Electricity trading in regional markets

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Connected National Systems

• In electricity sectors characterized by vertically integrated monopolies, the incumbent utility may have an interest in developing the interconnection with neighboring systems, to take advantage of economically-advantageous import opportunities.

• In this case, interconnection is typically developed and used for mutual support purposes or sporadic transactions.

• In some cases, interconnection capacity is also used for frequency regulation and reserve capacity sharing between different control areas.

• This is a very primitive “Regional Market” notion.
From Cross-Border Trading to Regional Markets

• More intensive electricity trading between countries (TSOs, single buyer or national utilities), typically on the basis of medium/long-term contracts, may develop when the two systems have complementary electricity generation structure

• With liberalization of national electricity markets, a plurality of participants – generators, traders, suppliers – may be interested in selling or buying electricity across the borders

• Greater integration of national electricity markets may be progressively promoted (bilateral, trilateral, by groups, at regional level, etc.)
Trading and Electricity Markets - The time dimension

**Long-term/ Mid-term (years to days ahead)**
- Forward Market
- Uncoordinated Trading
- Procure firm generation
- Hedge against price volatility

**Day D-1**
- DA Market
- Schedule gen.
- Short term opportunities
- Gross or Net

**Days D-1 / D**
- Intra-Day Market
- Adjust ('optimise') buy/sell positions

**Real Time**
- Real-Time Market AS activation
- Supply / Demand Balance

**Time-line**
Integration options

• Various degree of integration of National Markets are possible that represent subsequent steps in the development of a Regional Market
  – Cross-border bilateral trading between incumbent monopoly utilities, TSOs or single buyers
  – Cross-border trading between market participants
  – Access of market participants in one control area to the wholesale market of the other control area
  – Centralized dispatch (coupling) of national wholesale markets
  – Integrated regional electricity market
  – Regional market for other products like ancillary services, capacity, adequacy reserves, etc.
Development patterns of electricity markets

Are network investment plans carried out in practice?
Congestion Management

• Congestion occurs when the available transmission capacity is not sufficient to satisfy the demand for transmission services (e.g., from commercial transactions)

• Therefore, congestion depends:
  — on the demand for transmission services
  — on the available transmission capacity

• Liberalization has increased and made more explicit the demand for transmission services

• Congestion may occur:
  — within a control area
  — between control areas (cross-border)

• In some cases, congestion within each control area is pushed on the borders (i.e. available cross-border capacity is reduced to avoid congestion within a control area)
Typically, cross border transmission capacity is low, therefore rules become necessary for allocating this capacity to transactions.

Commercial vs physical flows

- In this case physical and commercial flows coincides
- Commercial transaction originates physical flows

- Transfer capacity is allocated by SOs
- Scheduled flows are controlled through AGC or manually
- A scheduled transaction between A and B originates also flows in C and D
- It is necessary the action of all the regional SO to manage congestion, or a centralized entity
Approaches to congestion management

• **Ex-post** adjustment of market outcome
  - Re-dispatching
  - Counter-trading

• **Ex-ante** congestion management
  - Explicit allocation of (physical) transmission capacity rights (PTRs)
    ✓ Market based (auctions)
    ✓ Non-market based (limited access, priority list, first-come-first-served, pro-rata)
  - Implicit allocation of transmission rights (market coupling, market splitting)
  - Security Constrained Economic Dispatch (SCED)
EU experience: from bilateral trade to market coupling
The Trilateral Market Coupling (TLC)

- Since November 2006
  - Countries involved: **France, Belgium, Netherlands**
  - PXs: the EPEX Spot French Auction with APX-ENDEX and Belpex
  - Involves Day-Ahead allocation
Bilateral Trading Results

Before TLC: Severe sub-optimisation of cross-border capacity

Use of BE-NL "Capacity" (% of av. capacity) versus PXs price difference (€), before Market coupling

Capacity nominations going against the prices: "Counter-flows"

