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# WP3 Expert Workshop

## Preliminary assessment of market design options

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# Most relevant pending market design issues

## Long-term electricity mechanisms and markets

1. (3.1.1) Long term CRM mechanisms
2. (3.1.4) Long-term cross-border products and long-term markets
3. (3.1.2) (3.2.5) Support mechanisms and participation of RES in markets (LT & ST)
4. (3.1.3) (3.2.6) Support mechanisms and participation of DSR in markets (LT & ST)

## Short, and very short term electricity market

5. (3.2.1) Network representation
6. (3.2.2) Timing of markets
7. (3.2.3) Bidding protocols and pricing rules in ST energy markets
8. (3.2.4) Frequency regulation services and balancing mechanism

# Long Term – CRM mechanisms (i)

- When do we need CRMs?
  - When the market is not capable of doing its job to ensure the LT SoS
    - Short-term market is not providing optimal signals
      - Flawed regulatory rules (e.g. explicit or implicit price caps)
    - Lack of tools to hedge generators risk in the long term
      - The problem is not short-term price volatility but long term one
  - CRMs are a questionable solution to solve the missing money due to overcapacity

***Distinguish between missing money and missing capacity***
*In liberalized markets, investments are not guaranteed by the State.*
*Only where there is a real threat to generation adequacy and security of supply as a result of closure or mothballing does the financial viability of existing plant become a matter of public concern.*
*It is very important that there should not be state support to compensate operators for lost income or bad investment decisions.*

*Source: 2013, European Commision, "Generation Adequacy in the internal electricity market - guidance on public Interventions"*

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# Long Term – CRM mechanisms (ii)

- Design alternatives for CRM

  Capacity Markets

  Bilat. Capacity Markets

  Capacity Payments

  Reliability options

  Strategic reserves

  Long-term energy auctions

VS


- Classification of cross-border participation
  - One single European mechanism
  - National mechanisms with implicit or explicit consideration of XB capacity
  - National mechanisms without consideration of XB capacity

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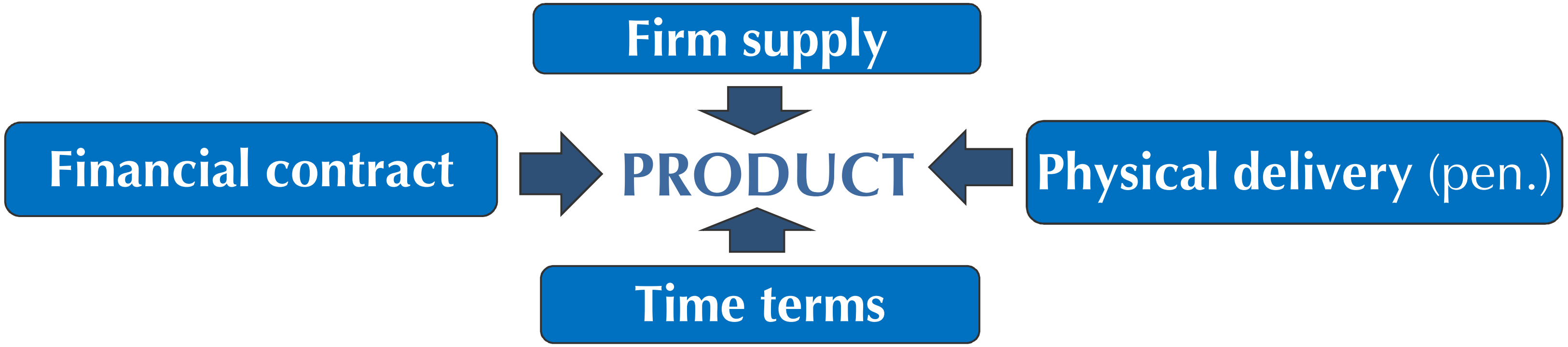
# Long Term – CRM mechanisms (iii)

Design elements: the product of the CRM mechanism as the cornerstone




Essential to identify the market failures to properly design the product

- Lack of tools to hedge risk
- Short-term prices do not provide a proper availability signal

# Long Term – CRM mechanisms (iv)

## Financial contract: a key design element to hedge the price risk

Firm supply

Financial contract → **PRODUCT** ← Physical delivery (pen.)

