



CROATIAN POWER EXCHANGE

TRADING PLATFORM
CLEARING AND SETTLEMENT
MEMBERSHIP



TRADING PLATFORM

Wilhelm Söderström, Nord Pool Spot

Ante Mikulić, CROPEX

European day-ahead market

A fair and transparent calculation of day-ahead power prices is an important factor for the success of the integration of the European power market.

- Price Coupling of Regions (PCR)
 - The initiative of 7 Power Exchanges to develop a single price coupling solution
 - EUPHEMIA algorithm
- Multi-Regional Coupling (MRC)
 - Coupling of regions and efficient management of available transmission capacities between areas and countries

The integrated European electricity market is expected to increase liquidity, efficiency, social welfare and transparency of prices and flows.



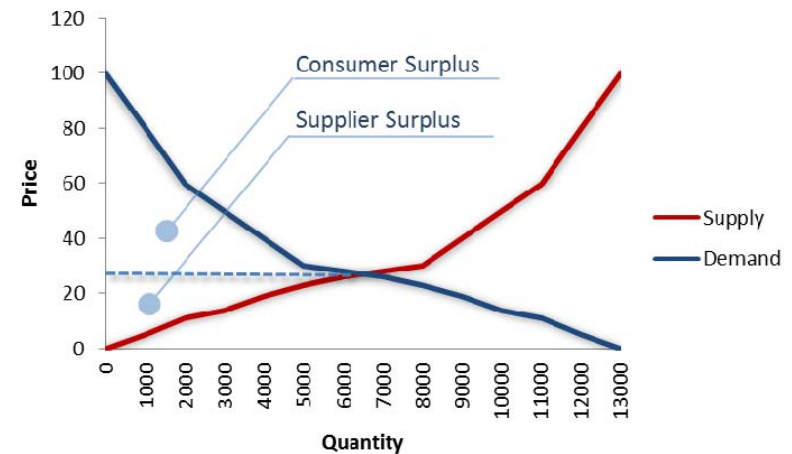
Euphemia algorithm

EU + Pan-European Hybrid Electricity Market Integration Algorithm

Main Objective = Maximize Social Welfare - while respecting all the given constraints

Social welfare = consumer surplus + supplier surplus + congestion rent

- Algorithm currency is Euro
- Optimization time 10 min
- Price limits: Min -500€ Max 3000€
- EUPHEMIA uses the **Branch-and-Bound** technique for solving the optimization problem.



More information is found in the Euphemia public description:

http://www.nordpoolspot.com/globalassets/download-center/pcr/euphemia-public-description_nov2013.pdf

CROPEX and PCR

PCR Input data

- Topology
- Network data (zero for Croatia from the start)
- Aggregated order curves, CROPEX orders will be included in the Nord Pool Spot order book

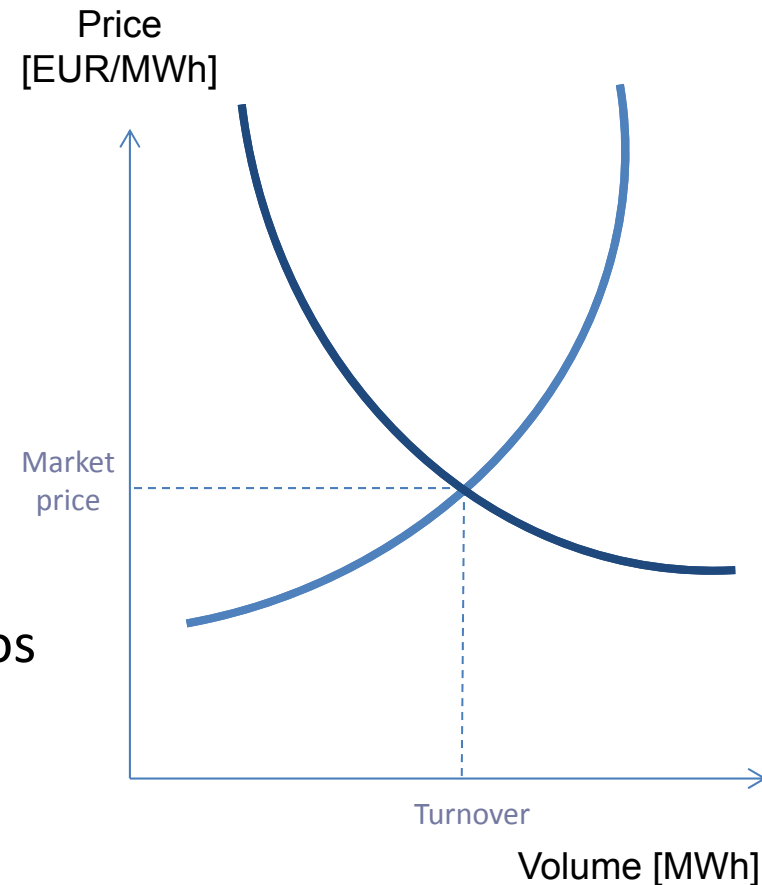
PCR Output

- Prices and cross border flows
- Each PX allocate volumes based on the prices.



CROPEX Day Ahead Market

- Daily auction of power for delivery the following day (365 days per year)
- Prices are calculated based on supply and demand using the Euphemia algorithm as part of PCR (European market coupling)
- Web-based trading solution
- Orders submitted electronically in Euros
- Linear single hourly order curves



Linear vs. Stepwise single hourly curves

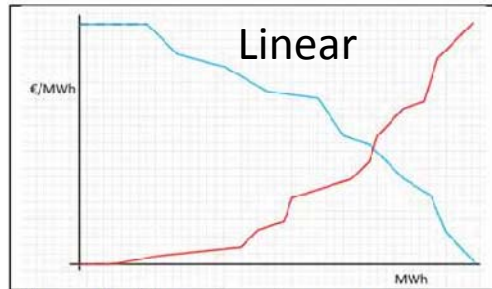


Figure 6 – Linear piecewise aggregated curve.

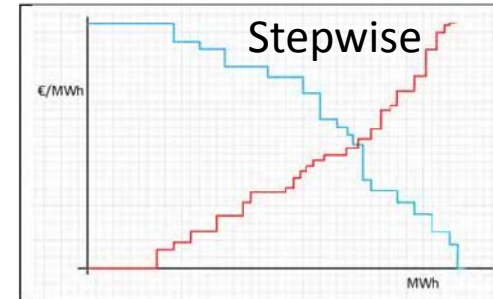
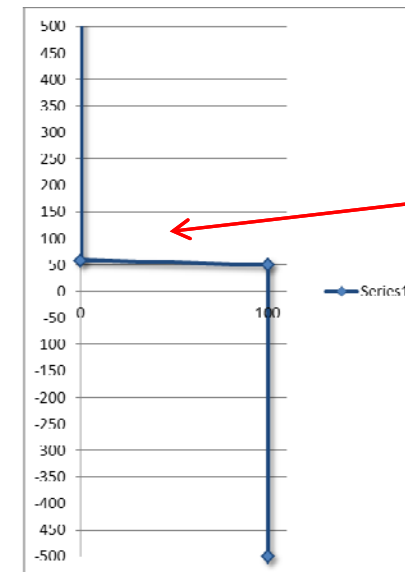


Figure 7 – Stepwise aggregated curve.

