




Presentation of PCR

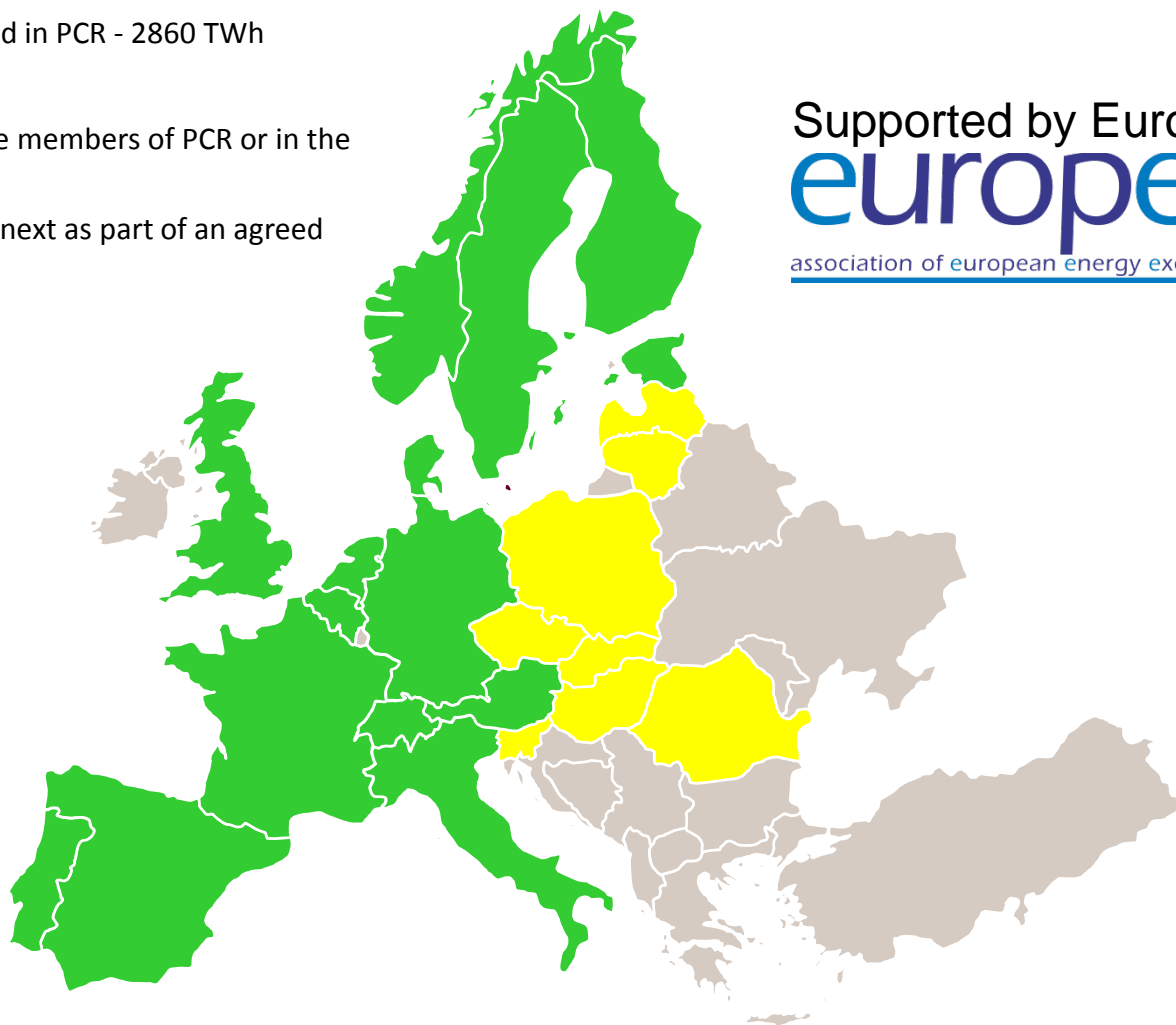
Rickard Nilsson, Nord Pool Spot, Member of PCR Project Board

NWE TSO Day Ahead Project

NRA – TSO – PX meeting, 15 June, 2011

Development of the Price Coupling of Regions (PCR) Initiative

-  Markets initially included in PCR - 2860 TWh
-  Markets either associate members of PCR or in the process of joining PCR
-  Markets that could join next as part of an agreed European roadmap