Capacity nominations in the right direction but not fully using the ATC: "Sub-optimal flows"

Capacity nominations in the right direction but not fully using the ATC: "Sub-optimal flows"

Capacity nominations going against the prices: "Counter-flows"
Market Coupling Results

After TLC: Full optimisation of cross-border capacity allocation

Use of BE-NL « Capacity » (% of av. capacity) versus PXs price difference (€), during Market coupling

Capacity nominations always in the right direction, and fully using the ATC: Capacity optimization

• BE-NL price divergence is observed only when the cross-border capacity is congested (used at 100%)
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Requirements for Cross-Border Trading

• Cross-border electricity trading requires:
  – “Sufficient” interconnection capacity
    • which is greater than the level required for mutual support ...
    • ... however, it may be inefficient to have a level of capacity which avoids congestion at all times
    • CAREM has already an interesting cross border capacity, this is a big advantage
  – Rules for trading
  – Open Access to national grids required for transit
  – Access rights to the interconnection capacity
  – A Congestion Management approach to manage any residual congestion (efficiently)

• Efficient cross-border electricity trading should be supported by efficient trading/dispatch within each national market
Open Access Concept

‘Open Access’ means the non-discriminatory provision for use of transmission lines, distribution systems, by any person engaged in the generation, trading or consumption of electricity.

But in case the demand for the use of a facility (e.g. an interconnector) exceeds the available capacity, the allocation method of the scarce capacity, should be efficient and based on non-discriminatory access.
Benefits and Requirements for Open access

- **Benefits**
  - Utilities, TSOs, IPPs, trader and consumers (if authorised) can use the existing transmission system to conclude power trading arrangements
  - Facilitates cross border trading as there are uniform and non discriminatory rules to obtain access to the regional network

- **Requirements**
  - Coordination among the regional TSOs to schedule the cross border transactions informed by the market participants.
  - Allocation of capacity requires some methodology when it is scarce
  - Once transactions are scheduled (normally on a day-ahead basis), TSO are responsible to maintain the scheduled cross border flows
  - Area control based on secondary frequency control and AGC is the effective method. However, manual control can be used if AGC is not available.
  - After real time operation, deviations must be identified and settled
  - compensation of deviations in monetary terms or in kind (energy)
  - There should be defined transparent and non discriminatory reasons/criteria for the change or curtailment of scheduled transactions
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Products and Services:

- Energy traded through
  - Bilateral contracts
  - Day-ahead markets(*)
  - Balancing markets(*)
- Ancillary services
- Long term reserves
- Reliability (capacity markets)

Trading Mechanisms

Supported by:
- Transmission
- Congestion management
- Operation coordination
- Control of scheduled cross border flows

(*) Classical opportunity trading, typical between TSOs, today tends to day-ahead and balancing markets
Spatial Dimension of Markets

- **Single price**: offers-bids are accepted regardless of the location and physical possibility to deliver the energy. The SO corrects the “dispatch” to relieve congestion. Additional costs are passed to consumers through a tariff up-lift.

- **Nodal pricing**: transmission constrains are taken into consideration during the clearing process. Nodal prices (LMP) reflects the costs to consume energy in each node taking into consideration transmission constrains and (in some cases) losses.

- **Zonal pricing**: the region is split into zones, each one becomes a single price zones (SPZ). Congestion is only considered between SPZ. Zones are defined so as to get low internal congestions and leave structural congestions between zones.
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Time sequence of markets

- Forward markets
- Day ahead market
- Annual auction
- Monthly auction
- Daily auction with use-it-or-lose/sell-it
- Resale of annual/monthly interconn. capacity
- Balancing market
  - Balancing mechanism
  - Imbalance arrangements and pricing
  - Intra day market
  - Automatically Activated reserves

Closure times differ:
- Year
- Month
- Day (D-1)
- Day (D)
Short Term (Opportunity) trading

Market prices and costs are always different. Opportunity trading takes advantage of this characteristic.