Linear curves:

- Two consecutive points of the curve cannot have the same price
- If the price ends up in between two price steps, the order will be **matched based on linear interpolation**

Currency: EUR		at ref. price ⚙	-500,0	50,0	50,1	3 000,0	+
Hour 1	00 - 01		100,0	100,0	0,0	0,0	
Hour 2	01 - 02		100,0	100,0	0,0	0,0	
Hour 3	02 - 03		100,0	100,0	0,0	0,0	
Hour 4	03 - 04		100,0	100,0	0,0	0,0	



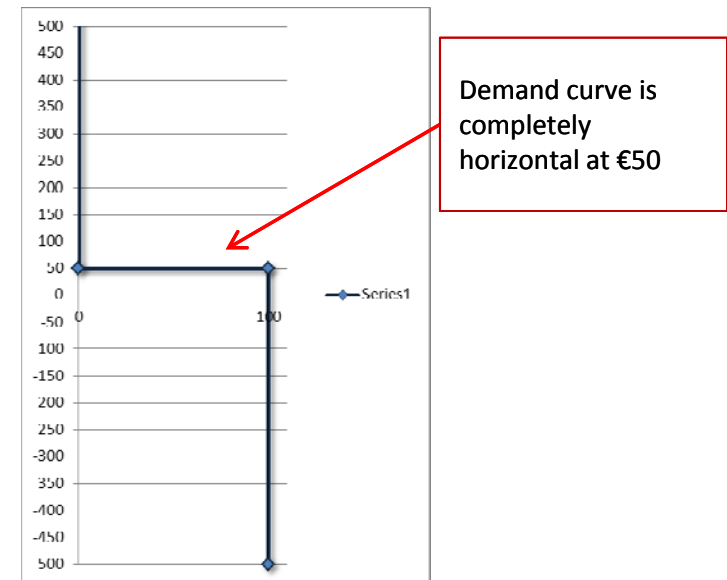
Linear interpolation between €50 and €50,1, therefore not possible to have fully horizontal demand curve between two price points

Linear vs. Stepwise single hourly curves

Stepwise curves:

- Two consecutive points always have either the same price or the same quantity
- Horizontal steps in the curve
- Either all the volume is being matched or nothing at all

Currency: EUR		at ref. price ⚙	-500,0	50,0	50,0	3 000,0 +
Hour 1	00 - 01		100,0	100,0	0,0	0,0
Hour 2	01 - 02		100,0	100,0	0,0	0,0
Hour 3	02 - 03		100,0	100,0	0,0	0,0
Hour 4	03 - 04		100,0	100,0	0,0	0,0