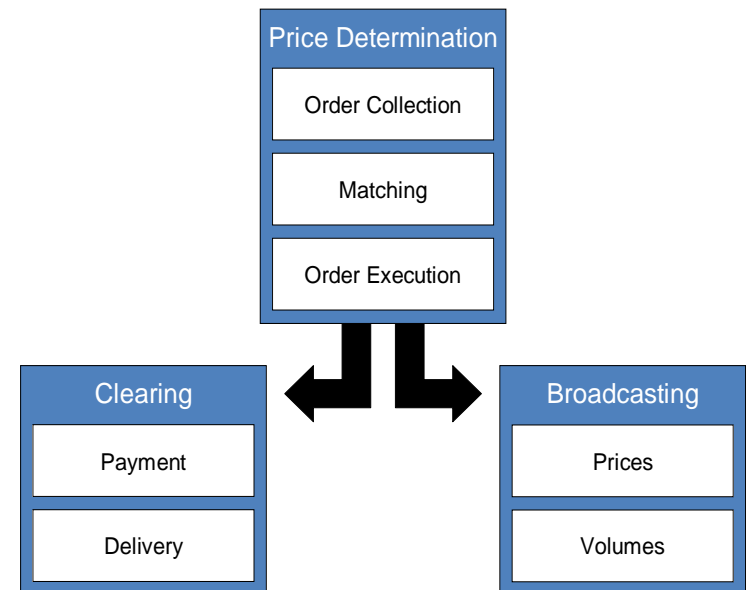
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Agenda

1. Basic background to Implicit Auctions, Market Coupling and PCR
2. Decentralized governance
3. PCR Governance. Current situation
4. One single algorithm
Appendix II. Algorithm requirements and current situation
5. Decentralized operation
Appendix III. PCR: Communication flows in the PCR and System Design status
6. Implementation

TSOs and PXs role

- The use of implicit auction requires a certain level of cooperation between TSOs and PXs
- TSOs
 - operate, develop and maintain the HV grid,
 - They manage interconnections
 - They sometimes buy energy to provide ancillary services and compensate losses
- PXs
 - provide price determination, clearing services
market transparency
 - have matching of bids as their core function
 - have no influence nor interest in the market price
- In market coupling, PXs
 - provide liquidity to market
 - guarantee competence
 - ensure neutrality



Essential features of PCR

- Price Coupling of regions (PCR) is a price coupling project.
- The PCR initiative is focused on the delivery of a common European price coupling solution (with associated algorithms, systems, procedures and inter-PX co-operation arrangements), where this solution can potentially be implemented in a variety of local regulatory/governance settings. Its philosophy is to build on the existing contractual, regulatory and operational solutions, setting at the European level the needed harmonization and governance principles.
- It is consistent with PCG principles and AHAG/ASAEG proposals, and it has been welcomed at the Florence Forum.
- To this aim it is based on three main principles.
 - One single algorithm
 - Decentralized operation
 - Decentralized governance

PCR - Organization of the Project amongst PXs

The Steering Committee (SC)

- the ultimate decision-making entity for the project
- comprises all PCR PXs with representatives authorized to take decisions for their own organization

The Project Board (PB)

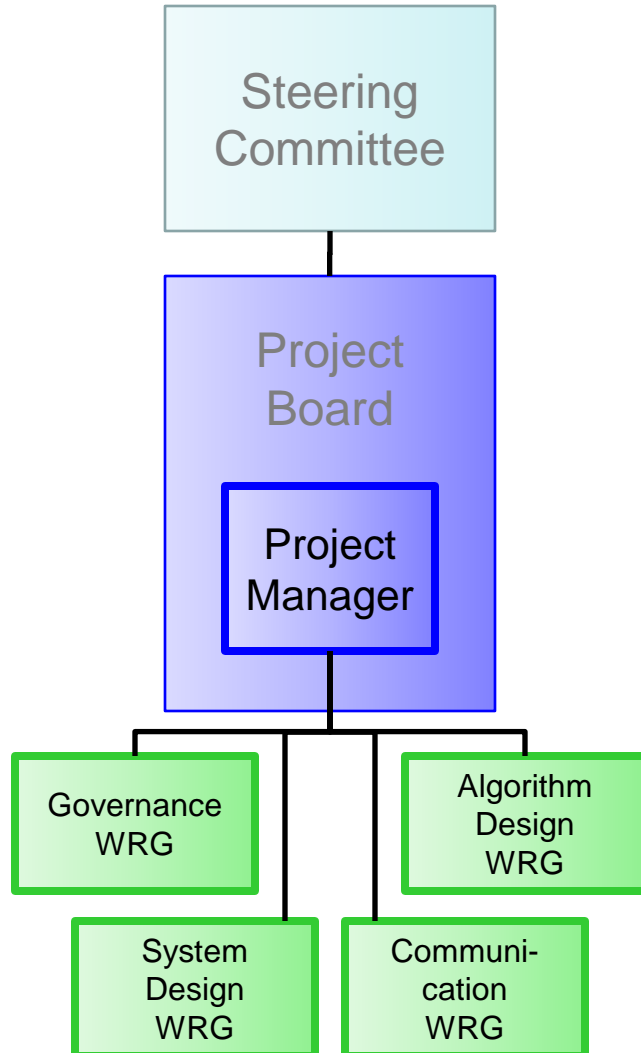
- responsible for the efficient management of the project.
- ensures project is focused throughout its lifecycle on achieving the objectives and delivering the required deliverables
- ensures a cost-conscious approach to the project and balances when necessary the demands of the various interests
- comprises a representative of all PCR PXs & Project Manager

The Project Manager (PM)

- has the authority to run the project on a day-to-day basis on behalf of the PB
- is mainly responsible to ensure the project produces the required deliverables within the timeframes set and with the required standard of quality
- Coordinates the works of the Project Board

Adequately resourced Workgroup (WRG) teams.

