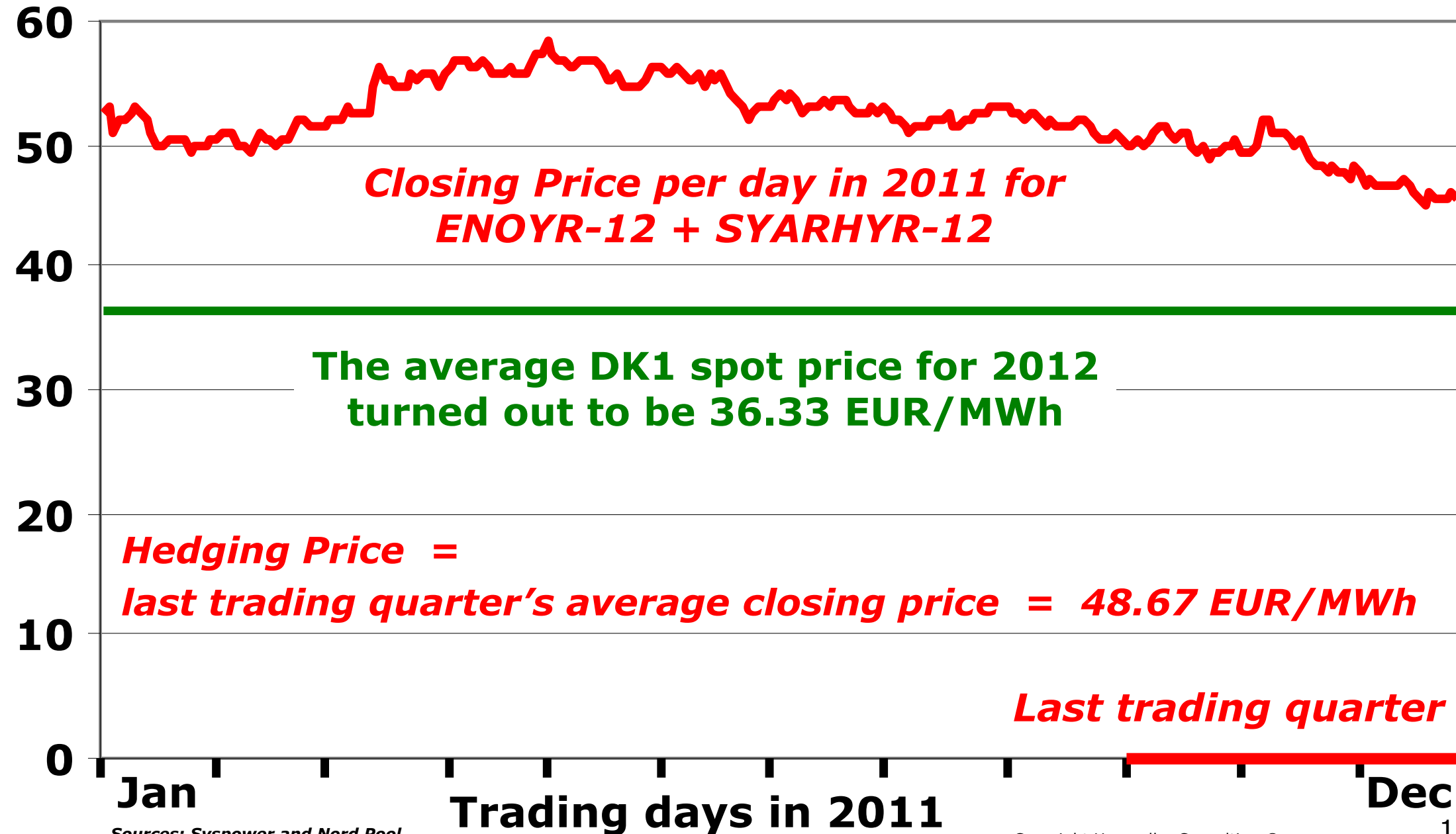
Appendix 1
Closing Prices
Variation during the last year of the financial contract's trading period

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 four slides show the daily Closing Prices for four financial contracts.**

➢ **For each contract, the daily Closing Price is shown during the last year, where the contract was traded.**