CROPEX – Market operations

Market Operations

Member Support

Monitoring
of trades

Market
surveillance

REMIT
reporting

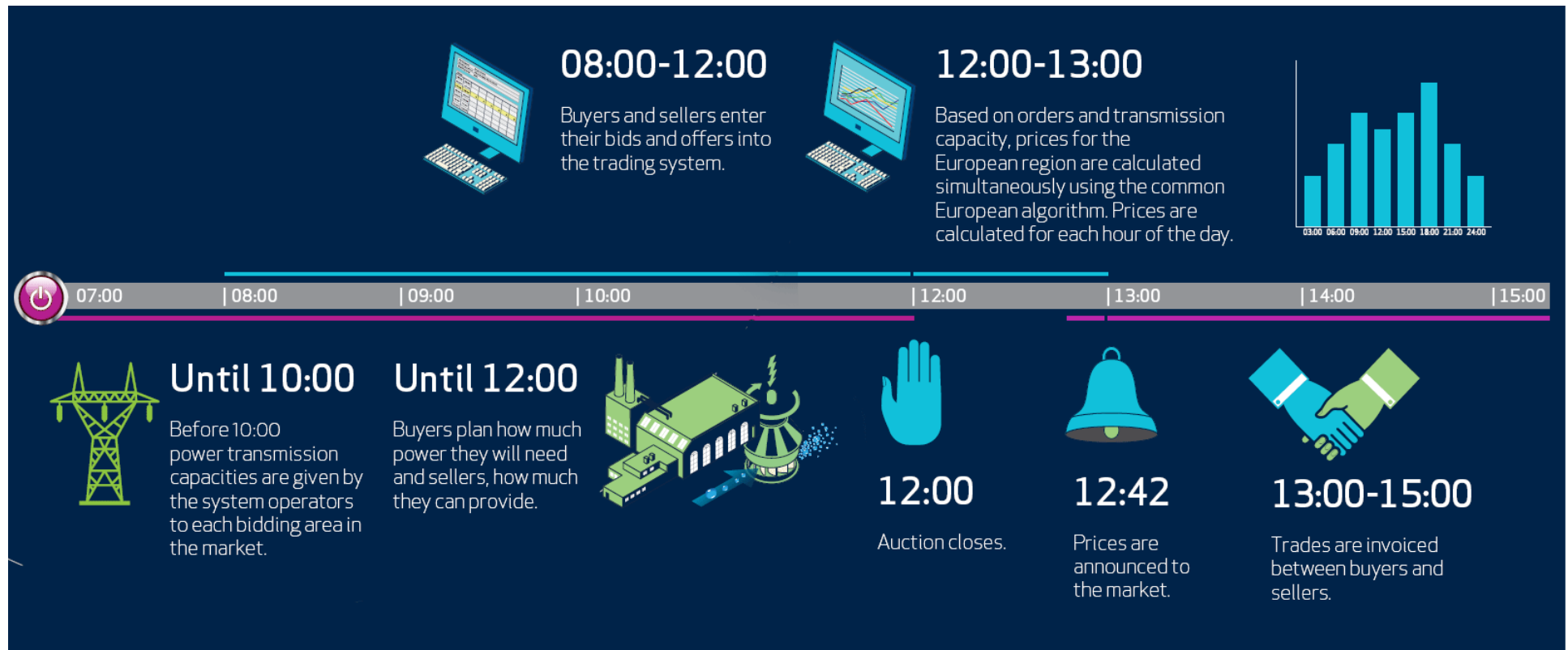
General
questions

Technical
problems

Entering
of bids

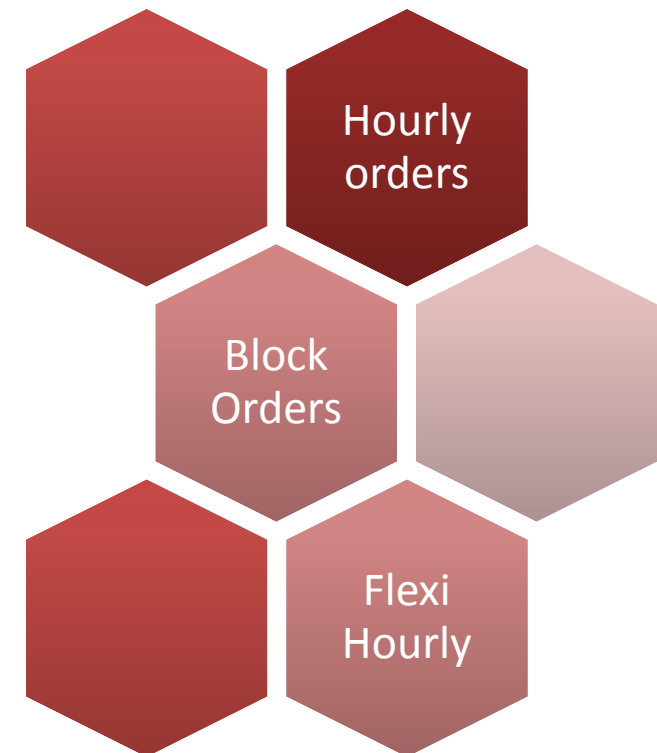


CROPEX and PCR Daily routines



CROPEX – Trading platform – Product info

CROPEX Day Ahead Market	
Order Type	Hourly Orders
Trading Hours	00:00 CET – 24:00 CET
Gate Closure	12:00 CET
Trade Lot	0,1 MW
Tick Size	Euro 0,1/MWh
Price Steps	64
Minimum Price	-500,00 €
Maximum Price	3000,00 €




CROPEX – Trading platform - Login

A screenshot of the CROP ⇒ X login page. The page features the CROP ⇒ X logo and the text 'CROATIAN POWER EXCHANGE' at the top. Below the logo is the text 'Day Ahead'. The page is divided into two sections: 'DIGIPASS' and 'PERSONAL'. The 'DIGIPASS' section has a shield icon and two input fields labeled 'Username' and 'Key'. The 'PERSONAL' section has a person icon and two input fields labeled 'Username' and 'Password'. A 'Log In' button is located at the bottom. A link for 'Forgotten your password?' is also present.


CROP ⇒ X
CROATIAN POWER EXCHANGE

Day Ahead

 **DIGIPASS**

Username

Key

 **PERSONAL**

Username

Password

[Forgotten your password?](#)

Log In

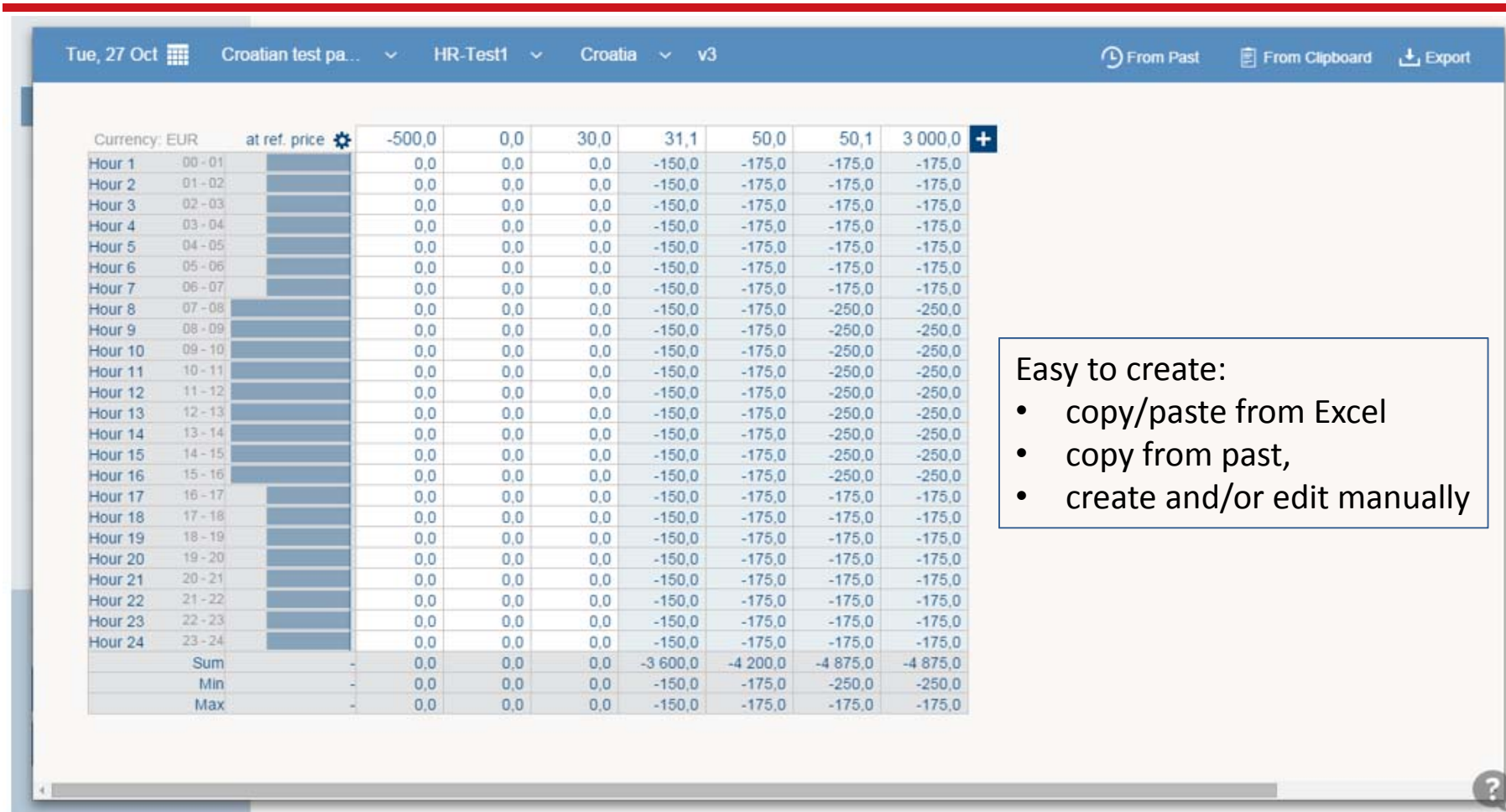
CROPEX Trading Platform - Overview

The screenshot displays the CROPEX Trading Platform interface for Tuesday, 27 Oct. The main content area is titled 'ORDERS (1, 3 MISSING)'. It features a 'Hourly (1, 3 missing)' section with a bar chart showing volume at reference price from 00:00 to 24:00. A table below the chart shows a total volume of -4 875,0 MWh, last updated at 13:27. The interface also includes sections for 'Block (0)' and 'Flexible Hourly (0)', both indicating no orders for the current date. A sidebar on the left contains navigation options like 'Orders', 'Results', and 'Quick Create' buttons for 'From Past' and 'Upload'.



