Introduction

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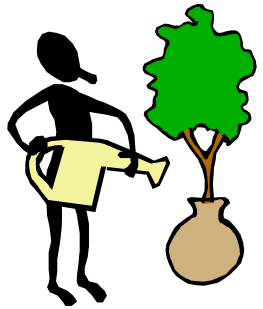
- **Concerning the documents referred to in this presentation:**
  - **At *houmollerconsulting.dk*, you can download the documents from the sub-page *Facts and findings*.**
- **The appendix contains a list of the terms and acronyms used in this presentation.**
- **This PowerPoint presentation is animated**
  - **It's strongly 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*.**

Spot trading

With market coupling as part of the spot trading

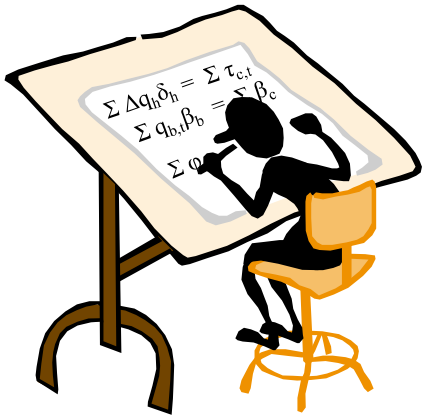
For a simple case with only two price zones, the slides no. 4-6 illustrate the spot price calculation, when we have market coupling *)



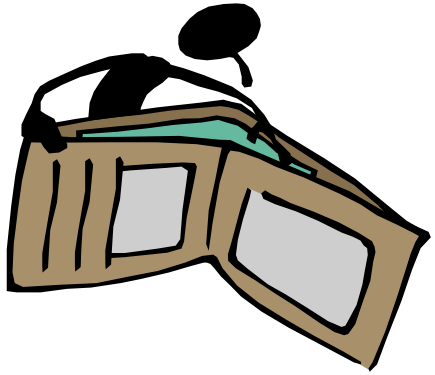
And the slides no. 4-6 illustrate the value created by the spot trading.*)

The slides no. 8-17 discuss how to maximize the value created by the spot trading.

***) For a throughout discussion of these issues, please see the PowerPoint presentation *"Welfare criterion"*.**



Spot trading: the price calculation and the value created by spot trading



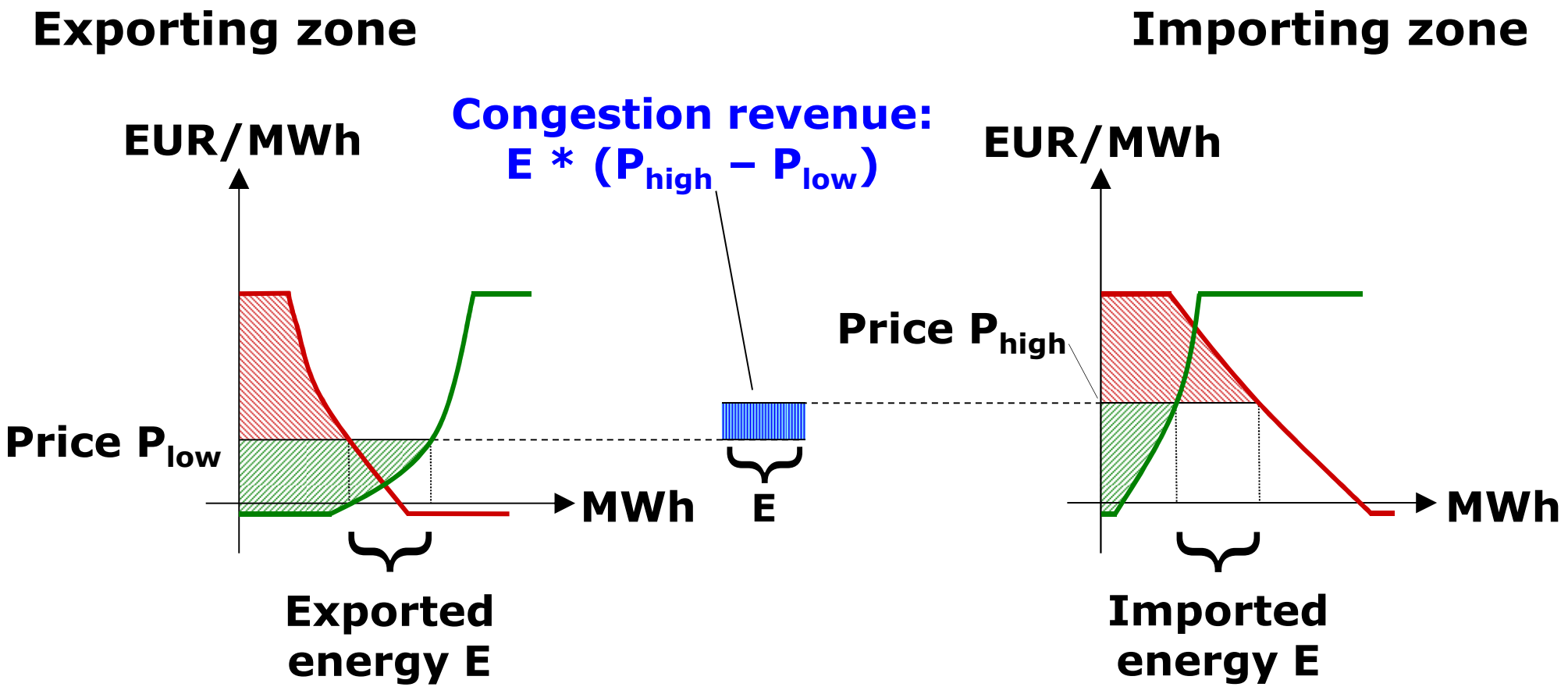
At the following slides, the red curves illustrate the spot exchanges' demand curves.

