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Physical and Financial Capacity Rights for Cross-Border Trade:

Interim Report Summary

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Key objectives of the study

- *Identify advantages and disadvantages of tradability of long-term TRs (discussed in the interim report)*
- *Should rights **be financial transmission rights** (FTRs) or **physical transmission rights** (PTRs), (or variants/hybrids); (discussed in the interim report)*
- Propose **practical recommendations**, including the **preconditions necessary, for a facilitating a market in the rights** which will meet the needs of participants, and deliver efficient and reliable long-term price signals (future work)

Emerging Conclusions (1)

- Long-term contracts including TRs are desirable
  - reduce risk, and help to underwrite investment plans
- Anything PTRs can do FTRs can do better
  - main advantage: standard two-sided FTR is a firm obligation and can be netted to release a potentially far larger market on either side of any IC
- FTRs tend to mitigate market power
  - market power may be exacerbated with both FTRs and PTRs, but there are simple remedies: traders can outbid those with market power if markets liquid

Emerging Conclusions (2)

- Advantages in issuing amounts of varying durations
  - either encourage continuous trading or hold periodic auctions for re–trading
- Determining ATC requires TSOs to make assumptions years ahead about conditions expected to prevail in real time. Effect of netting potentially very significant.
  - Difficult, forward FTRs likely to be inter-zonal so forward amounts based on inter-zonal ATCs
- TSOs must provide sufficiently granular load flow data to the relevant SO day-ahead to maximize ATCs (flow-based calculation)
  - to maximise the value of all interconnectors between different price zones

FTR obligations increase competition

- Consider an IC with ATC of 2 GW connecting two concentrated markets, A, B (G = 25 GW, peak L = 20 GW; similar plant in each)

- Large Industrial Consumers (LIC) base-load demand = 8 GW
  - PTRs only release say 1 GW in each direction
  - 87% of market dominated by incumbent G

- Now SO issues 1 GW LT FTR obligations each way
  - Initially LICs buy 1 GW A→B, G_B loses 1 GW custom, sells to A, FTR of 1 GW B→A nets to zero; SO continues to issue FTRs subject to net value of 1 GW

- Any customer in any country can potentially choose their electricity supplier

Key Objectives of Long-Term TR Trading

- Promotes efficiency in the use of cross-border transmission
- Promotes competition between generators across borders
- Tends to mitigate market power in generation, rather than reinforce it
- Facilitates required investment in cross-border transmission capacity
- Allocates risk efficiently to TSOs and rewards them appropriately
- Accommodates intermittent generation

Desirability of Contracting

- Long-term transmission rights enable competition to be extended across borders with scarce transmission capacity.

Objective	Advantages	Disadvantages
Promotes efficiency in use of cross-border transmission	can facilitate increased efficiency in the use of transfer capacity	
Promotes competition between generators across borders	Greater competition across borders, extent depends on arrangements.	Price convergence can harm some stakeholders but could be compensated. Insiders profit from poor transparency; will resist the increased competition.
Tends to mitigate market power in generation	increased competition should mitigate market power. Use-it-or sell-it (UIOSI) prevents harmful capacity withholding.	Large import shares enhance market power of dominant firms; address by import restrictions and liquid trading, with UIOSI.
Facilitates investment in interconnector capacity	Robust forward TR prices indicate value of more capacity	Private investment may require derogations, or supplementary revenue.
Efficiently allocates risk to TSOs, and rewards them appropriately	TSOs can bear the (modest) additional risks of more and longer-term TRs (compensation for unavailability for IC revenues) thus reducing risks to traders.	TSOs may resist bearing additional risks by alarming regulators.
Accommodates intermittent generation	Accurate ATCs ensure IC SO always financially hedged.	Requires providing more information; allocates more responsibility to supra-national dispatch.

Differences between PTRs and FTRs

- Target Model: TRs should either be
  - PTRs as options with use-it-or-sell-it (UIOSI), or
  - FTRs; either options or obligations.

- ERGEG's *Framework Guidelines on Capacity Allocation and Congestion Management for Electricity* (Feb 2011, not yet formally adopted by ACER), **proposes that the TRs on any specific border should be either FTRs or PTRs *but not both*. NCs shall define nature of FTRs in terms of options OR obligations.**

- Physical dispatch + FTRs is at least equivalent to PTRs in the certainty of delivery and price

PTR properties

- PTR grants ***directional*** volume capacity rights to an interconnector (flowgate) between ***two zones*** (rather than point to point)
  - e.g. a PTR from England to France differs from a PTR from FR to GB
- PTRs are physical: without them no cross-border bilateral trading can take place
- If PTRs ***are nominated*** the holder must physically deliver power from its own units and/or buy in PX ***or pay imbalance penalties***
- PTRs with UIOSI ***not nominated*** receive cross-border price difference if positive, otherwise zero.