Order(s) at reference price	Sum	Last Updated	
	-4 875,0 MWh	13:27	You

- Overview of all portfolios and orders.
- Graphic presentation of potential realized volume at reference price.
- Alerting if hourly orders are missing.

CROPEX Trading platform - Orders



The screenshot displays the CROPEX Trading platform interface. At the top, there is a navigation bar with the date 'Tue, 27 Oct', a grid icon, and several dropdown menus: 'Croatian test pa...', 'HR-Test1', 'Croatia', and 'v3'. On the right side of the navigation bar, there are buttons for 'From Past', 'From Clipboard', and 'Export'. Below the navigation bar, the main content area shows a table with the following data:

Currency: EUR	at ref. price 	-500,0	0,0	30,0	31,1	50,0	50,1	3 000,0 
Hour 1	00 - 01	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 2	01 - 02	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 3	02 - 03	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 4	03 - 04	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 5	04 - 05	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 6	05 - 06	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 7	06 - 07	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 8	07 - 08	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 9	08 - 09	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 10	09 - 10	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 11	10 - 11	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 12	11 - 12	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 13	12 - 13	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 14	13 - 14	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 15	14 - 15	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 16	15 - 16	0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Hour 17	16 - 17	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 18	17 - 18	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 19	18 - 19	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 20	19 - 20	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 21	20 - 21	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 22	21 - 22	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 23	22 - 23	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Hour 24	23 - 24	0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0
Sum		0,0	0,0	0,0	-3 600,0	-4 200,0	-4 875,0	-4 875,0
Min		0,0	0,0	0,0	-150,0	-175,0	-250,0	-250,0
Max		0,0	0,0	0,0	-150,0	-175,0	-175,0	-175,0

At the bottom right of the interface, there is a help icon (a question mark inside a circle).

- Easy to create:
- copy/paste from Excel
 - copy from past,
 - create and/or edit manually

CROPEX – Trading Platform – Reasonability check

Wed, 28 Oct

Orders Results

HR-C3

HR-C3

Croatia

Clear All

REFERENCE


Fri, 2 Oct

Area Price

ORDERS (1, 4 MISSING)

Hourly (1, 4 missing)

Order(s) at reference price Sum



1 756,3 MWh

Block (0)

You currently have no orders for this date.

Add Block

Flexible Hourly (0)

You currently have no orders for this date.

Add Flexible Hourly

- Red alerts to warn the Trader for volume deviations from a historical date and price.
- User configured and set by each portfolio.

Order(s) at reference price SUM Last Updated

Reasonability Check Failures vs Fri, 2 Oct

Hour 1	50,3MW	+32,3MW	Hour 9	100,0MW	+76,5MW	Hour 17	100,0MW	+79,5MW
Hour 2	50,3MW	+33,0MW	Hour 10	100,0MW	+76,6MW	Hour 18	50,3MW	+28,8MW
Hour 3	51,1MW	+34,2MW	Hour 11	100,0MW	+76,0MW	Hour 19	50,3MW	+27,9MW
Hour 4	51,1MW	+34,4MW	Hour 12	100,0MW	+75,6MW	Hour 20	50,3MW	+27,0MW
Hour 5	51,1MW	+34,9MW	Hour 13	100,0MW	+75,9MW	Hour 21	50,3MW	+26,9MW
Hour 6	50,3MW	+34,5MW	Hour 14	100,0MW	+76,6MW	Hour 22	50,3MW	+28,5MW
Hour 7	100,0MW	+81,4MW	Hour 15	100,0MW	+77,9MW	Hour 23	50,3MW	+30,4MW
Hour 8	100,0MW	+78,6MW	Hour 16	100,0MW	+79,1MW	Hour 24	50,3MW	+31,5MW

Ignore Edit Order

Currency: EUR at ref. price

32,3	1	00 - 01	-500,0	45,0	45,1	3 000,0	+
33,0	2	01 - 02	100,0	50,0	0,0	0,0	
34,2	3	02 - 03	100,0	50,0	0,0	0,0	
34,4	4	03 - 04	100,0	50,0	0,0	0,0	
34,9	5	04 - 05	100,0	50,0	0,0	0,0	
34,5	6	05 - 06	100,0	50,0	0,0	0,0	
81,4	7	06 - 07	100,0	100,0	0,0	0,0	
78,6	8	07 - 08	100,0	100,0	0,0	0,0	
76,5	9	08 - 09	100,0	100,0	0,0	0,0	
75,6	10	09 - 10	100,0	100,0	0,0	0,0	
76,0	11	10 - 11	100,0	100,0	0,0	0,0	
75,6	12	11 - 12	100,0	100,0	0,0	0,0	
75,9	13	12 - 13	100,0	100,0	0,0	0,0	
76,6	14	13 - 14	100,0	100,0	0,0	0,0	
77,9	15	14 - 15	100,0	100,0	0,0	0,0	
79,1	16	15 - 16	100,0	100,0	0,0	0,0	
79,5	17	16 - 17	100,0	100,0	0,0	0,0	
28,8	18	17 - 18	100,0	50,0	0,0	0,0	
27,9	19	18 - 19	100,0	50,0	0,0	0,0	
27,0	20	19 - 20	100,0	50,0	0,0	0,0	
26,9	21	20 - 21	100,0	50,0	0,0	0,0	
28,5	22	21 - 22	100,0	50,0	0,0	0,0	
30,4	23	22 - 23	100,0	50,0	0,0	0,0	
31,5	24	23 - 24	100,0	50,0	0,0	0,0	
Sum			2 400,0	1 750,0	0,0	0,0	
Min			100,0	50,0	0,0	0,0	
Max			100,0	100,0	0,0	0,0	