The green curves illustrate the spot exchanges' supply curves.

Spot trading (with market coupling included)

The price setting and the traders' surplus

For one hour. Only two price zones



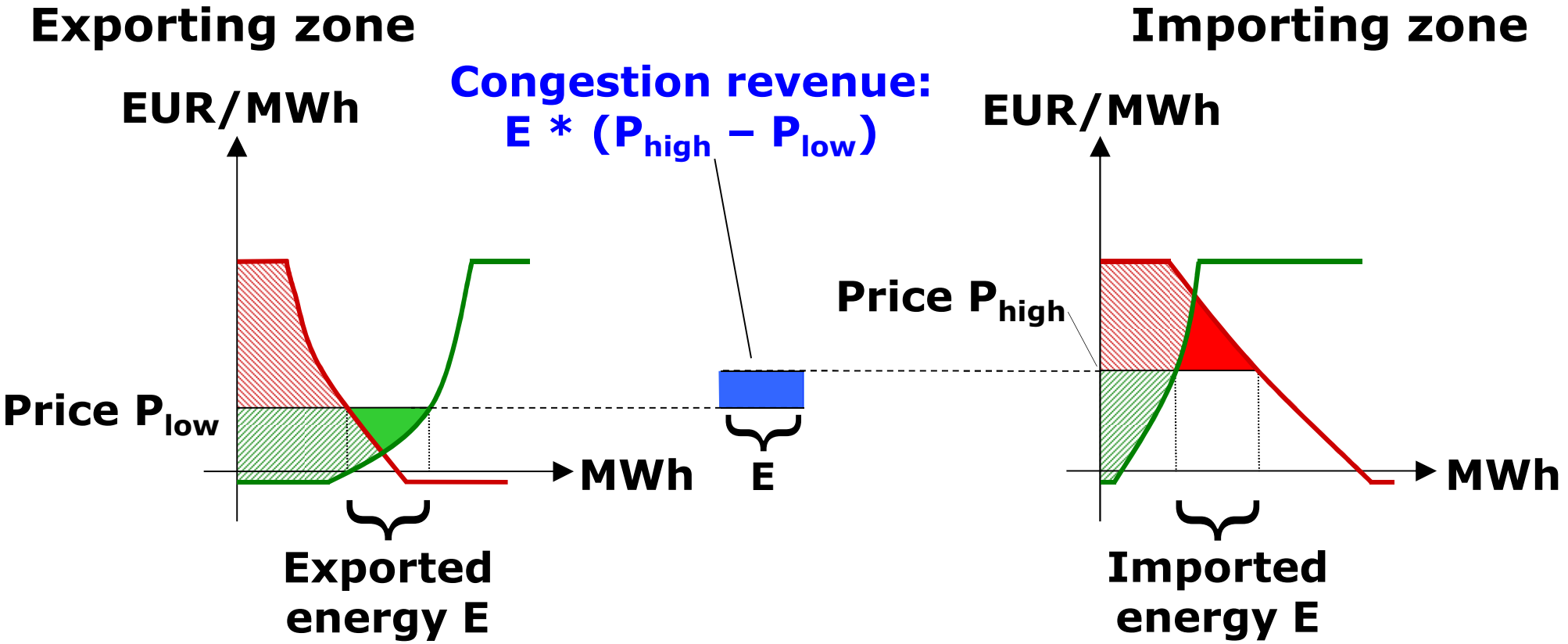
Traders' surplus:

Green areas: sellers' surplus

Red areas: buyers' surplus

The value created by spot trading

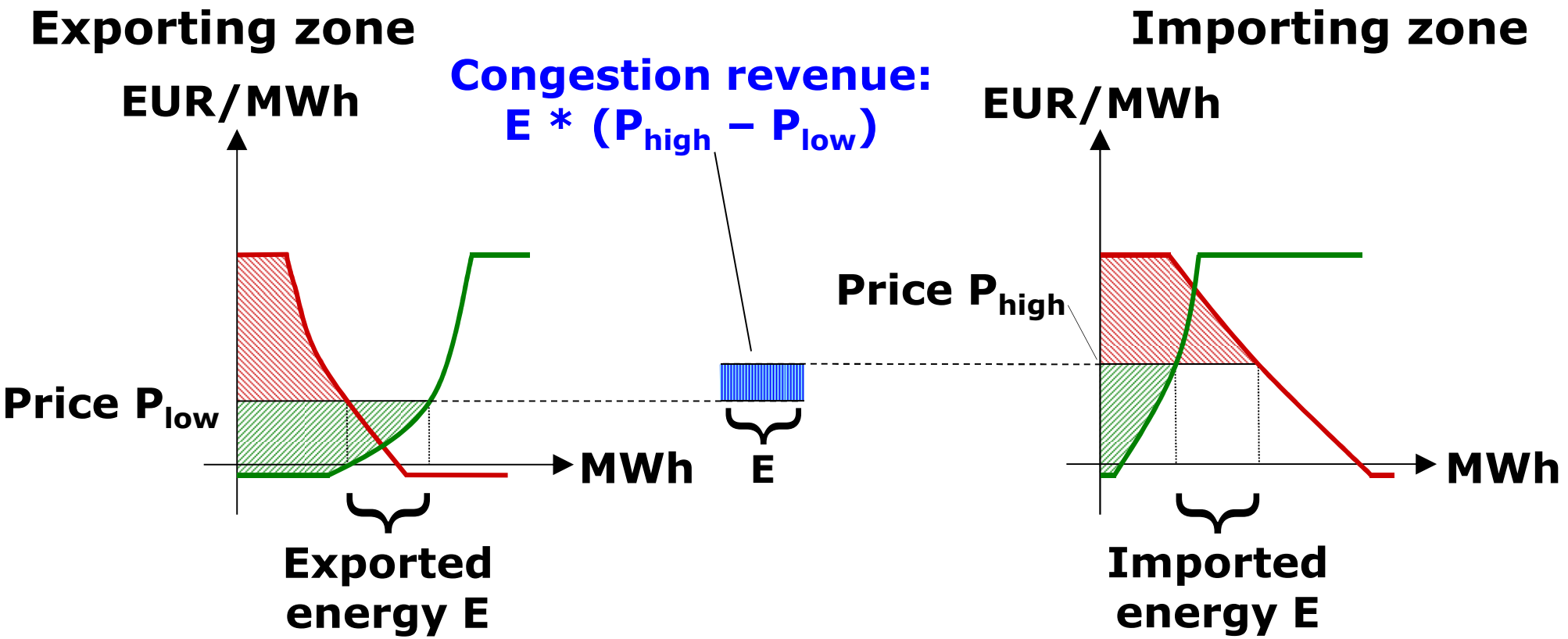
All the red, green and blue areas illustrate the <u>total</u> value created by the spot trading