FTR properties assume market coupling

- An FTRs is always from one price zone (or node under LMP) to another price zone/node and is ***directional***
- FTRs as an **obligation** receives, ***or is liable for***, the price difference between zones.
- FTRs as an **option** have a payout only if there is a gain
- FTR options are equivalent to PTRs with UIOSI
- FTRs have no physical interpretation: holder receives (/pays) price difference irrespective of whether he participates in the energy markets
- The financial product, CfD, as in Nord Pool, is equivalent to an FTR ***obligation*** in terms of payout ***but*** CfDs are not under-written by the TSO and have no claim on the congestion surplus

Cross border bilateral trading under PTRs and FTRs

- **Target Model**: ***PTRs must be nominated ahead of the D-1 market coupling*** to calculate ATC for the market coupling (NTC – volume of nominated rights)
- Nominated PTRs oblige holder to contract/produce/consume nominated energy: can => *welfare loss (and lost profit) due to inefficient dispatch and adverse flows*

This implies:

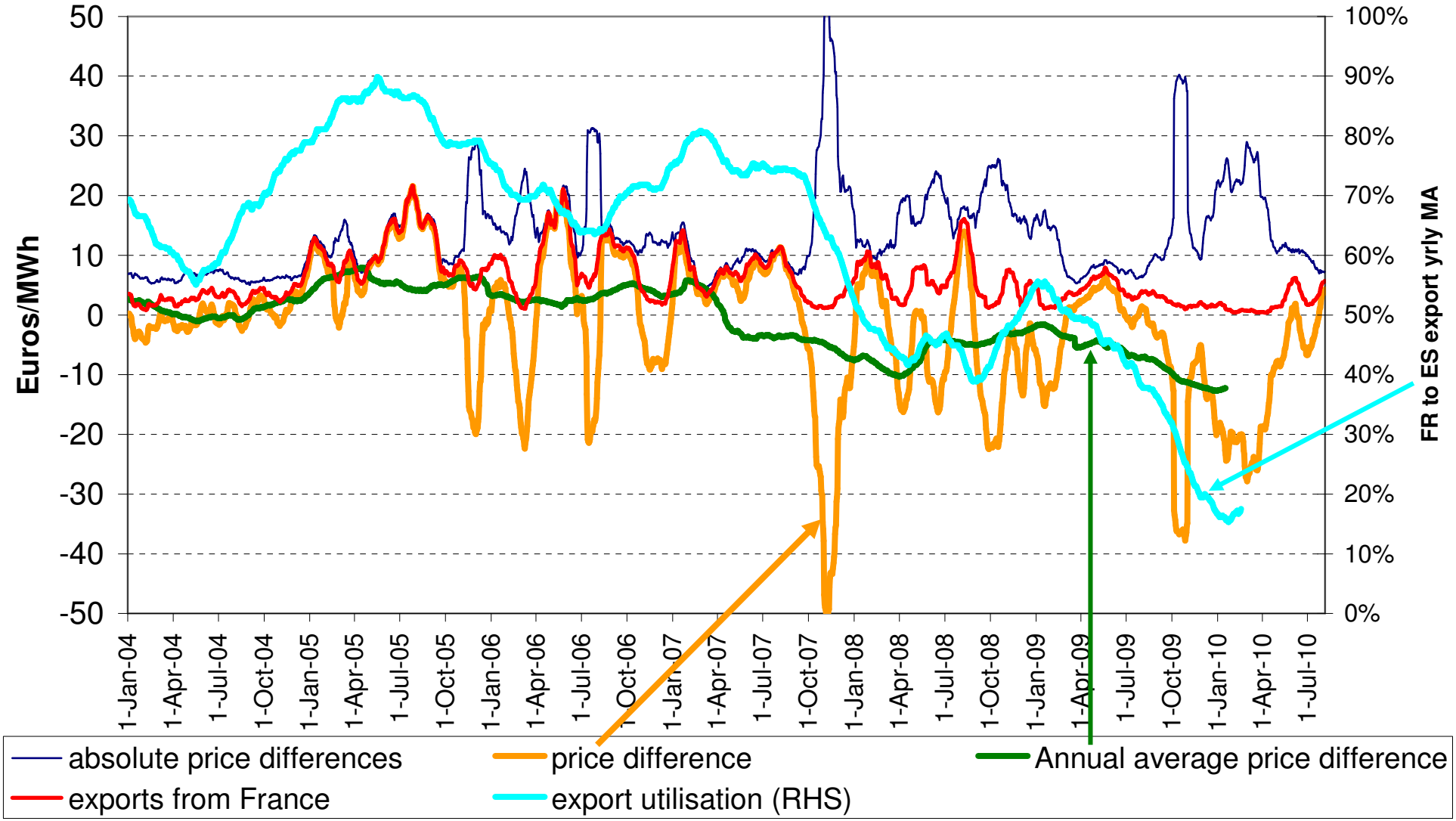
– With sufficient liquidity in local PXs, it is better not to nominate the PTRs