Benefits from cross border trading are only limited by congestion, losses, or trading barriers.
Short Term (Opportunity) trading
Day-ahead markets

• Takes advantage of the prices (or marginal costs) differentials between interconnected countries

• The only condition to benefit is that prices (cost) differentials are greater than transactions costs (but the only real transactions costs are losses, although regulation can create barriers like transaction based tariffs)

• Typical forms of opportunity cross border trading:
  – Transactions between TSOs/national utilities/Single buyers (countries without markets)
  – Participants of a country present offers in short-term markets of neighboring countries (EU, USA)
  – Regional day-ahead, intraday markets (EU, Central America, SAPP)
Concepts about Regional Day-ahead markets

Common activities

- Market participants allowed to participate (licensed) present daily offers/bids
- The MO processes the offers/bids and: select the offer/bid that will clear the market, accept buying bids; set the price
- Accepted bids-offers turn into obligations for the participants
- The SOs introduces technical “corrections” to ensure system security (unless SCED)
- The MO settles the transactions

Alternative designs – obligations of participants

- **Gross pool**: mandatory, all the energy must be traded in the day-ahead market, contracts are financial (for price hedging)
- **Net Pool**: only differences between physical contracts and actual generation-load are traded in real time (balancing) market
Cross-border Day-ahead markets

Alternatives for cross border Day-ahead markets

- **Bidding at the border**: Participants of a country present offers-bids in the Day Ahead of another (interconnected) country and vice versa. Offers-bids can be presented in the borders (i.e. regulatory seams are smoothed). Approach used in USA.

- **Superposed regional market**: Each county has (or not) an internal market, but market participants-TSOs-utilities-SB are allowed to offer-bid in a regional day-ahead market with its own rules. It requires a regional MO, regional congestion management and access charges. Used in Central America.

- **Common market**: There is an unified day-ahead market. Offers-bids do not discriminate between internal-external transactions. Regional MO substitutes national MOs.

- **Market coupling**: Close to common market, but several MOs are involved. Unified clearing of cross border offers-bids. PCR in EU.
Long-term trading: Bilateral Contracts and Forward Markets: Bilateral (OTC)

- **Physical**: most common and simple alternative for cross border trading. Obligation of seller to inject and the buyer to withdraw the committed capacity.

- **Financial**: requires a price reference and short-term markets in each country. It covers price differentials for a certain volume and profile of power = $PX$.
  
  » The seller compensates the buyer when spot price (SP) is greater than contract price (CP), the amount $(SP-CP)*PX$
  
  » The buyer compensates the seller when spot price is lower than contract price (CP), the amount $(CP-SP)*PX$

- Long term contracts are normally linked to some “structural price differential”.
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Network charges

• The power transmission service is a natural monopoly, given today’s technology, due to the cost of the required investments, strong economies of scale and “use of land” constraints. The solution normally adopted to this situation is to make the transmission service a regulated activity, subject to regulated tariffs.

• Fixed Costs:
  • Sunk: Investments
  • Non avoidable: O&M, administration, taxes

• Variable Costs:
  • Losses
  • Congestion
  • Security (reactive compensation, etc)

• The same concept can be applied to cross border transmission systems.
Cross Border Tariffs: Compensation for Transit

• **Transit**: power flow in a country originated in a transaction between agents of third countries. Both the source (generation) and the sink (demand) are in third countries.

• **Transit compensation**: It is the economic compensation that the transmission owner (or other agents established in the internal regulation) of a country receives when their transmission facilities host transit.

**Costs**

- Actual **variable costs** linked to transit:
  - Incremental losses (that may be negative)
  - Congestion costs (need to redispach)

- **Fixed costs**:
  - Unless there is an agreement to expand and allow greater transit, there are no fixed costs
  - But hosting countries may require a fee for the use of their transmission facilities
Transaction between \textit{j1} and \textit{k1} requires to use the transmission systems of third countries.
Transit example

Total transits arises from all the scheduled cross border transactions
Example: 100 MW DE → FR: a commercial transaction...
Difficulties to Identify Transit Costs

- Electricity is not traceable, it is not possible to identify responsibility of each agent in the use of transmission systems.
- Consequently, when there are several transactions that originate transits, it is not possible to identify the responsibility of each agent.
- Losses are not linear.
- Congestion depends on the flow pattern.