CROPEX Trading Platform - Results



TRADE REPORT



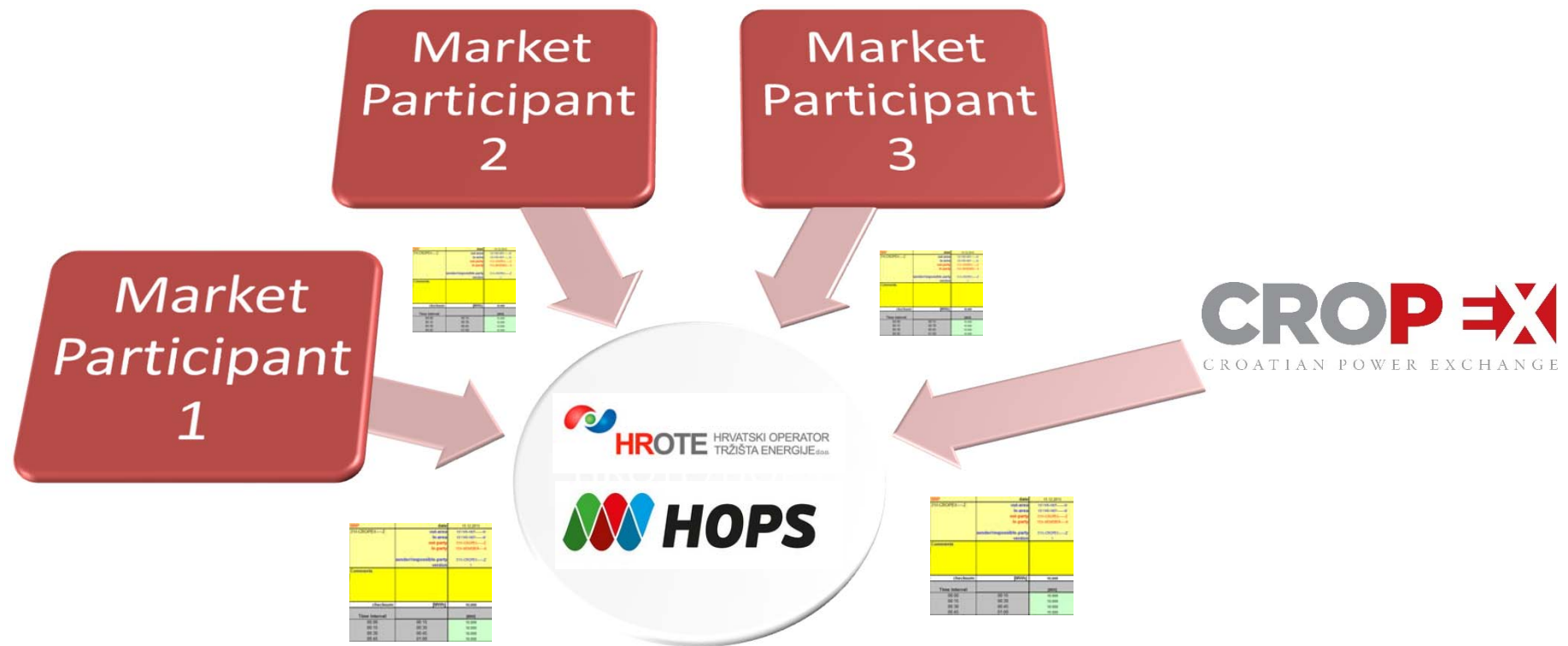
CROPEX Trading result report

Reporting period start 23.10.2015 00:00:00 +
 Reporting period stop 24.10.2015 00:00:00 +
 Date 22.10.2015 14:55:07 +
 Account: MEMBER 1
 Participant: MEM1
 Currency: EUR
 Area: CROPEX

Results

Hour	Area Price EUR/MWh	Hourly Trade Volume MW	Curtailment volume MW
23.10.2015 00:00:00 +	15,25	10,00	0,00
23.10.2015 01:00:00 +	23,72	10,00	0,00
23.10.2015 02:00:00 +	35,45	10,00	0,00
23.10.2015 03:00:00 +	38,42	10,00	0,00
23.10.2015 04:00:00 +	36,12	10,00	0,00
23.10.2015 05:00:00 +	42,42	10,00	0,00
23.10.2015 06:00:00 +	43,04	10,00	0,00
23.10.2015 07:00:00 +	47,89	10,00	0,00
23.10.2015 08:00:00 +	46,88	10,00	0,00
23.10.2015 09:00:00 +	42,34	10,00	0,00
23.10.2015 10:00:00 +	48,53	10,00	0,00
23.10.2015 11:00:00 +	47,89	10,00	0,00
23.10.2015 12:00:00 +	49,01	10,00	0,00
23.10.2015 13:00:00 +	43,17	10,00	0,00
23.10.2015 14:00:00 +	42,63	10,00	0,00
23.10.2015 15:00:00 +	40,08	10,00	0,00
23.10.2015 16:00:00 +	35,12	10,00	0,00
23.10.2015 17:00:00 +	38,98	10,00	0,00
23.10.2015 18:00:00 +	42,89	10,00	0,00
23.10.2015 19:00:00 +	47,77	10,00	0,00
23.10.2015 20:00:00 +	38,45	10,00	0,00
23.10.2015 21:00:00 +	35,27	10,00	0,00
23.10.2015 22:00:00 +	32,48	10,00	0,00
23.10.2015 23:00:00 +	34,83	10,00	0,00
Min	15,25	0,0	0,0
Max	48,53	0,0	0,0
Sum		0,0	0,0
Avg	35,24		

NOMINATIONS





CLEARING AND SETTLEMENT MEMBERSHIP

Silvio Brkić, CROPEX

CLEARING SOLUTIONS AT SHORT TERM POWER MARKETS (DAM, ID)

In-house clearing

PX acts as CCP (Central Counter Party) between sellers and buyers

PX organizes clearing and settlement function internally

Suitable for Spot markets

External clearing

PX does not act as CCP

CCP role is taken by external financial institution/clearing bank

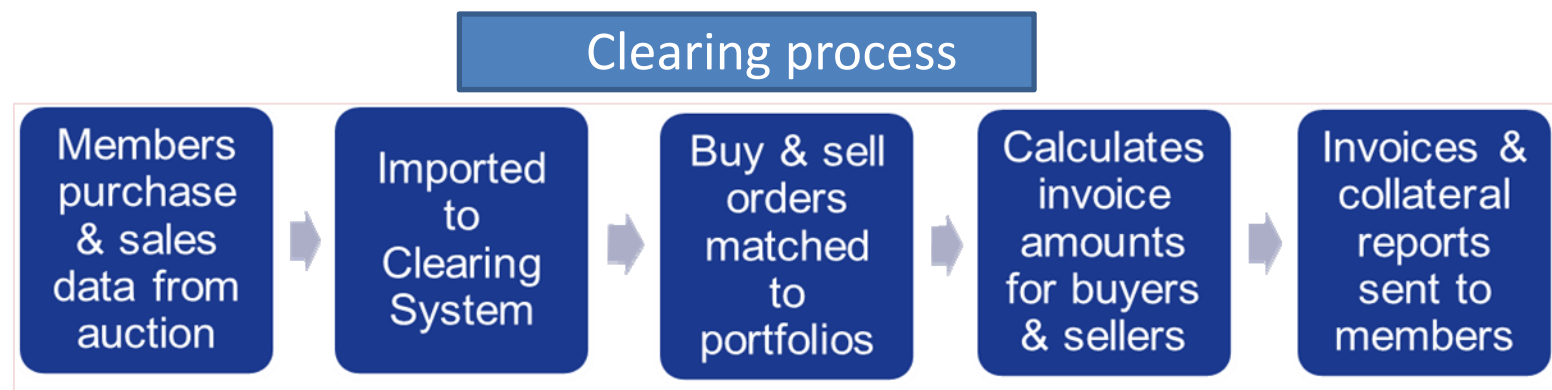
POWER EXCHANGE CLEARING SOLUTIONS OVERVIEW