Time terms

| | Efectiveness | | |
|---|---|---|---|
| **Financial contract** | Hedging generator | Hedging demand | Incentives demand participate LT market |
| No | 1 | 1 | 4 |
| Option with low strike price (variable generation cost) | 4 | 4 | 1 |
| Option high strike price (scarcity price) | 3 | 3 | 3 |

- Very high rate
- High rate
- Medium rate
- Low rate

# Long Term – CRM mechanisms (v)

## Time terms: a key design element to hedge new investors

Firm supply

Financial contract → PRODUCT ← Physical delivery (pen.)

Time terms

**Lag period**

**Contract duration**

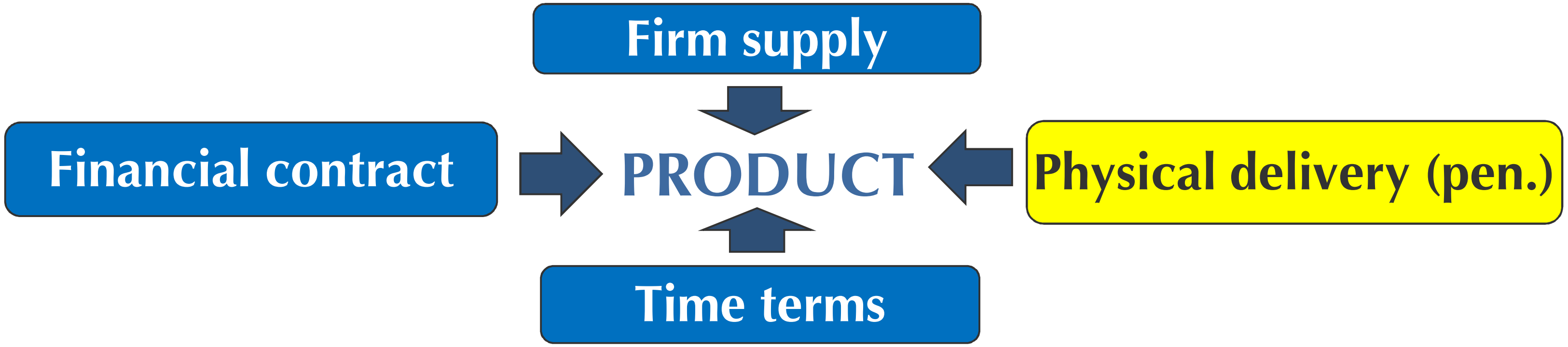
**The contract is signed**

Effectiveness hedging new plant's risk increases if lead time is around construction time (3 years)

Tradeoff:
- New investment need long contract durations.
- Very long-term contracts involve a high risk for the demand.
- 5-7 years for new investors seems to be reasonable

# Long Term – CRM mechanisms (vi)

Penalty: reinforcing the short-term price signal in case of scarcities




| | **Efectiveness** | | |
|---|---|---|---|
| **Penalty for non-physical delivery** | Short-term availability incentive (scarcity) | Hedging generator | Hedging demand |
| No | Short-term market price | Lower risk | Higher risk |
| Yes | Short-term market price + penalty | Higher risk | Lower risk |

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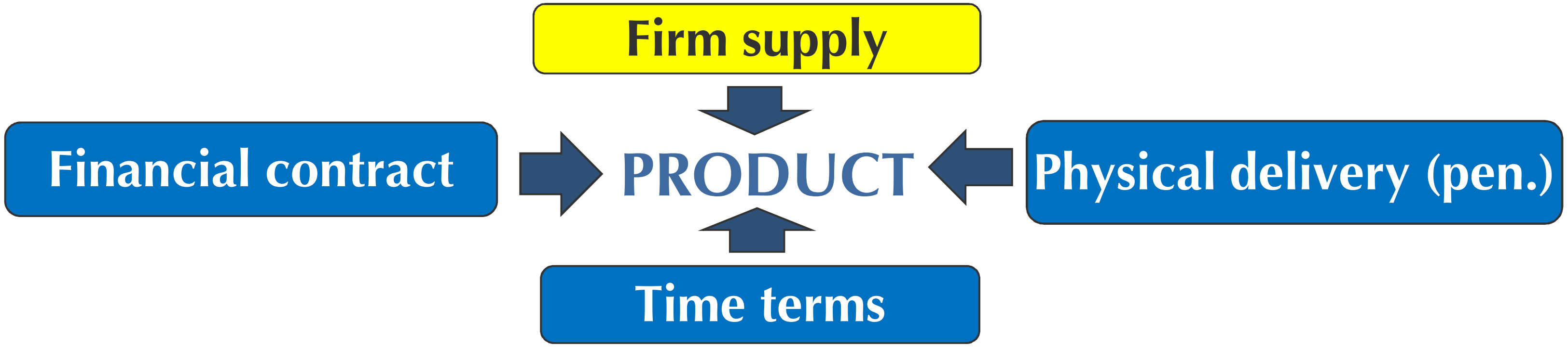
# Long Term – CRM mechanisms (vii)

