1. Introduction

This document describes the function of the market coupling software used by European Market Coupling Company EMCC.

The terminology used in this document is explained in appendix A.

Although EMCC does not publish prices, EMCC's IT tool nevertheless calculates the day-ahead prices and the day-ahead plans for the cross-border energy flow for all the bidding areas in the EMCC region. Hence, inside the software, it looks as if EMCC is trading energy between all the bidding areas in the EMCC region.

For each of their bidding areas, the participating exchanges send bids and offers to EMCC. Therefore, inside the software, the participating energy exchanges looks like participants being members of an exchange operated by EMCC.

2. The software's constraints and the criterion

2.1 Description of the constraints and the criterion

The following must be fulfilled, when the EMCC IT-system calculates the day-ahead prices and the day-ahead plans for cross-border energy flows:

A) For each hour and each bidding area: (Total volume bought) = (Total volume sold).
B) For each hour and each bidding area: (The demand price) = (The supply price).
C) The planned **energy flow** between two bidding areas is never bigger than the trading capacity between the two areas.
D) The **ramping** constraints.
E) Deadband: For some interconnections, transfer power loss has to be taken into account.
F) Bids are executed according to the bid curves the power exchanges submitted. All price limits are respected.
G) Flexible hourly sales bids are executed in the hour with the highest welfare gain, which usually means the hour with the highest price, if that price is higher than the bid price.
Analogously for flexible hourly purchase bids.
H) For **sales block bids**: A sales block bid must not be executed if the average price in the respective hours is lower than the bid price.
For purchase block bids: A purchase block bid must not be executed if the average price in the respective hours is higher than the bid price.
Note: This may force the software to select, which block offers will be included in the trading. For instance, the software will have to carry out such a selection, if there are 3 very similar block offers of which only 2 can be included in the trading. Naturally, this selection is done in an automatic process. Correspondingly for block purchase bids.
I) In A-H, the software's constraints are listed. Within the freedoms left, the software will choose a solution, which is good according to the so-called "**economic welfare criterion**". This criterion aims at maximising the buyers' and the sellers' total economic gain. When applying maximization of economic welfare to market coupling it usually leads to cross-border flow from the area with the lower price to the area with the higher price, as long as not contradicted by capacity or ramping constraints.

Please refer to **fig 1**: For every bidding area, there is one such area A between the two curves for every hour of the following day. Hence, the total number of such areas is (Number of bidding areas) * 24

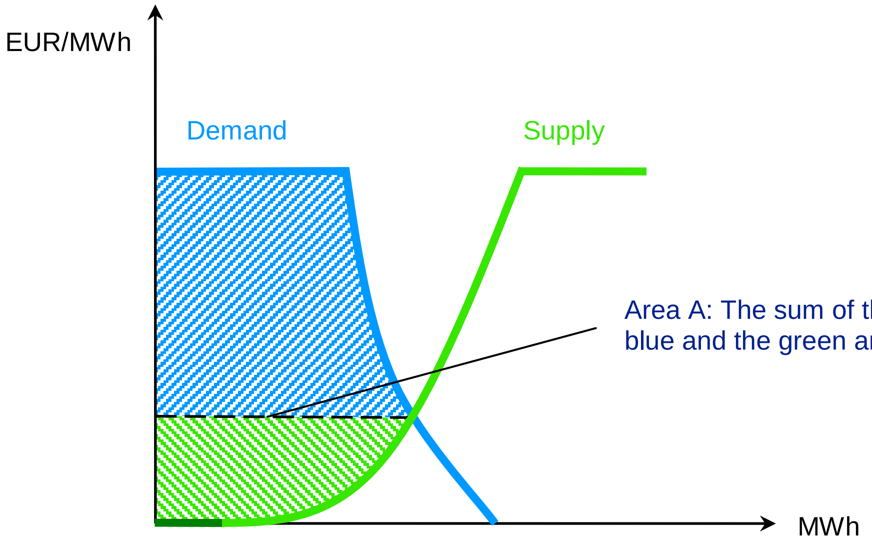

Fig. 1 For one hour for one bidding area: The buyers' and the sellers' total gain is the area between the supply and the demand curve (The area A on the left side of the intersection of the two curves)

Strictly following the economic welfare criterion would mean the software would choose the solution, which maximises the sum of these areas.

Because the welfare gain will be bigger when selling power in an area with a higher price than when selling in an area with a lower price the economic welfare criterion will usually lead to a power transfer from the area with the lower price to the area with the higher price.

However, as the number of possible solutions is very, very big, it is not always possible for the software to find the solution, which gives the absolute maximum of this sum of areas. Hence, the software will be content with a solution, which is the best according to this criterion among all the possible solutions found during the calculation.

2.2 Ramping

Note: There are no additional, special criteria for the ramping. The automatic ramping is also carried out according to the constraints and the criterion listed above.

Example: Assume the flow in one hour t on one cross-border link to be 1000MW and the ramping be limited to 600MW. Then, the flow in the following hour t+1 will have to be between 400MW and 1600MW while still respecting the capacity constraints.

The software will carry out the ramping in a way, which will keep the sum of the areas mentioned in section I) as high as possible. In this way, the software will try to minimise the influence, ramping has on the sum of the participants' economic gains.

3 Disclaimer

EMCC will not accept any liability due to statements in this document.