– Then non-nominated PTRs with UIOSI ***are equivalent to FTR options***

FTR options or obligations are superior to PTRs as they are point-to-point (price zone to price zone), independent of the network topology, in contrast to PTRs that are defined strictly over a specific interconnection

Price differences, Spain-France

monthly moving averages of hourly differences



Trading example: Spain – France in 2006

- 1 yr base-load contract €50.65/MWh in Spain; €48.13 in France
- But PTR FR→ES worth €8.49/MWh (value of exports only)
  - does this mean L_S cannot bid for PTR when $Ep_F - Ep_S$ = €2.52/MWh?
- No: not if LIC actively trades
  - G_F has MC €30/MWh, contract to sell to L_S who holds PTR at €48.13/MWh
  - 19 July 2006: p_F = €116.83/MWh, p_S = €55.30/MWh, $p_F - p_S$ = €61.53/MWh
  - L_S sells into FR market, profit = €116.83 - 48.13/MWh = €67.87/MWh, releases PTR (value = 0), having paid €8.49/MWh, buys in ES at €55.30/MWh rather than at contract of €48.13/MWh, loss of (€7.17)/MWh,
  - net gain = €67.87- €7.17- €8.49 = € 52.21/MWh *on this day*
- same as L_S holding Spanish CfD for €48.13/MWh and one-sided FTR FR→ES for €8.49/MWh

PTR / FTR: Options/Obligation

- As PTRs + UIOSI = FTR options, we need only consider FTR options and obligations
- **Initial conclusion**: FTR obligations enable a wider range congestion risks to be hedged, and greater willingness of market participants to hedge, than FTR options as they will always be a subset of the possible auctioned volume of FTR obligations.

	Options	Obligations
Payout	Max (0, P_{sink} – P_{source})	P_{sink} - P_{source}
Volume	***Limited***, as to guarantee feasibility it is necessary to consider all possible combinations of the exercise of options – **At the time of auction netting impossible, maximum directional volume = transmission capacity**	***Maximum*** - subject to transmission system security constraints. **Volume of FTRs can be much higher than physical system capacity due to netting (facilitates EU-wide trading)**
Firmness	Assuming system topology un changed 100%; firm	Assuming system topology unchanged, 100% firm
Definition	Point to point, ***impossible to decompose*** to A to hub to B	Point to point, ***decomposable to any set of rights*** as long as initial source and sink are the
Market Power	Can increase market power, but not reduce it	Potential to both increase and reduce market power
Credit Risk	Since payout is only positive TSOs/counterparty credit risk is not an issue	Payouts can be negative so possible credit risk, which **can be mitigated through a clearing house**

FTR Options and Obligations Experience

- All US nodal markets offer FTR obligations: market participants satisfied
- Only PJM and CAISO (and only for Merchant Transmission projects) offer FTR options
- Market participants' demand for FTR Options has been quite limited
- Many ISOs (MISO, NYISO and New England ISO) issue FTR obligations in annual and monthly FTR auctions; exploring possibility of issuing FTR options for a few years
- Reluctant to issue/administer FTR options market because of challenge in designing a set of options while ensuring TSO revenue adequacy (but nothing stops traders issuing them)
- Lack of adequate models or methods to price FTR options raises serious concerns about the liquidity of secondary markets
- In practice both FTR options and obligations are offered and it is left to market participants to decide which rights are desirable