➢ **The four contracts hedged against the 2012 spot price for respectively**

  ✓ **Western Denmark (DK1).**

  ✓ **Eastern Denmark (DK2).**

  ✓ **Southern Sweden (SE4).**

  ✓ **The Nordic System Price.**
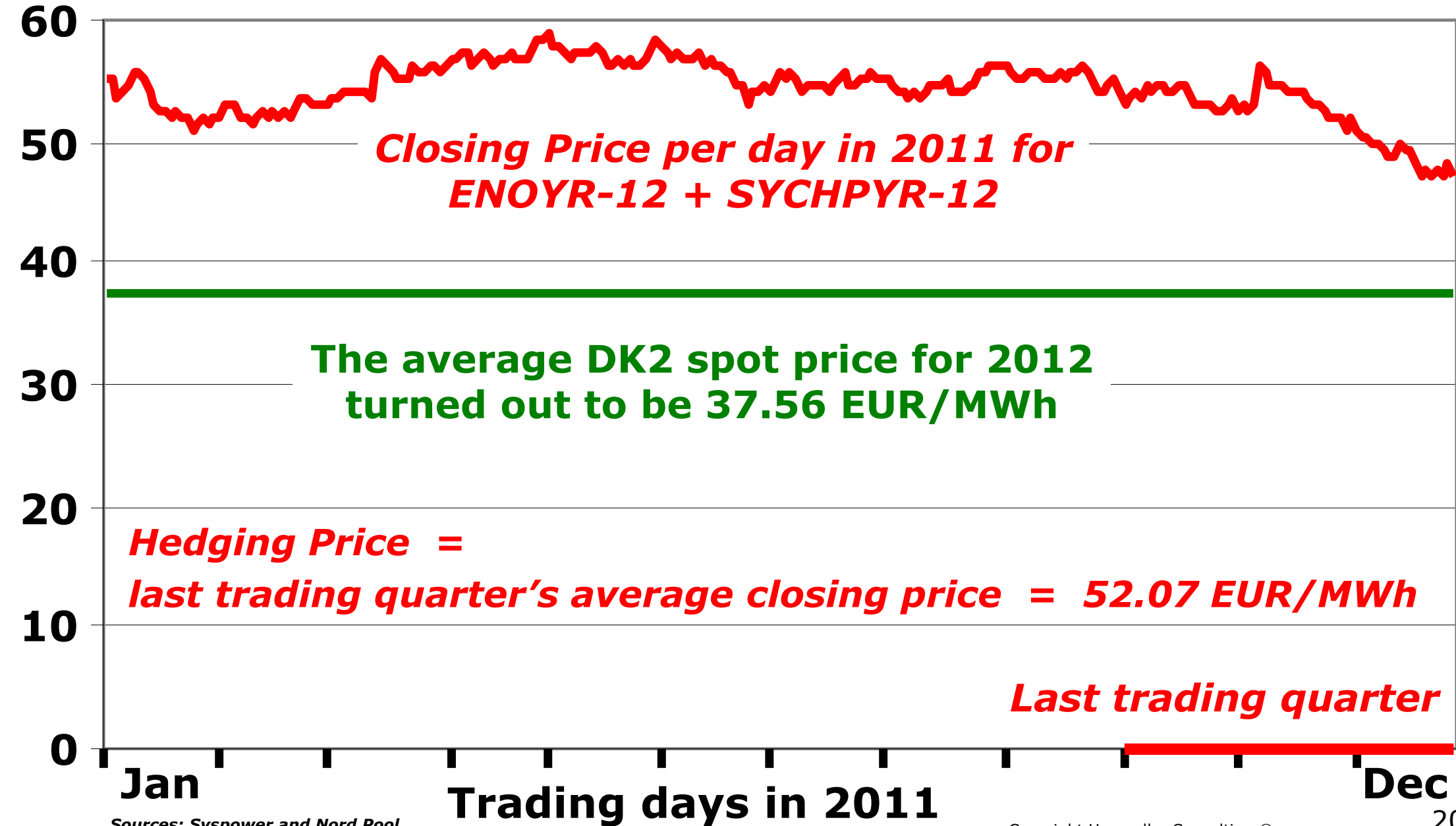
Western Denmark (DK1) – the year 2012

EUR/MWh

Closing prices and the year's average spot price

Closing Price per day in 2011 for ENOYR-12 + SYARHYR-12

The average DK1 spot price for 2012 turned out to be 36.33 EUR/MWh

Hedging Price =
last trading quarter's average closing price = 48.67 EUR/MWh

Last trading quarter

Jan **Trading days in 2011** **Dec**

Sources: Syspower and Nord Pool

19

Eastern Denmark (DK2) – the year 2012

EUR/MWh

Closing prices and the year's average spot price

Closing Price per day in 2011 for
ENOYR-12 + SYCHPYR-12

The average DK2 spot price for 2012
turned out to be 37.56 EUR/MWh

Hedging Price =
last trading quarter's average closing price = 52.07 EUR/MWh

Last trading quarter

Jan **Trading days in 2011** **Dec**

Sources: Syspower and Nord Pool

Copyright Houmoller Consulting ©

20

Southern Sweden (SE4) – the year 2012

Closing prices and the year's average spot price

EUR/MWh

Closing Price per day in 2011 for
ENOYR-12 + SYMALYR-12

The average SE4 spot price for 2012
turned out to be 34.21 EUR/MWh

Hedging Price =
last trading quarter's average closing price = 52.10 EUR/MWh

Last trading quarter

Jan

Trading days in 2011

Dec

Sources: Syspower and Nord Pool

21

Copyright Houmoller Consulting ©

Nordic System Price – the year 2012

Closing prices and the year's average spot price

EUR/MWh

Closing Price per day in 2011 for ENOYR-12

The average System Price for 2012 turned out to be 31.20 EUR/MWh

Hedging Price =
last trading quarter's average closing price = 42.24 EUR/MWh

Last trading quarter

Jan

Trading days in 2011

Dec

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).