- in charge of producing project deliverables under common responsibility of all PXs.
- Are coordinated by a Workgroup Leader.
- Current work groups (may be adapted in later phases of project):
- **Governance WRG**: takes care of governance & contractual aspects
- **Algorithm Design WRG** which handles proof of concept via simulations, requirement collection and validation, as well as the algorithm specifications
- **System Design WRG**, which takes care among others of
 - the definition of the technical/IT solution and business processes
 - the solving of Market design issues and operational solution
- **Communication WRG**, organises external communication related to the Project.



3. PCR Governance. Current situation

PCR Governance WG (GOWG) – Scope, Working Process and Organization

- Identification of Governance issues in need of legal review and/or development of Agreements between the PCR parties is managed via a group consisting of persons from each PX
 - Members have deep knowledge about current (DA spot) market design and regulations each of them uphold and are faced with locally/regionally
 - Combined the group has also deep knowledge about current EC Regulations/Directives/Guidelines relevant for Market Coupling
 - Also the group considers, and single members are directly involved in, current EC scope work on renewed regulations, codes, guidelines, etc., linked to for ex. AHAG
- Main line of work is up to this date to jointly develop Term Sheets for and then draft needed set of PCR Agreements between the PCR parties
 - The group also ensures that modifications of Agreements are made, for ex. if scope of PCR, PX parties involved in PCR, or external ,for ex., regulatory requirement is modified
 - All work is finally reviewed and approved in PCR PB and subsequently SC upon which – in case of developed Agreements – signature is made by all PCR Parties

PCR Governance WG (GOWG) – Status on Main Deliverables

- Confidentiality & Data sharing agreements **Signed**
- IPR Co-ownership principles **Agreed**
- IPR Co-ownership agreement **Target to be ready in July 2011**
- Joint PX Cooperation principles **In progress**
- Joint PX Cooperation agreement **Target to be ready in July 2011**

Project Finance

- Each PX is responsible for the funding and the financing of its contribution to the project in a decentralised way since harmonizing this is not necessary for the purpose of price coupling
- Local financing/recovery of costs is the responsibility of each PX
- A cost sharing agreement between PXs will describe what are considered as common costs and how PXs share these costs between them
- In this way, cost efficiency is ensured compared to a more centralised management of costs

4. Algorithm Work Group (ALWG)

One single algorithm

Algorithm requirements and current situation

The PCR Algorithm

- The future PCR Matching Algorithm will calculate hourly prices over all the PCR areas, satisfying all the core requirements satisfied by the already existing individual PX algorithms.
- This is necessary both to build on the existing liquidity granted by the existing market rules and to avoid any unnecessary change in the local regulation.
- It is the intention of PXs to start using all the same PCR algorithm even before being all price coupled
- In order to build the PCR Matching algorithm, many steps have already been done:
 - *Proof of concept:* PXs have already proven the possibility to implement the existing market features in a single algorithmic solution (see Appendix 1) by means of a proof of concept, used for simulations based on historical data from Epex, NPS and Omel
 - *Requirements:* PX are completing assessment of the core requirement of the algorithm
 - Starting point:* noting that PXs already have matching solutions and that none of these current solutions exactly satisfy all the requirements, but that most of them could possibly be enhanced to satisfy all the PCR requirements, PXs have agreed to implement the future solution by starting from existing solutions

Main Requirements for Future PCR Algorithm

- Market and Network features
 - Order types (e.g. linear/stepwise, blocks, MIC Orders, linked blocks)
 - Network modelling (e.g. ATC, Flow-Based, Ramping, Flow-Related Charges and Losses)
 - Price/Network modelling (e.g. in ATC, price difference only if congestion)
- Price Calculation Requirements
 - Welfare Maximization – Price Coupling Algorithm
 - Curtailment and Indeterminacy Rules
 - Performance and reproducibility
- Outputs of Algorithm
 - Prices and Net Positions
 - Potential Set of Feasible Flows

Overview of the PCR algorithm requirements

1. Orders
 - I. hourly orders: stepwise and linear interpolated curves;
 - II. fill-or-kill block orders;
 - III. profile block orders;
 - IV. linked block orders;
 - V. minimum income conditions orders;
 - VI. maximum payment condition orders;
 - VII. load gradients constraints;
 - VIII. schedule stop constraint;
 - IX. indivisibility constraint;
 - X. merit order priority;
2. Price properties
 - I. welfare optimization;
 - II. Italian national uniform purchase price (PUN);
 - III. price range and precision;
 - IV. curtailment rules;
3. Network properties
 - I. balance constraints;
 - II. interconnection constraints (ATC and flow-based);
 - III. ramping constraints (on flows and net positions).