Concern: Target Model preference towards FTR / PTR options (and against obligations)

Volume of Allocated Rights

- Calculating volume of rights to allocate to follow co-ordinated capacity allocation methodology for DA ATC calculation. This is a 4 (5 including validation) step process:
  - Step 1: Creating Input for Common Grid Model (CGM):

    Each TSO creates a forecast file describing their part of the grid, starting from common and shared hypothesis (D-2 for day-ahead capacity calculation)

    Forecasts intra zonal injections (for their impact on the interconnector)
  - Step 2: Building the Common Grid Model:

    Merge input files describing each zone

    Resulting CGM provides coherent description of the whole European power system to determine coordinated capacity calculation
  - Step 3: Capacity Calculation Process

    Based on a harmonised risk assessment to ensure secure system operation

    Two methods possible (2015): coordinated ATC and coordinated Flow-based.
  - Step 4: Capacity allocation

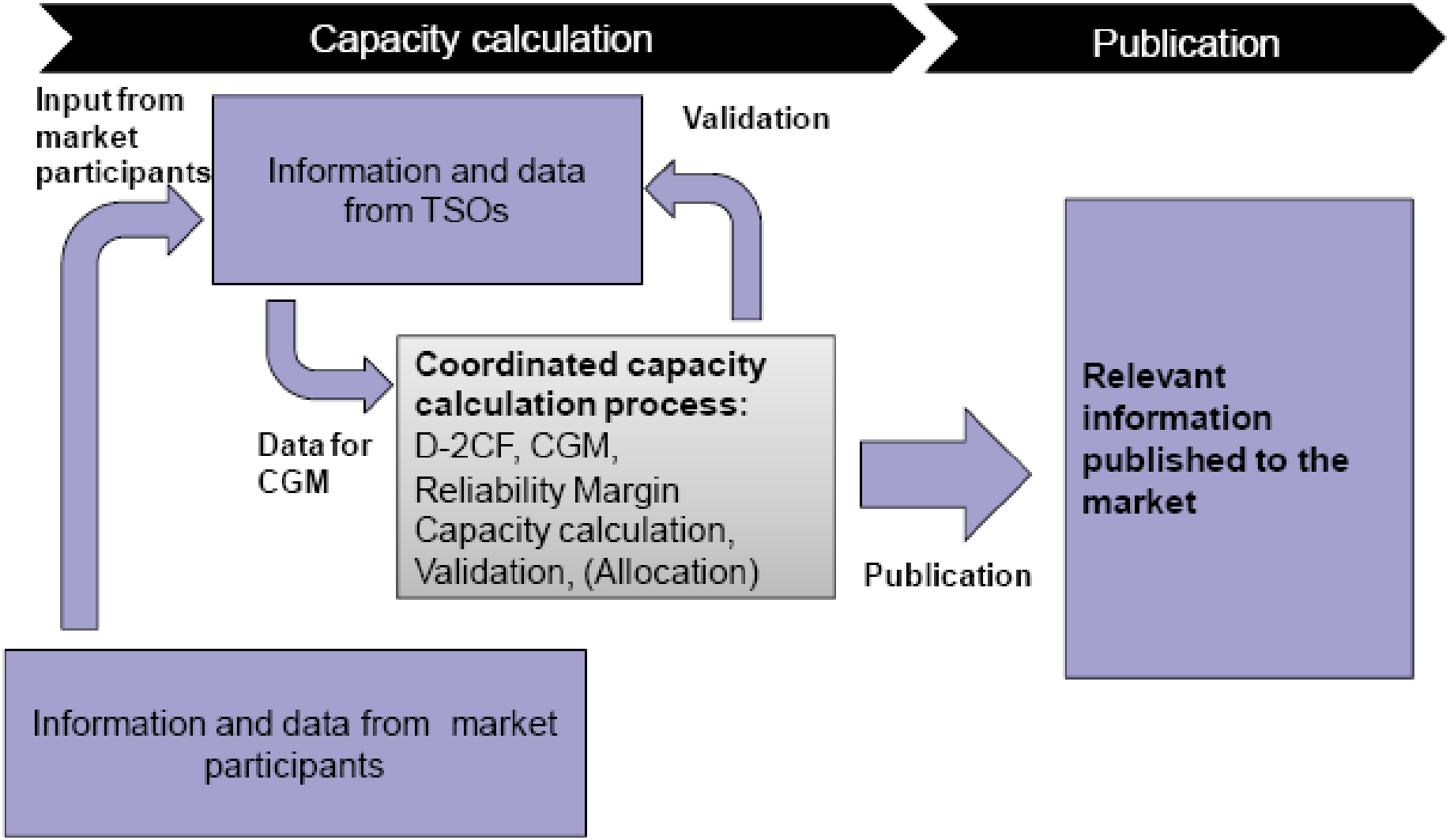
    Capacity is allocated, either explicitly; or implicitly, with price coupling as the target model for day-ahead.