➢ *Cleared volume* Concerning the volume for "German financial contracts" at the slides no. 11 and 12:
  ✓ 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).
  ✓ From 2019 and onwards, this is Phelix DE futures.

➢ *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
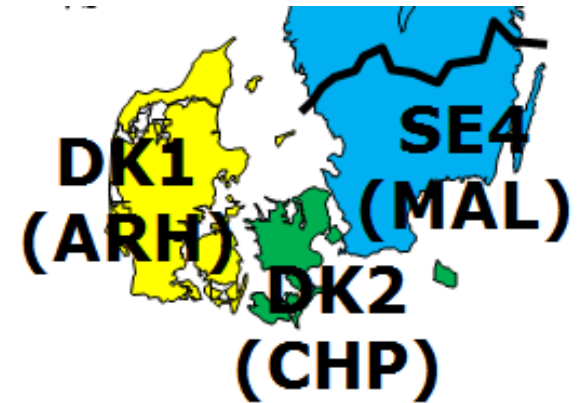
- *Correlation* Given two data sets, the correlation measures the degree to which the two data sets move in lockstep. Please refer to the next-to-last slide.

- *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 www.eex.com.

- *ENOYR-12* See *ticker symbol*.

- *EPAD* Electricity Price Area Differential. See *CfD*.

- *Financial contract* In this presentation, it's a common term for the power derivatives *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 PDF document "The Liberalized Electricity Market".

The liquidity of the Nordic contracts displayed at the slides 11 and 12 illustrates turn-over for all Nordic power derivatives, though.

➢ *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*.

➢ *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 <u>not</u> a price paid from one player to another. The role of a financial contract's price is explained in the PDF document "The Liberalized Electricity Market".

➢ *hedging price* See *Hedging price*.

➢ *LEBA* London Energy Brokers' Association. See the web site lebaltd.com.

The LEBA curve at slide no. 12 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.

➢ *Nasdaq OMX* An exchange, where the players can trade Nordic power derivatives (and other products). Please refer to https://www.nasdaq.com/solutions/european-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 AT spot price** See **Phelix DE/AT spot price.**

➢ **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 physical or 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.

➢ **Southern Sweden** See **SE4.**

Terminology and acronyms – 6
As used in this presentation

➢ *Spot price* **Please refer to the PowerPoint presentation "Maximizing the economic value of market coupling and spot trading" (or the PDF document with the same name).**

➢ *SYARHYR-12* **See *ticker symbol*.**

➢ *SYCHPYR-12* **ticker symbol of the Nasdaq OMX CfD, which hedged against the difference between the DK2 spot price and the System Price during 2012. CPH indicates CoPenHagen.**

➢ *SYMALYR-12* **ticker symbol of the Nasdaq OMX CfD, which hedged against the difference between the SE4 spot price and the System Price during 2012. MAL indicates MALmø (the biggest town in SE4).**

➢ *System Price* **A virtual spot 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 1992-2021" (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 Nasdaq OMX contract, which hedged against the System Price during the year 2012 was ENOYR-12

- **ENO indicates <u>E</u>lectricity <u>NO</u>rdic**
- **YR-12 indicates the year 2012.**

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

- **<u>SY</u> indicates <u>SY</u>stem Price**
- **ARH indicates A<u>ARH</u>us (the biggest town in Western Denmark).**
- **YR-12 indicates the year 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.**
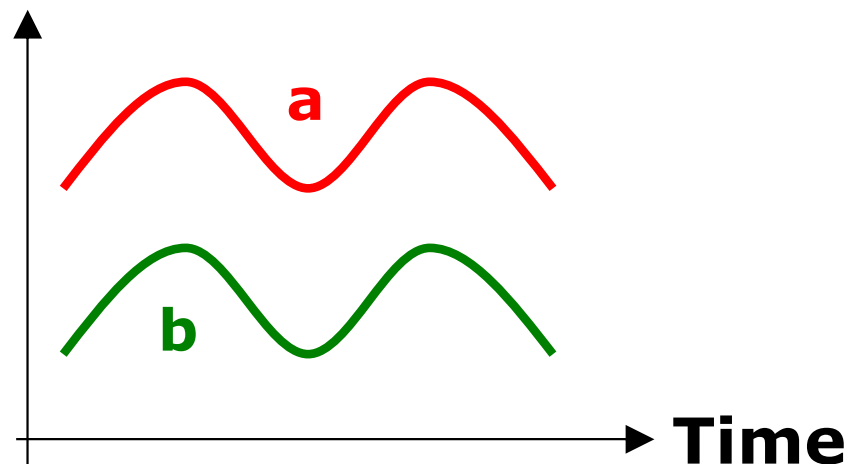
In this example
Correlation(a,b) = 1
as a and b move
in lockstep

Thank you for your attention!

Anders Plejdrup Houmøller
Houmoller Consulting ApS
Tel. +45 28 11 23 00
anders@houmollerconsulting.dk
Web houmollerconsulting.dk