PCR Algorithm Working Group Process

- First Phase of Simulation until 2010 September
 - historical dataset;
 - existing market features (approximate modelling allowed);
=> proof was given that a single algorithm can calculate prices over NPS/CWE/Omel (+ good quality of results and performance)
- Starting Point Selection phase from 2010 October
 - PXs agreed on a Starting Point Selection process
Aim: Among existing matching algorithms, select one solution to be used as a starting point for next developments
- Starting Point Selection process split into 4 activities
 - #1 common list of (functional and non-functional)requirements
 - #2 assessment methodology for every requirement
 - #3 assessment of the fulfilment of the requirements by existing algorithms:
current fulfilment and ability to fulfil in an enhanced version
 - #4 technical recommendations (beginning of March 2011)

PCR Algorithm Working Group Process

- Starting Point Selection process – List of deliverables
 - List of Requirements
 - Assessment Methodology of the fulfilment of the requirements
 - Assessment Matrix of the fulfilment of the requirements by every algorithm candidate
 - Technical Recommendation (+ Assessment of the Distance to the Target)
 - Risks related to Implementation
- Next Activities
 - Elaboration of next steps (e.g. specifications, prototype, implementation, extensive tests)
 - Implementation of next steps
 - Provider selection

Status Algorithm Development

- PCR Steering Committee has selected the Cosmos algorithm which is used in CWE as the starting point to be developed in to a fully functional “PCR Algorithm” prototype that shall be able to support all PCR and target model requirements
 - mathematical optimiser-based solution preferred, which has proven efficient in Nordic (SESAM, 2007-) and CWE (Cosmos, 2010-) spot markets
 - subject to, among others, completion of PCR co-ownership and co-operation agreements as well as approval by each PX Board.

- Current priorities:
 - document selection process
 - Facilitate full knowledge transfer regarding starting point algorithm among PCR parties
 - commence evaluation of options to incorporate Italian “PUN” and Iberian “load gradient” requirements
 - engage with TSOs/regulators on how to validate algorithm against capacity allocation requirements



5. Decentralized operation

Decentralized technical & operational solution

- **Information sharing.** To place at the disposal of all the PCR members all the information needed to produce the complete core results for the whole PCR area.
- **Decentralization.** The information system utilizes as much as possible decentralized possibilities, avoiding the creation of central equipments/sites, to ease the governance and operation of the PCR.
 - In any case, where several PXs are already in operation in some form of partially centralized manner, nothing will prevent them to continue operating in the same way as they are today.
- **Parallelization.** All PXs are up and running every day, to be able to produce results under complete or isolated decoupling without entering into special operations.
 - Nevertheless some PXs may rely on some other PX trading system if they want to.
- **Subsidiarity.** Operational/business process will respect as far as viable the basis of PCR:
 - Pragmatically building and respecting the existing operational or business processes
 - Avoid any unnecessary changes to existing local procedures, liabilities, responsibilities procedures, liabilities, responsibilities and interfaces with market participants, Regulators, TSOs

The PCR Solution is based on applying several general enhancements to the existing infrastructures

- Use the same algorithm in each of the PCR Spot Market matching systems
- Connect the PXs systems in a way that all input and output data is shared in aggregated and anonymous form per market Area, allowing for the incorporation of new PXs and new market Areas as required
- All data provided by any PX (be it network capacity constraints or order books) to the others should be validated beforehand by the PX providing the information,
- The results of the matching process will be validated by the PCR Matching algorithm to ensure that they are correct under the conditions pre-established by the PCR participants.

Four Operational Options for New Partners (depending on their desires or their regulatory situation)

Option 1:

Run the matching algorithm and enter into the rotating matching Coordinator responsibility procedure

Option 2:

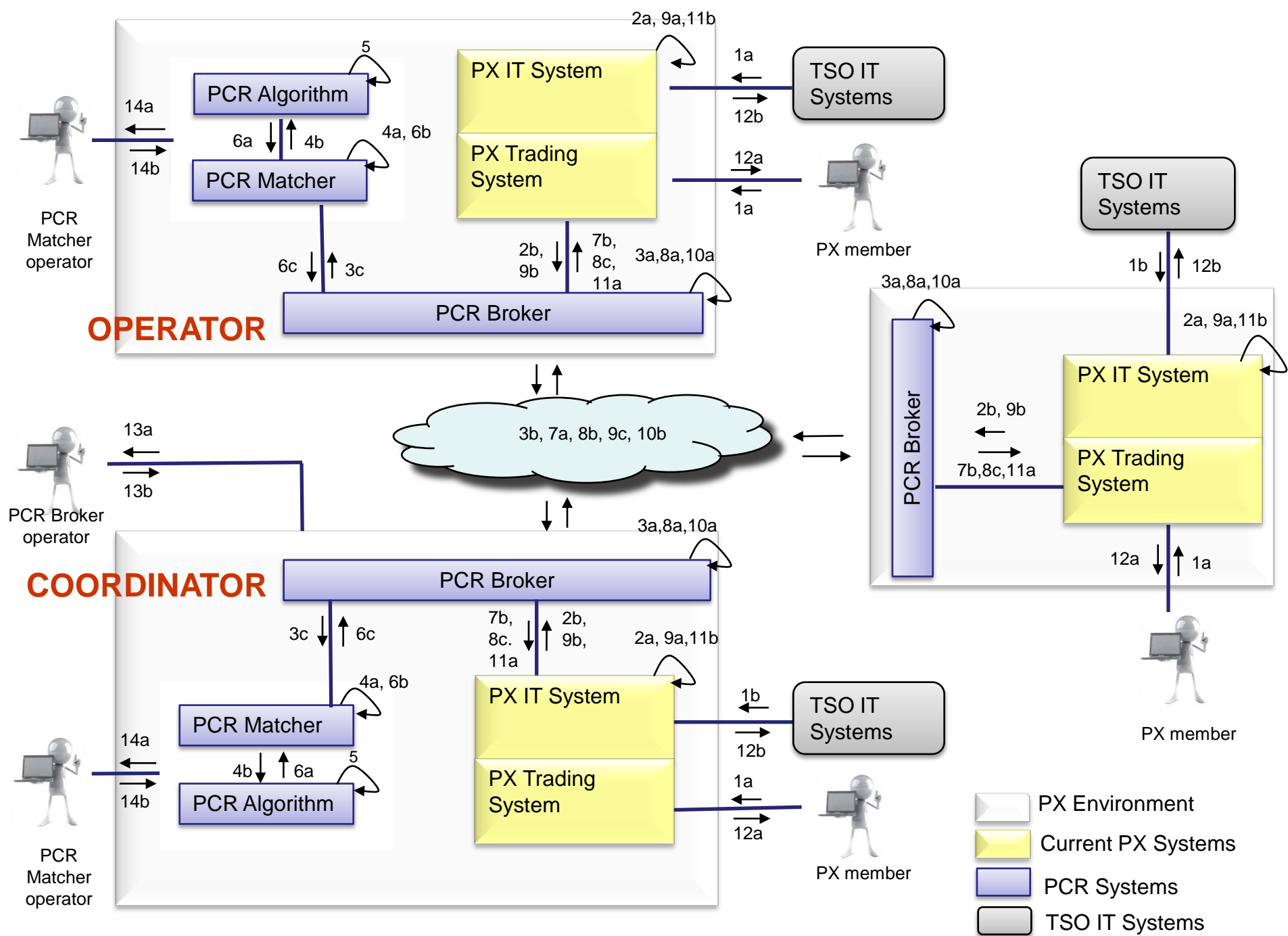
Run the matching algorithm and, since the same bid information, programs and parameters are available, it can do it for verification purposes and, might be, for fall back or decoupling potential preparation, but not assuming the Coordinator role in any moment.

Option 3:

Maintain its own trading system, provide the anonymous bid (and capacity information if applicable) directly to the other exchanges through the PCR IT systems and receive the results, but not run the matching algorithm

Option 4:

Reach an agreement with an already PCR participating exchange and decide to use an existing trading system while keeping its independence as an exchange



PCR HLFA: Normal Process Information Flows(1)

Description of the Normal PCR Process		
1		Reception of the bids and capacities
	a	Bids reception on PX' trading system
	b	Capacities reception on PX' trading system
2		Delivery of aggregated bids and capacities information
	a	PX information generation and Validation
	b	Transmission of information to the Broker
3		Gathering of all matching input information
	a	Information validation by the Broker
	b	Collection and distribution of all PXs' information through the Cloud
	c	Provision of information to the Matcher
4		Uploading of information by the PCR Matcher
	a	Uploading of the information in the algorithm structures
	b	Validation of all gathered information (cross-checking)
5		Running of the PCR algorithm
6		Downloading of the information in the PCR Matcher
	a	PCR Matcher access the results
	b	Validation of the obtained results
	c	Transmission of information to the Broker
7		Gathering of the PCR MC results files
	a	Distribution of PCR results through the PCR Cloud
	b	Gathering of the PCR results by all PXs

PCR HLFA: Normal Process Information Flows(2)