Information needed for CGM and ATC calculation

- The CGM for D-2 capacity calculation requires each TSO to provide the D-2 Capacity Forecast (D-2CF files). This includes:
  - Cross-border schedules from the reference day, topology (**planned outages of grid elements and associated operation schemes**), forecasts for **load** pattern, **renewable and other generation** pattern and planned outages (problematic long term)

INFORMATION AND HYPOTHESIS	SOURCE
Planned outages of grid elements	TSOs with the input of merchant line operators
Planned outages of operating units	TSOs with the input of GENCOs
Generation availability and pattern forecast	TSOs with the input of GENCOs
Load pattern forecast	TSOs with input of suppliers, DSOs and industrial customers
Renewable generation forecast (e.g. wind and PV generation)	TSOs with input of GENCOs
Cross border schedules (as far as already known on the basis of longer term nominations)	TSOs with the input of market participants (nominations of capacity from the reference day)
GSK pricing information	TSOs with the input of GENCOs

Calculating co-ordinated ATC for volume of rights



Long term ATC calculation

- Required for both FTRs and PTRs to take account of the effect of intra-zonal trades (injection/withdrawals) on the ***interconnector capacities***
- Requires TSOs to make ***assumptions*** on expected future conditions at the auction, months or years ahead
- Complicated by unpredictability of hourly wind making remaining ATC difficult to predict until a few hours ahead of time
- If ATC is correctly calculated, vol of allocated FTR obligations can be significantly higher than PTRs or FTRs options due to netting, provided Simultaneous Feasibility Test satisfied
- Even if ATC is zero (possible for some interconnectors) as long as FTR obligations are netted to zero then the directional auctioned volumes can be significant
- In this case the FTR obligations similar to Nord Pool CfDs, since trading counterparties underwrite the rights by buying counter-flow FTRs
  - As volume of CfDs does not depend on the physical capacity of the system, TSOs not exposed to any risks, only act as a “netter” of rights

Simultaneous Feasibility Test

- The Simultaneous Feasibility Test (SFT) is:
  - Important, because it tests that the FTRs are within network capacity when allocated
  - Achieved by representing all FTRs simultaneously in network model, with all loop flows from the external network
  - Solved for network flows in both the pre- and post-contingency states and checked for limit violations

- The SFT guarantees that if all outstanding FTRs are exercised simultaneously to support physical transfers then ***no transmission constraint or ATC violated***

- When the topology assumed for SFT is the same as used in the real time dispatch, TSO congestion ***revenues will be "adequate"*** to cover financial settlement of all outstanding FTR obligations

FTR / PTR: Firmness

- Firmness facilitates liquid forward and secondary markets and efficient pricing. If the network structure is maintained, SFT would ensure revenue adequacy.
- Fully firm FTRs: shortfall socialized
  - Inter-temporal smoothing of congestion revenue - surpluses cover shortfalls
  - Gaming: incentive to congest line though fictitious transactions in order to capture FTR revenues
- Not fully firm: prorate pay to FTRs to cover shortfall ("haircut" approach): IFA example
  - SO can curtail interconnector capacity if necessary
  - Pro-rate capacity curtailment in the following order: Intraday, DA, Long term nominations
  - Curtailed PTR holders compensated on the basis of the initial purchase price.
  - Participants take account of non-firmness when bidding (overall, IFA 93% available last 5 years).
  - Gaming not identified

We will consider a shared management of the shortfall between TSOs, FTR holders and all market participants but prefer TSO averaging (better incentives, lower risks)

Firmness in practice

- Nord Pool CfDs are 100% firm as cleared through the derivatives exchange
- CAISO, PJM, ISO-NE: reduce FTR payout pro rata => revenue recovery
- NYISO: shortfall recovered by TO's
- Texas: shortfall socialised to load
- In ISO-NE and PJM revenue adequacy excellent: 100% in 2008, 2009 & 97.7% in 2010 (PJM)
- Revenue ***inadequacy***: MISO 2006-2008 over 10%; NYISO 2005-2008 7%
  - NYISO and MISO reacted by making available a smaller number of FTRs