The green triangle, red triangle and the blue rectangle illustrate the value created by the spot cross-border trading (ie, the value created by the market coupling part of spot trading)

Maximizing the value created by spot trading

All the red, green and blue areas illustrate the <u>total</u> value created by the spot trading



The task for the spot calculation algorithm is to maximize the red, green and blue areas (ie, maximize the value created by the spot trading). The maximization runs over all price zones and all 24 hours of the next day.

Maximizing the value created by spot trading

Handling of interconnectors – 1

- Consider two neighbouring price zones Z_1 and Z_2 connected by a link L.
- Due to the block bids: the solution maximizing the value of spot trading will have many hours, where
  - The spot trading does not fully use the link's trading capacity.
  - Even though the prices are not equal ($p_1 \neq p_2$).
- For an explanation of this counter-intuitive fact, refer to the PowerPoint presentation "*Market coupling – technical issues*"
  - About 15 years ago, the introduction of block bids caused an explosion in the complexity of the spot price calculation
    - As the following slide illustrates: the consequences of this revolution are still not taken into account.

Handling of interconnectors – 2

- **The problem: all the current European spot calculation algorithms force their software to select non-optimal solutions**
  - **Solutions that never have unused capacity at interconnectors connecting price zones with different spot prices.**
- **This artificially introduced extra requirement is an example of planned economy forcing non-optimal solutions on the electricity market.**
- **Anecdotic evidence indicates this relic of planned economy reduces the value of the spot trading with 40%!**

Market economy

- The optimizations made by market economy do not lend themselves to intuitive understanding.
- For example: due to the fierce competition, we are probably close to the optimal solutions for groceries, mobile telephones, etc.
- However, it would be ridiculous to claim we ”intuitively” understand that the current pattern of grocery shops, mobile telephone manufactures, etc. is close to the optimal solution.
- Astonishingly, for market coupling we often hear arguments for non-optimal solutions
  - With the reasoning the non-optimal solutions “fit intuition”.
- We only have this discussion, because the electricity supply business has been rule by planned economy for so many years
  - And we’re still on a journey from planned economy towards market economy for the electricity supply business.

If the market economy's solution does not fit my intuition…

I'll choose other solutions!

Why market coupling?

Question: for the electricity grid – why have market coupling as day-ahead congestion management?

Actually, this is a step backwards to planned economy

As the day-ahead cross-border trading is placed in the hands of monopolies.*)

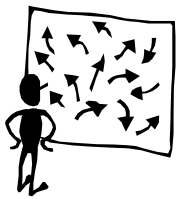
At the outset, allowing the players to do all the cross-border trading themselves is the solution conforming to market economy.

) See the PowerPoint presentation *"Market coupling makes real competition betw. spot exchanges unfeasible"

Answer: one of the necessary preconditions for a well functioning market is this

Both buyers and sellers must have full overview of the market

For the electricity supply business – where the grid is a monopoly transport system – it turns out, this precondition cannot be met for cross-border trading.



Practical experience shows the commodity (electrical energy) flows in the wrong direction very often, if the day-ahead congestion management is bilateral cross-border trading.

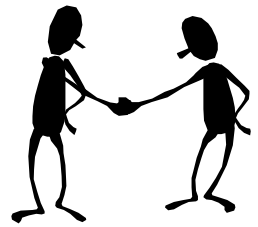
Basic requirement to market coupling

- The conclusion at the previous slide provides us with the basic requirement to market coupling:
  - **The solution produced by market coupling must correspond to the solution, which would have been produced by market players with full overview doing the cross-border trading themselves.**
- We'll never get lost, if we stay with this requirement.
- The technical details can be very complicated
  - However, the users of the market coupling can themselves appoint experts from Europe's universities who truly understand market economy and linear optimization.
  - By employing user-appointed advisors, an empowered market coupling user council can ensure the coupling adheres to the requirement.