Description of the Normal PCR Process		
8		Comparison and validation of the PCR MC results
	a	Comparison of results through fingerprint files
	b	Distribution of the comparison results through the PCR Cloud
	c	Transmission of information to PX' Systems
9		Validation of the PCR provisional MC Results by the PX
	a	Each PX validates the obtained results (directly or through third parties)
	b	Generation of the validation results information
	c	Distribution of all PXs' validation information through the PCR Cloud
10		Confirmation of the Official PCR MC results
	a	Analysis of validation information by the Coordinator
	b	Distribution of the analysis results through the PCR Cloud
11		Uploading of the PCR MC Results in the PX IT Systems
	a	Transmission of the analysis results to the PX' Systems
	b	Uploading of the PCR Results in the PX' Trading and IT Systems
12		Distribution of the information to participants
	a	Market results to participants
	b	Interconnection flows/net positions to TSOs
13		Interaction with the PCR Broker
	a	Monitoring of PCR Cloud
	b	Commands
14		Interaction with the PCR Matcher
	a	Monitoring of the Matcher and algorithm execution
	b	Commands

The Coordinator rotational responsibility concept

It is based in the following general principles:

- All PCR PX participants can **run in parallel the matching algorithm** for each of them to be responsible for their own results
- **A rotating Coordinator role**, among the PXs that decide to be involved in the Coordinator-Operator responsibilities, takes care of two basic functions:
 - In normal operation to produce the reference results, giving to all PXs the green light to publish them (or to continue with the pre-established operational procedures, in case steps are needed prior to publication)
 - In emergency or abnormal situations to be in charge of investigating the problem, evaluating in which state are the different Market areas, communicating the predefined emergency actions and, in general, be the central contact point in case of emergencies
- In case of decoupling, all PXs have access to the input data and to a **continuously used infrastructure** to run the algorithm in their areas of influence

PCR High Level System Design: Technical Principles

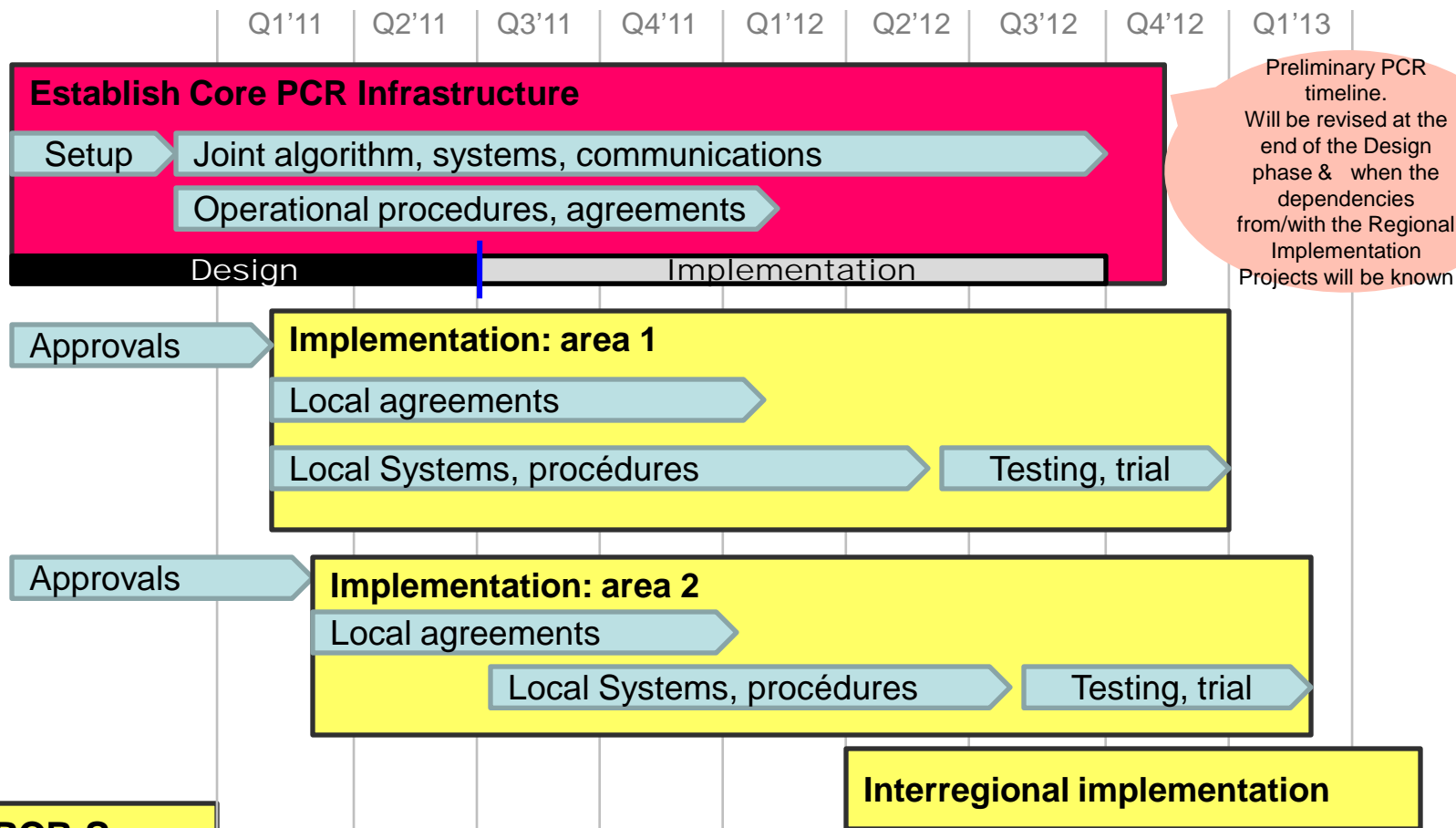
- The final solution is **decentralized** (no existence of a central site)
- **All PXs connected** to each other via direct lines, Internet or MPLS using secure channels
- **Each PXs is connected to the related TSOs** for receiving capacity information and sending the required information (nominations, clearing info,...) as today
 - This is **responsibility of each particular/regional PX**
- A **data sharing solution** is created based in the implementation at each PX of a PCR Connection Broker (**PCR Broker**) which is responsible of interfacing the PX systems with the rest of the PXs
 - Together, all the PXs' PCR Brokers form the **PCR Cloud**
- Each PCR Broker is in **continuous connection** to the other PCR Brokers, **access** to the internal PX market info, **validates it, and publishes it** to the rest of the PCR Brokers
- Several **validation layers** to ensure the detection of potential errors or problems as soon as possible in the information flows
- The **PCR Matcher** wraps the algorithm and ensures that each exchange runs the **same common algorithm** with the same data and the same configuration parameters