Consequence: no objective methods to allocate transits costs to agents.

Nevertheless, regional market have defined transit compensation fees, although not necessarily based on efficient criteria.
Transactional and Non-Transactional Transit Fees

• **Transactional**: each transaction pays a fee ($/MW, $/MWh) for each unit of transit
  
  – Pros: perceived as fair, each agent pays when it effectively schedules a transaction (and benefits of it)
  
  – Cons: if the fee includes fixed costs recovery it is inefficient. The transit fee is paid by agents as a variable costs, so they will schedule a transaction only when the benefit is greater than the fee. Consequence: economically efficient transactions are not scheduled.

• **Non-transactional**: agents that wish to schedule cross border transactions pay a fixed fee independent on the number or volume of transactions (it can be based on the maximum power the agents require)
  
  – Pros: does not discourage transactions, fees are independent of whether a transaction is scheduled
  
  – Cons: may be perceived as unfair. Obligation to pay even when the agents do not schedule because third parties’ transactions have a higher value.
International Experience – EU Initial Transactional Fees

• The initial approach of numerous Member States was to set up import and export tariffs based on the flows

  (transaction-based cross-border tariffs)

• This created a “pancaking”* of tolls collected for the use of each transmission system

*Pancakes are great when you start eating them, but by the time you get to the end you are totally sick of them
International Experiences – Current EU ITC mechanism

• Method: estimation ex-ante of transits, and then all agents pay a fee. Fee based on agreed “cost values” for infrastructure (LRAIC) and losses (average electricity price)

• Rationale: fully non transactional method

• Internal transactional variable costs are not recognized, implies hosting systems may be gaining/losing money.

• It is a compromise between different positions and approaches to cost calculation
Compensation for Losses

Contributions by perimeter countries

Contributions by ITC TSOs

\[ R_L \text{ and } C_p \text{ are calculated on a yearly basis} \]

\[ R_i = 100 \text{ Meuro} \]

\[ C_{ITC} = R_L + R_i - C_p \]
International Experiences – Central America

• Method: nodal prices plus a regional and locational transmission charge to recover costs of the whole Regional Transmission Network (RTN)

• Rationale:
  – Transactional for variable costs and non transactional method.
  – The RTN is a common asset shared by all the agents of the region, and paid consequently
  – Doubtful justification of the locational transmission charges to recover fixed costs

• Requires of a wide regional agreement to accept the RTN concept. Even countries without internal nodal prices accept that their transmission facilities part of the RTN will use this methodology
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Harmonization of National Frameworks

What is necessary for Cross Border Trading:

- Agreements on the NTC between countries on procedures and technical issues, mainly security and quality
- Procedures to inform TSOs on the proposed bilateral transactions
- TSOs approves the transactions
- On daily basis the parties informs TSOs on the power to be transferred
- Day ahead market clearing (if any)
- Procedures among TSO to prepare a schedule of cross border transactions, including bilateral contracts and day ahead cleared transactions
- Actions to maintain schedules cross border flows in real time
- Metering
- Mechanisms to settle deviations
- Capacity allocation and network charges
A Interconnection Code (IC or regional Grid Code) is highly convenient for operation of a regional markets as CAREM. This code has the following objectives:

- To implement common standards for satisfactory operational security, reliability and quality of supply in any Interconnected Transmission System;
- To encourage integrated planning of generation capacity and transmission expansion;
- To define responsibilities for the operation and management of the Interconnected Transmission System;
- To ensure non-discriminatory access to the regional Interconnected Transmission System for all Users, and
- To ensure that TSOs are adequately trained and authorised.
Q&A