- Also, an empowered, user-dominated market coupling council will give us a customer-driven, bottom-up governance for the European market coupling.

Consequences of the basic requirement

- A bilateral cross-border trading system used by players with full oversight would produce many hours, where neighbouring price zones have different prices, although their interconnector's capacity is not fully utilized
  - Due to the effect of the block bids, this is the solution providing the best value for the players.
- Further: the current Euphemia market coupling algorithm favours small block bids at the expense of big block bids, even though this reduces the value of the spot trading
  - This was never requested by end users – and this also violates the basic requirement.
  - Moreover, as block bids are mainly used by producers, this favours some producers at the expense of all the consumers
    - And at the expense of the rest of the producers.
  - This feature is another relic of planned economy.
- An empowered market coupling council with advisors appointed by the council itself can deal with such relics.



Including grid losses in the optimization

Actually, the optimization illustrated at the slides no. 4-6 is imperfect

As it does not include the economic value of the grid losses.

For virtually all other commodities, the transportation costs are included in the trading of the commodity .

However, for AC grids, even with flow-based market coupling, the precise flows are not known.

Hence it only makes sense to include the losses for the DC links.

This squares nicely with the fact that the losses for DC links are much higher than the losses for AC links.

If E_{loss} is the energy lost, the value of the grid loss is about

$E_{loss} * p_{mean}$ (the energy lost multiplied with the price of energy).

Note: this is the economic loss, also if the grid loss is not bought!

No matter how the loss is handled: the cost of an energy E_{loss} disappearing is ($E_{loss} * p_{mean}$), if the energy price is about p_{mean}

$$P_{mean} = (p_1+p_2)/2$$

Including DC grid losses in the optimization – 1

- The issue is not the physical grid loss
  - ie, the issue is not the amount of energy lost.
- The issue is the economic value of the grid loss
  - ie, the issue is the amount of money lost.
- Also compare with trading of other commodities: the relevant entity is the cost of the transportation.
  - A case illustrating the point: when the spot prices are negative, a physical grid loss is an advantage!
- Hence, the algorithm should not try to model the physical grid loss
  - ie, the point is not to model the fact that an input of energy E at one end of the link gives an output of $(E - E_{loss})$ at the other end of the link.
- Also when the DC grid losses are taken into account: the point is still to maximize the value of the spot trading.

Including DC grid losses in the optimization – 2

- The point is <u>not</u> to ensure the congestion revenue can cover the value of the grid loss.
- The spot calculation algorithm would produce inferior, non-optimal solutions, if we introduced a requirement like this:

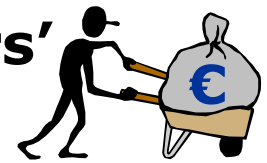
$$E_{loss} * p_{mean} \leq \text{(congestion revenue)}$$

- Same result, if we introduced another, similar requirement aiming at making the congestion revenue bigger than the cost of the grid loss.

$$P_{mean} = (p_1+p_2)/2$$

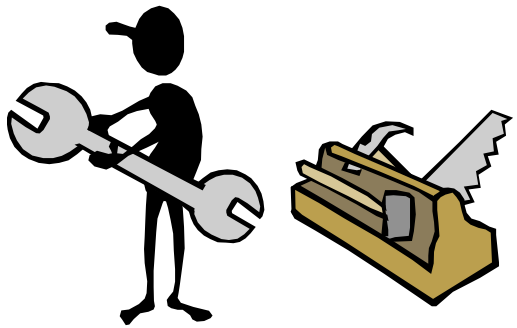
Including DC grid losses in the optimization – 3

- Referring to the slides no. 4-6:
- The point is to maximize the value of the spot trading
  - Now also including the economic value of the DC grid losses.
  - This will make the market coupling emulate a optimal bilateral cross-border trading system
    - Where cross-border traders with full overview would pay for the DC grid losses.
    - ie, would pay for the DC transportation of the commodity.
- Hence, for some hours, it will make perfect sense to reduce the congestion revenue (the blue area) to zero
  - As this may give a substantial increase in the traders' surplus (the red and green areas).