6. Implementation

IN scope and OUT of scope of PCR

In Scope of PCR: Common algorithm, core systems and procedures, joint PX governance



OUT of PCR Scope:

local governance arrangements, local nominations, clearing & settlement, cross border shipping...

Thank you for your attention!

APX-ENDEX is Europe's premier provider of power and gas exchange services for the wholesale market, operating transparent platforms for short term and futures trading in the Netherlands, the United Kingdom and Belgium. Established in 1999, APX-ENDEX provides exchange trading, central clearing & settlement and data distribution services. APX-ENDEX has over 300 memberships from more than 15 countries. APX-ENDEX offers benchmark data and provides industry indices. APX-ENDEX's offices are located in Amsterdam, London and Nottingham.

Belpex is a leading contributor to the integration of the European electricity markets, accountable for delivering transparent price signals to its participants and the community. Belpex is focused on delivering electricity market services that bring value to its members and the entire Belgian electricity wholesale market. Belpex provides a trading platform for the negotiation of spot electricity trades and green certificates. Purchase/sale transactions are concluded directly, but anonymously, between the market participants.

EPEX Spot SE is a Paris-based company under European law (Societas Europae) with a branch in Leipzig. EEX AG and Powernext SA each hold 50 percent in the joint company, in which they integrated their entire spot power trading activities. EEX AG main shareholders are Eurex Zürich AG and Landesbank Baden-Württemberg. Powernext SA main shareholder is a Holding of TSOs formed by RTE, TenneT and Elia. The product range of EPEX Spot SE encompasses spot power trading for France, Germany/Austria and Switzerland. These countries account for more than one third of the European power consumption.

GME is the company which organizes and manages the wholesale electricity market in Italy. On GME, producers, consumers and wholesalers may enter into electricity purchase and sale contracts for the next day and, from 2008, also trade electricity blocks for forward physical delivery. GME also organizes and manages Environmental Markets, i.e. the venues where Green Certificates, Energy Efficiency Certificates and Emission Allowances are traded. GME has been attributed, moreover, by law no. 99 of 23 July 2009, the exclusive management of the Italian natural "Gas Exchange".

Operador del Mercado Ibérico de la Energía, polo español S.A. (OMEL) is a Spanish company created with the purpose of managing markets in underlying energy assets. As its main function, OMEL is the responsible of the management of the Iberian spot electricity market, running everyday the daily and six intraday markets encompassing all Iberian energy. In addition to this principal function, OMEL is responsible for the management of several energy-related product auctions, including both physical and financial products.

Nord Pool Spot runs the largest market for electrical energy in the world, offering both day-ahead and intraday markets to its participants. 330 companies from 20 countries trade on the exchange. The Nord Pool Spot group has offices in Oslo, Helsinki, Stockholm, Fredericia (Denmark), Tallinn and London. Nord Pool Spot is owned by the Nordic transmission system operators. In 2009 the group had a turnover of 288 TWh representing a value of EUR 10.8 billion.