Main differences between two clearing models:

- In-house clearing:
 - simple model (traders have contractual relationship only with PX)
 - easy to implement (less time consuming)
 - risks effectively managed (limited to spot power transactions)
 - prevailing clearing solution
 - External clearing:
 - less simple (traders have contractual relationship with PX and Clearing House)
 - demanding to implement (more time consuming)
 - more useful at cross-border multi-commodity markets plus financial products
-

CROPEX'S CLEARING SYSTEM

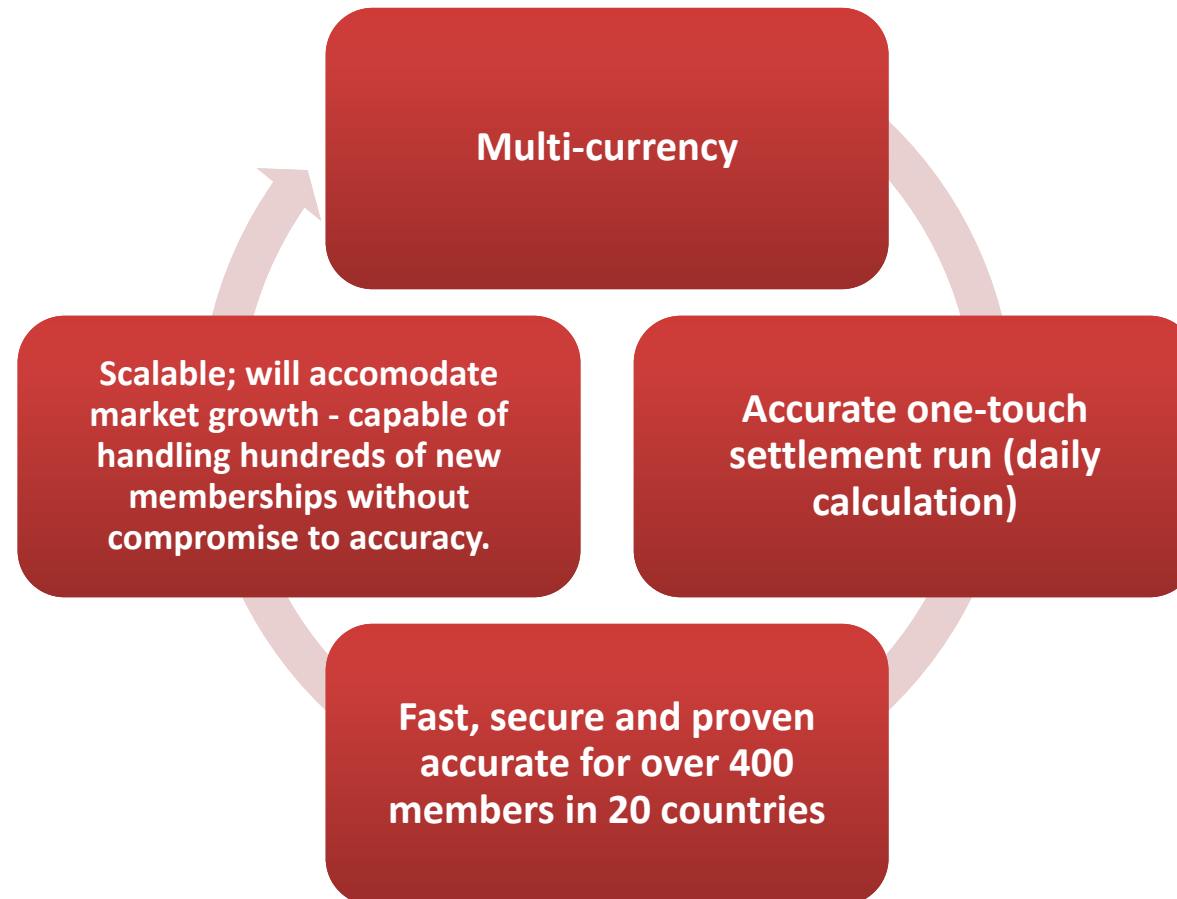
- Nord Pool Spot's standard clearing platform used
- Customized for CROPEX
- Connected via Virtual Private Network (VPN)
- Allows realtime monitoring, maintenance and support



KEY FEATURES

- Secured central register of all member information:
 - name, address, trading portfolio(s) & contact details
 - Overall view - control of daily collateral requirements & payments
 - Per member calculation of applicable fees and VAT
 - Produces daily invoices and collateral requirement reports
 - Automatically distributes invoices and reports to members
 - encrypted & password protected
 - Reporting tool:
 - trading, clearing, statements, fees & collateral reports for:
 - members, reconciliation, audit, accounting & regulatory reporting.
-

CAPABILITIES

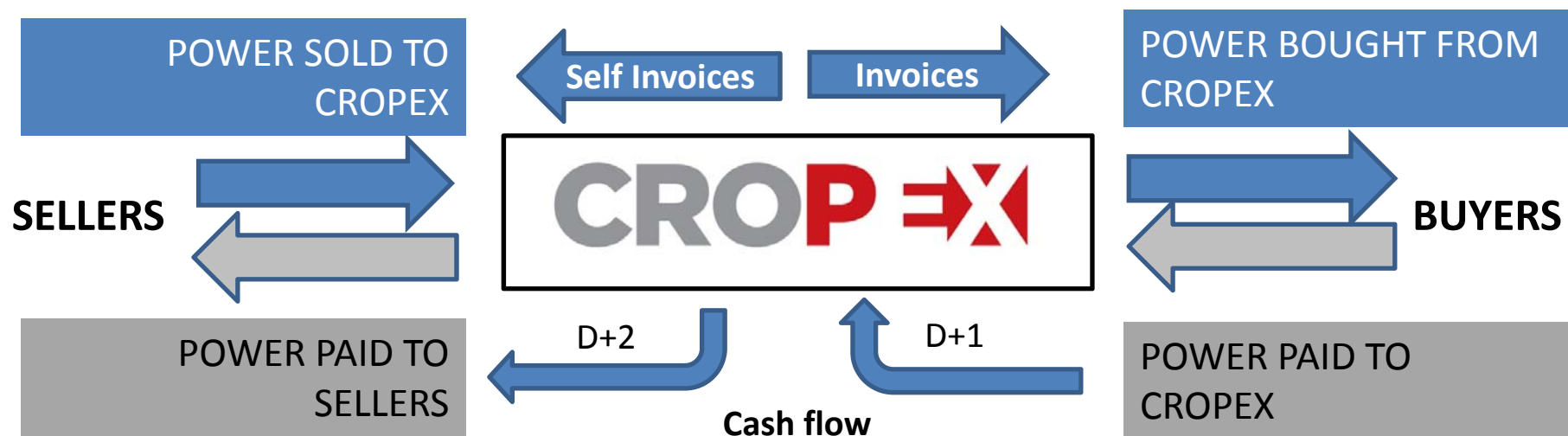


CROATIAN DAY AHEAD MARKET: MAIN FEATURES

- Trade is performed every day (trading day D) for each of 24 hours at day ahead (delivery day D+1)
 - For each trading day marginal clearing price (MCP) is calculated and determined for each of delivery hours at D+1
 - Accepted hourly bid-ask transactions are concluded at the same (clearing) price
 - CROPEX acts as Central Counter Party (CCP) between concluded transactions
 - All trades are anonymous
-