Transmission Rights: Durations

- Currently PTRs are offered with ***annual, quarterly and monthly*** durations
- Traders desire TRs with longer durations, to match energy market products
- Florence Forum PCG proposed that forecast ATC should be sold for the next ***4 years***:
  - 10% for Y+3; 20% for Y+2 ; 40% for Y+1; total = 70%
- Given difficulty of computing LT ATC, TSOs may be reluctant to issue significant volumes
  - Particularly for FTR options and PTRs where netting is not possible
- In US markets with FTRs majority of ISOs offer annual or monthly FTRs
- In PJM longer duration FTRs are offered but only as obligations. ***Majority of auctioned rights result from netting rather than ISO auctioned capacity***
- **Nord Pool CfDs** are not auctioned but offered as futures contracts. There are CfD contracts for months, quarters and the ***three nearest calendar years***
- High level of open interest of CfDs ***may*** indicate that most trading is for long-term CfDs
  - we have not been able to confirm this quantitatively

FTR Durations in PJM: FTR Auctions

- ***Long-term (LT) FTR obligations auction***:
  - Residual capacity is auctioned for the subsequent 3 years
  - Auctioned capacity = Total System Capacity *less* ARR (Auction Revenue Rights) allocated capacity
  - Duration for 1 (for year 1, 2) or for all 3 years
  - Transmission investments are not considered in auctioned capacity
- ***Annual FTR Auction Obligations (and Options):***
  - Auctioned capacity = Total System Capacity *less* long-term FTR auctioned capacity
  - ARR holders effectively convert their ARRs to FTRs
  - Self-scheduled FTRs clear as price-taking FTR bids and do not set auction price
- ***Monthly Balance of Planning Period FTR Auction Obligations (and Options)*** **:**
  - Auctioned capacity = residual after LT and Annual FTR sales + FTRs offered to auction
  - Participants can bid to buy or sell FTRs
  - FTRs: **monthly** for any of the 3 next months remaining; or **quarterly** for any remaining quarter

Secondary Trading: Efficient pricing requires liquid trading of the underlying instrument

- Given a large number of FTRs, liquidity can be relatively low
- Secondary markets enabling reconfiguration and re-trading are very thin (confirmed by PJM, the most liquid market) but absolutely necessary
- Pricing and trading of FTRs done through central periodic auction. Liquidity depends on the frequency of that auction
- In PJM the secondary trading is organised as follows:
  - Market participants can buy and sell existing FTRs through the PJM-administered, bilateral market or market participants can trade FTRs among themselves without PJM involvement
  - For PJM administered FTRs, option/obligation and sink and source definitions must remain the same but volume can be broken down to 0.1MW
  - Duration can also be altered as long as the new start and end times are within the original FTR duration
- The advantage of CfDs over FTR or PTRs: CfDs can be continuously traded without need for any centrally administered auctions - should lead to better price discovery

Transmission Rights and Bilateral/OTC Energy Trading

- In the US LMP pools, participants can nominate self-scheduled trades that are automatically accepted by the pool clearing algorithm. In PJM around 30% of total trades
- Self-scheduled participants pay access charge equal to the LMP differential between their nominated sinks and sources, which can claim back if they hold the equivalent FTRs
- Consequently, these participants bear no liquidity risks or PX fees
- In Europe self-scheduled trades could be subject to an access charge equal to the price difference between nominated zones

Common misconception: a move towards FTRs might impede OTC or bilateral energy trading

Emerging Conclusions

- LT TRs are desirable - reduce risk, help to underwrite investment plans
- FTRs have several advantages PTRs and no obvious disadvantages; notably a standard two-sided FTR is a firm obligation that can be netted to release a far larger market
- FTRs tend to mitigate market power as do PTRs+UIOSI provided trading is liquid (and dominant importers cannot monopolise imports)
- There are advantages in issuing amounts of varying durations, and either encouraging continuous trading or holding periodic auctions where they can be re-traded
- Determining ATCs requires TSOs about future conditions (months and years ahead) (potentially a significant problem). Effect of netting potentially very significant.
- All actions should be taken, including providing sufficiently granular load flow data to the relevant SO, to maximise the value of all interconnectors between different price zones