Extra slides on decentralized solution

Advantages of the decentralized approach (I)

Normal market process are almost identical in the decentralized and centralized alternatives:

All bidding area prices and net positions are **produced in an algorithm run** which uses all input data from the different regions/countries.

The only different process in the decentralized approach is the comparison of the different obtained results

This process **ensures the validity of the results** providing a very important verification of the overall process

All PXs have **more confidence** in the obtained results:

They all **have access to all** input data and results **information**

They **run**, if they want to, **the algorithm everyday** verifying the provided results

They **have direct access and know-how to all tools** to verify the results, run simulations, perform analysis,...

Service to the market participants and stakeholders is **improved**:

Each PX takes care of its participants and stakeholders

Having access to all input information and having run the algorithm, they are **capable of answering all potential questions**

No need for participants and stakeholders **of contacting a central site in a different language** to resolve their doubts

Advantages of the decentralized approach (II)

Operation is ensured in almost all circumstances

PX personnel **run the market processes everyday**

In case of any technical problem in the Coordinator, **several PXs may take over** in no time (hot standby)

In case of decoupling, all PXs have all information and the operational people ready to run the decoupled areas

PX' **operators are used to running the system everyday**, not only in periodic or exceptional situations

PCR ensures **overall efficiency**

Regulation and operations are maintained as much as possible on each Region/Country. No need to change all PX and participants processes

PX use the existing infrastructures, except for the particular new PCR modules

These common modules are commonly developed. **Costs**, shared by all PXs, **are divided** as the number of PXs increase

No need of special redundancy sites (all PXs may provide the market results). Use by the PX of the same algorithm for the decoupling scenarios (no need of maintaining secondary systems)

PCR **implementation is fast** and ensures success

PCR **minimizes the need of regulatory changes**. This avoids unnecessary delays

No need of creating new entities, nor to create complicated governance structures

PXs **already count with trained personnel** and start with existing **and proved infrastructures** on which PCR is based

Decentralized technical & operational solution. Main requirements (I)

- **Cost effectiveness:** Simplify as much as possible the complexity of the solution, its operation and maintenance activities in order to reduce the implementation and operation costs.
- **Decentralization:** Absence of one single central site where all information converge.
- **Maintaining the existing PXs infrastructure:** Each PX must be allowed to maintain its current trading system and IT applications, connecting to PCR through normalized interfaces. PCR common infrastructure and applications must be reduced to the indispensable.
- **Maintaining the existing Information channels with PXs stakeholders:** Each PX must maintain its existing communication channels and procedures with its stakeholders (participants, TSOs, Regulators ...),
 - If there are several PXs that wish to cooperate in a common manner with a set of TSOs or stakeholders this is not a problem, since the decentralized concept still applies in the same way to each of them.
- **Extendibility:** The PCR solution will be opened to the incorporation of new market areas and the modification of the existing topology managed by the involved, or newly added, PXs.
- **High availability.** The system must necessarily be available at the matching process period. The PCR solution must include the necessary redundancy so that no single point of failure exists in any part of the PCR indispensable infrastructure.

Decentralized technical & operational solution. Main requirements (II)

- **Adequate Performance:** Results must be provided in reasonable and controlled timeframes, including the necessary functionalities and safeguards to ensure that an acceptable solution is reached in the existing PCR time limits.
- **Operation flexibility:** Allowing for the modification of the “standard” procedures when special situations appear (fallback procedures, decoupling...), always under the Coordinator control.
- **Auditability:** All actions and traffic occurring within the PCR Operations and IT systems should be recorded and auditable for incident evaluation and correction.
- **Answer to predefined questions readily available:** The PCR system should provide complete output data and logging facilities to all PXs, to permit them to analyze and understand the results,
- **Security:** All information exchanged should be digitally signed and encrypted
- **Stand alone operation:** The local PCR system at each PX should require minimal manual intervention
- **Communications must also be redundant:** The level of security in the communications will be selected by each PX deciding how it builds its redundant communications infrastructure.

Operational or business process associated to the PCR

- Cross market area settlement of transactions
 - Today there are several existing Regional Market Coupling/Splitting markets in operation, or close to be in operation, with solutions in place for this processes
 - The solutions to be applied in the different new borders covered by the PCR do not need to be the same as the existing ones, but still need to be compatible with them.
 - The PCR concept calls for this issue to be discussed by the involved parties in each border (PXs, National Regulators, TSOs).
- Cross border energy shipping arrangements:
 - the energy shipping solution already in place in the different Regional or National markets will be respected as much as possible
 - the new cross border flows shipping or communication solution that need to be reported to the involved TSO will be discussed in a bilateral or multilateral manner among the involved PXs, Regulators and TSOs.
 - in case some degree of harmonization is needed the issue will be raised and discussed with the involved parties