CONTRACTUAL AND FINANCIAL FLOWS AT CROPEX

CROPEX is Central Counter Party (CCP):
It buys power from sellers and sells power to buyers
It takes counter-party risks



CLEARING AND SETTLEMENT AT CROPEX: MAIN ELEMENTS

- EUR is trading currency (EU wide practise)
 - Collaterals in HRK and/or EUR:
 - Cash deposits
 - CROPEX opens account for each participant at selected settlement bank
 - deposits secured against legal enforcement and foreclosure following amended Electricity Market Act
 - Bank guarantees
 - subject to CROPEX approval
 - Collateral minimum for net sellers
 - Collateral minimum for net buyers
 - seven times of average net purchases for preceding 7 days
-

SETTLEMENT

- CROPEX is responsible to execute daily net settlements (fund transfers) on behalf of trade participants
 - Original transactions and net position will be calculated in EUR
 - Transactional settlements (funds transfers) envisage:
 - Domestic settlement, executed in HRK, where resident trade participants are involved
 - FX settlement, executed in EUR, where non-resident trade participants are involved
 - Currency exchange transactions are involved in settlement, members (trade participants) will be informed on applicable exchange rate (daily basis) on which CROPEX will translate EUR into HRK (and *vice versa*)
-

CLEARING & SETTLEMENT AT CROPEX: TIMELINE

D

- 14:00 – Trades confirmed official
- 14:00 - CROPEX participants receive Statements (Invoices)
- 15:00 - CROPEX participants receive Security Reports (Collateral Checks)

D+1

- Net Buyers pay to CROPEX
- Collateral call (if Net Buyers have not paid):
 - bank guarantees activated / cash deposits debited
- Collateral calls must be met by 11:00

D+2

- CROPEX pays to Net Sellers (Self Invoices are deposited)

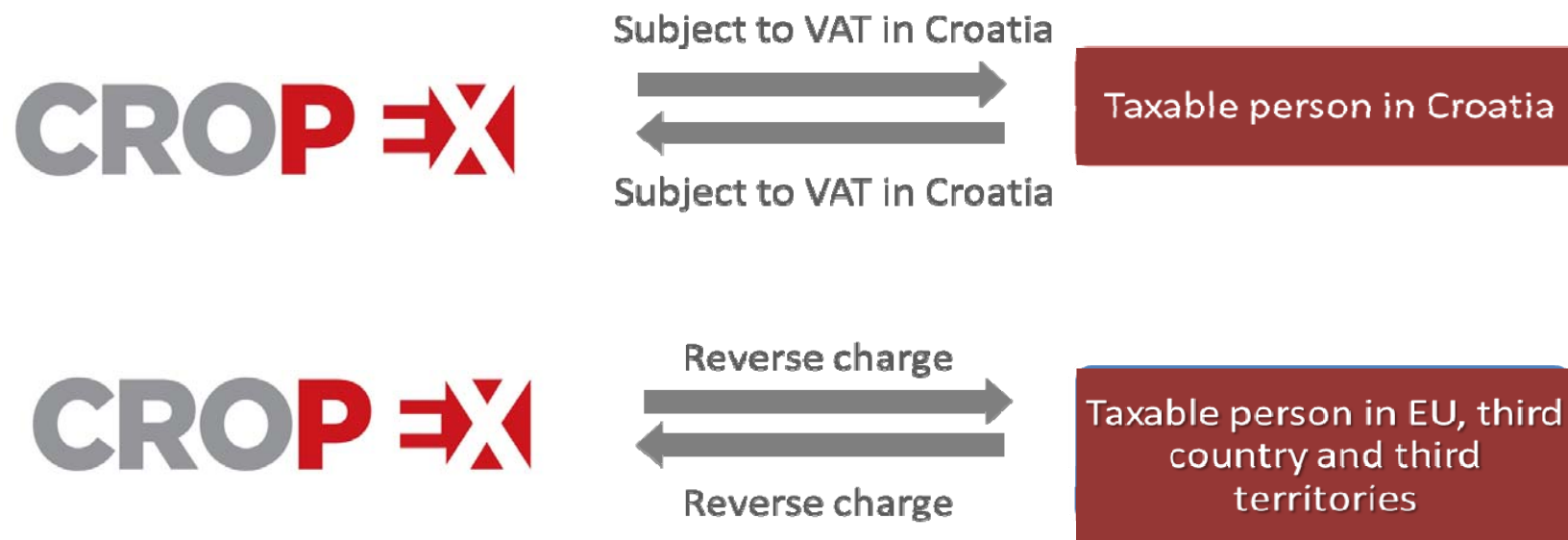
SETTLEMENT CYCLE

D/day	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
1	Trade	Trade	Trade	Trade	Trade	Trade	Trade		
2		Debit	Debit	Debit			Debit	Debit	
3			Credit	Credit			Credit	Credit	Credit

Same colours are in the same settlement cycle.
Same colours are invoiced on the same day.

VAT with regard to seat of the traders

- Croatian VAT Act harmonised with the EU directive 2006/112/EC of 28 November 2006 on the common system of VAT
- VAT reverse charge mechanism applied