- Note the consequence: also when the DC grid losses are taken into account, the optimal solution will sometimes create the same prices at the two sides of a DC link.

The tools providing a safer spot price calculation



Open source software
Establishing transparency

HoumollerConsulting
QUALITY ADVICE

- **The IT system used for European spot price calculation (and thereby the European market coupling) must be open source software**
  - **As every grid user will be forced to finance and use this software**
    - **You cannot choose between competing European market coupling systems…**
- **Open source software allows everybody to scrutinize the IT system**
  - **For example, everybody from the *geek community*.**
- **This gives us a safer IT system, as practical experience shows**
  - **Because we use crowd sourcing for the detection of flaws in the software.**
- **The urgency of installing effective flaw detection is illustrated by the spot exchanges' many costly calculation errors**
  - **Please refer to the PowerPoint presentation *"Market coupling and spot price calculation"*.**
- **It's also illustrated by Nord Pool Spot's inability to re-calculate the spot prices for 5 August 2013 – and by Nord Pool Spot's inability to publish the re-calculated spot prices for 26 June 2013 in due time**
  - **It's further illustrated by APX' & Belpex' inability to receive the customers' bids for 9 July 2013 electronically – thereby devastating market coupling.**

Appendix
Terminology and acronyms

Terminology and acronyms – 1

- ***Block bids*** **Please refer to the PowerPoint presentation "*Market coupling – European price coupling*".**
- ***Double auction*** **A calculation method whereby an exchange's price is set by using the exchange's supply curve and the exchange's demand curve. Please refer to slide no. 4.**
- ***Energy flow*** **Actually, in this presentation, "energy flow" means "day-ahead plans for cross-border energy flow".**

  Note that market coupling/splitting does not create energy flows. It merely creates day-ahead plans for the cross-border energy flows. Later, these plans my be modified by market players' intra-day, cross-border trading and/or the TSOs' cross-border trading of regulating energy.
- ***Euphemia*** **The algorithm used by the current spot calculation in Western Europe. Euphemia has been used for this since 4 February 2014. See the PowerPoint presentation *Single spot exchange for the Single Electricity Market*.**
- ***Flow*** **Short-term for energy flow.**

Terminology and acronyms – 2

- ***Market coupling*** **A day-ahead congestion management system, you can have on a border, where two electricity exchanges meet. The day-ahead plans for the cross-border energy flows are calculated using the two exchanges' bids and information on the day-ahead cross-border trading capacity.**

  Please refer to the chapters 8 and 9 in the PDF document "*The liberalized electricity market*".

  For simplicity, apart from the appendix, in this presentation "market coupling" is used as short-hand for "market coupling/splitting".

- ***Market splitting*** **A day-ahead congestion management system, you can have on a border, where you have the same electricity exchange on both sides of the border. The day-ahead plans for the cross-border energy flows are calculated using the exchange's bids and information on the day-ahead cross-border trading capacity.**

  Please refer to the chapters 8 and 9 in the PDF document "*The liberalized electricity market*".

  For simplicity, apart from the appendix, in this presentation "market coupling" is used as short-hand for "market coupling/splitting".

Terminology and acronyms – 3

- ***Open source software*** **In this presentation, this means software where the source code is available to everybody.**
- ***Price zone*** **A geographical area, within which the players can trade electrical energy day-ahead without considering grid bottlenecks.**
- ***Spot exchange*** **In this document, a spot exchange is an electricity exchange where**
  - **Electrical energy is traded day-ahead.**
  - **The day-ahead prices are calculated by means of double auction.**
- ***Spot price*** **A price calculated by a spot exchange. Either by a the spot exchange itself or by a company, to which the calculation has been outsourced.**
- ***Spot trading*** **Trade done with a spot exchange.**
- ***TSO*** **Transmission System Operator.**

Thank you for your attention!

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