Appendix A – terminology and acronyms

Auction trading system	in this document, this denotes a trading system, where the price is set by calculating the intersection between the supply curve (constructed on the basis of all the sale offers) and the demand curve (constructed on the basis of all the purchase bids).
Bidding area	when a participant sends his bids/offers, the participant must specify in which bidding area he wants to trade. *Example: A participant may send bids/offers specifying that these bids/offers refer to Eastern Denmark. Normally, Norway is divided into a number of different bidding areas. For the time being, the areas Germany, Finland, Sweden, Eastern Denmark and Western Denmark each constitute one bidding area.*
Block bid	a block sales offer is an offer, where the seller states he wants to sell a given volume during some specified hours, if the average price during these hours is above a certain limit. The seller will either sell the whole volume or nothing. Compare single-hour bid. *Example: During the four hours from 7 am to 11 am, I will sell 200 MWh per hour if the average price is 30 EUR/MWh or higher*. A block purchase bid is a bid, where the buyer states he wants to buy a given volume during some specified hours, if the average price during these hours is below a certain limit. The buyer will either buy the whole volume or nothing. *Example: During the five hours from 4 pm to 9 pm I will buy 100 MWh per hour if the average price is 20 EUR/MWh or lower*. A block bid is the common term for block sales offers and block purchase bids.
Cross-border energy flow	The EMCC region is divided into a number of bidding areas. In this document, cross-border energy flow is the flow on the power lines connecting two neighbouring bidding areas. Hence, the "border" need not be a border between two countries. It may be a border between two bidding areas inside a country.
EMCC	European Market Coupling Company GmbH
EMCC region	the region covered by the energy exchanges participating in the EMCC market coupling.
Linear interpolation	Used for single-hour bids *Example: Suppose a player has sent the following single-hour bids for the hour between 8 am and 9 am: At the price 20 EUR/MWh, the player will buy 400 MWh. At the price 30 EUR/MWh, the player will buy 200 MWh. If the price during this hour turns out to be 25 EUR/MWh, the player has bought 300 MWh*.
Ramping	On a DC link connecting two bidding areas, the TSO's may specify a ramping constraint. Assume the trading capacity on a north-south link is 1,000 MW and assume the TSO's for this link has set a ramping constraint of 600 MW. This means the energy flow between the two bidding areas connected by the link cannot shift with more than 600 MW from one hour to the next. Even if the economic welfare criterion would suggest a bigger shift it will always be kept inside this range. In order to comply with the ramping constraint, the software may even be forced to send energy in the direction of the low-price area during some hours. Naturally, also in such cases the constraints **A-D** and **F-H** as well as the criterion **I** are applied when the software produces a solution.
Single-hour bid	A purchase bid or a sales offer where the player states he wants to trade during a given hour. Compare block bid and linear interpolation.

<u>Example 1:</u> For the hour between 10 am and 11 am, the player wants to buy 20 MWh, if the price is between the minimum price and 25 EUR/MWh.
<u>Example 2:</u> For the hour between 6 pm and 7 pm, the player wants to sell 30 MWh, if the price is between 35 EUR/MWh and the maximum price.

TSO	Transmission System Operator

Appendix B – The Economic Welfare Criterion

In Fig. 2 we consider one MWh. The buyers are willing to pay a rather high price for this MWh. However, also for this MWh, the buyers will pay the market price.

Hence the buyers' gain for this MWh is the red area in fig. 1B:

[(The buyers' bid price for this MWh) – (The market price)] * 1 MWh

For the MWh in question, the sellers are willing to sell at a rather low price. However, also for this MWh, the sellers will get the market price.

Hence the sellers' gain for this MWh is the green area in fig. 1B:

[(The market price) – (The sellers' offer price for this MWh)] * 1 MWh

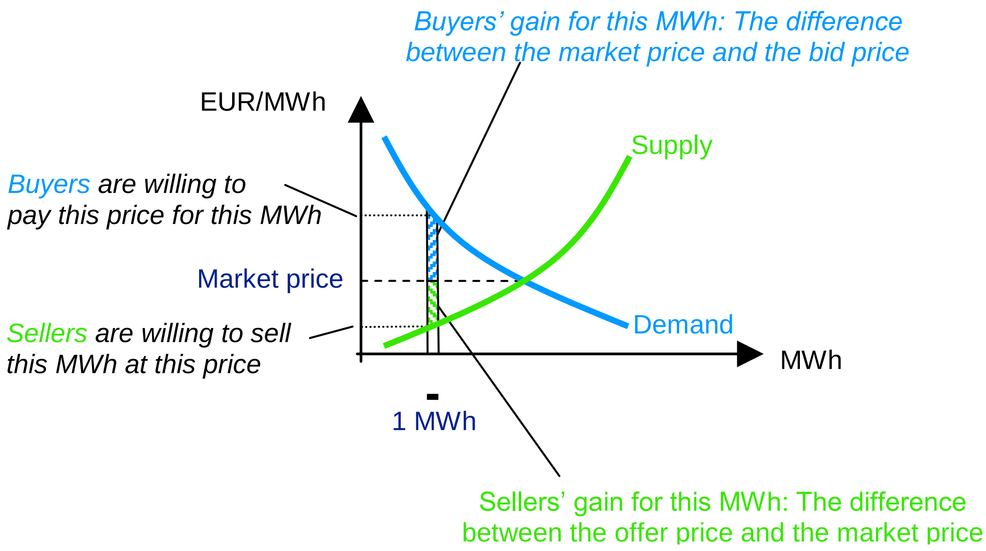

Fig. 2 the buyers' and the producers' gain for one MWh.

Now please refer to Fig. 1 in the main text. By considering all the MWh traded, we conclude from the argument above, that the total gain for both the sellers and the buyers is the area between the supply curve and the demand curve. Therefore

maximising this area will maximise the sum of the participants' economic gains.