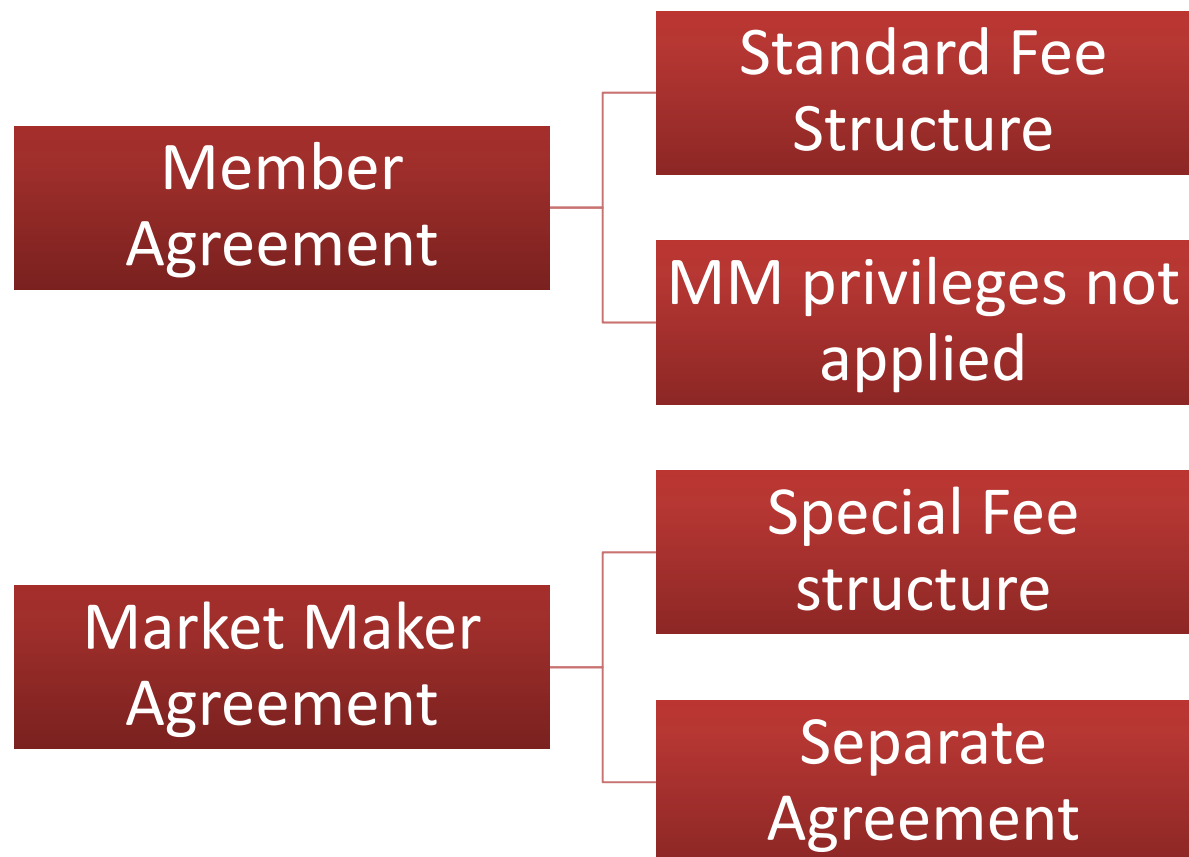
MEMBERSHIP



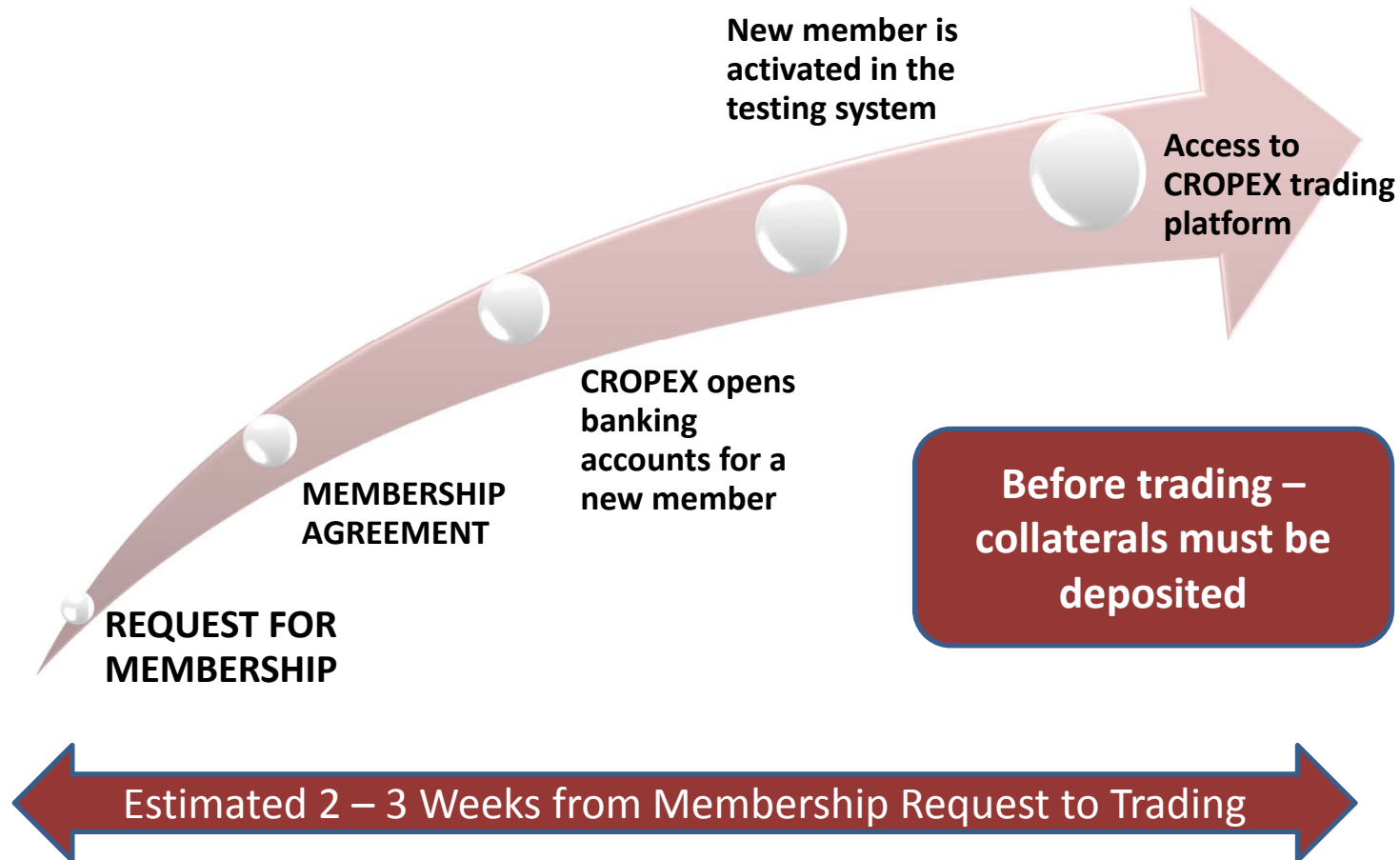
PRECONDITIONS FOR MEMBERSHIP



MEMBER AGREEMENTS



MEMBERSHIP PROCEDURE



ADMISSION FEES

FIX FEE			VARIABLE FEE	
Entrance Fee	Annual trading fee	Annual clearing fee	Trading Fee	Clearing Fee
15.000,00 €	10.000,00 €	2.000,00 €	0,06 €/MWh	0,02 €/MWh

*Subject to changes, final version to be published together with Trading Rules

TESTING

- From beginning of November initial admission phase starts
 - We invite all interested companies and potential market makers to contact us on info@cropex.hr to be part of CROPEX from the go-live date and help us in member testing of IT platforms and procedures
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THANK YOU FOR YOUR ATTENTION.

Contact:

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CROATIAN POWER EXCHANGE Ltd.

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