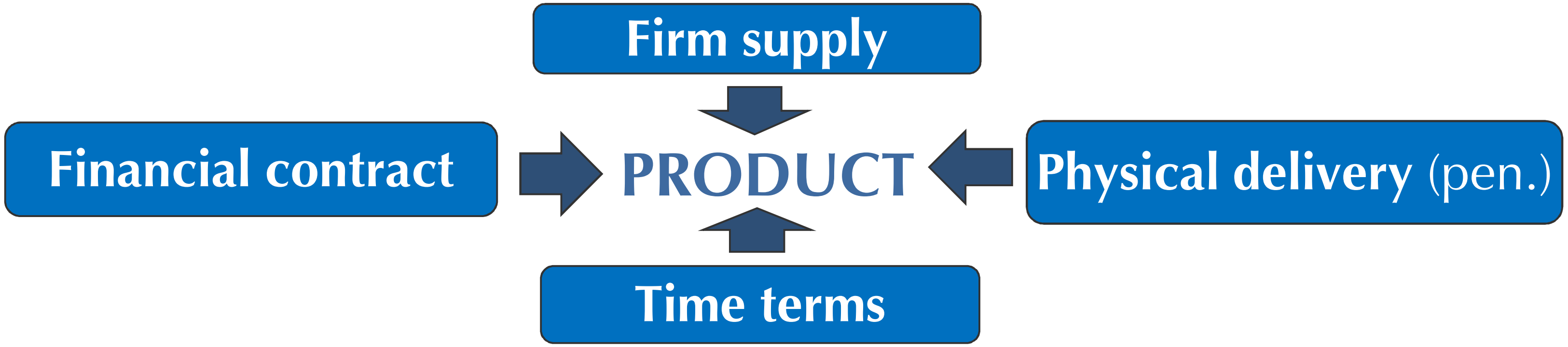
Penalty: reinforcing the short-term price signal in case of scarcities




- A common feature in Capacity Remuneration Mechanisms to ensure there is physical back-up
  - Known as capacity credit, energy credit, firm capacity, firm energy, etc.
  - The expectation of the contribution of the plant to the Security of Supply
    - Expectation of production in case of scarcity
      - High demand, high or low temperature, high prices, etc.
      - High prices should be the preferred option if we trust the market

# Long Term – CRM mechanisms (viii)

Design elements: the product of the CRM mechanism as the cornerstone




Essential to identify the market failures to properly design the product

- Financial contract and time terms → hedge risk
  - Option with high strike price, lag period of 3 years and contract duration of 5
- Firm supply → ensure there is physical back up
- Penalties for non-physical delivery → enhance the short-term availability incentive

# Long Term – CRM mechanisms (ix)

Purchasing mechanism

- Centralized:
  - One central entity is in charge of defining the product(s)
  - The procurement is carried out by means of a centralized auction
- Decentralized (with standard products)
  - One central entity is in charge of defining the product(s)
  - Market parties bear the responsibility of procuring the product(s) in bilateral or organized markets.
- Decentralized (without standard products):
  - Many elements of the products are not standardized (e.g. contract duration or lead time)
  - Market parties bear the responsibility of procuring themselves the product(s) in bilateral or organized markets.

# Long Term – CRM mechanisms (x)

## Purchasing mechanism

| | Efficiency | | | | | | |
|---|---|---|---|---|---|---|---|
| | Marginal cost reflictivility | Economies of scale and lumpiness | Vertical Market power | Cost causality | Diversity of products | Implementability | Experience |
| Centralized (standard products and auction) | 4 | 4 | 4 | 3 | 2 | 4 | 4 |
| Decentralized (standard products and bilateral) | 3 | 2-3 | 2 | 4 | 2 | 4 | 4 |
| Decentralized (non-standard products and bilateral) | 3 | 2-3 | 2 | 4 | 4 | 4 | 4 |

Very high rate | High rate | Medium rate | Low rate

It is also possible to allow for a hybrid approach (a centralized auction for those not having bilateral agreements)

# Long Term – CRM mechanisms (xi)

- Cross-border participation
  - Single and homogeneus CRM
    - Same mechanism in all systems
    - Different requirements
  - Implicit account of interconnections
    - Different mechanisms
    - When defining requirements it is account for the statistical contribution of interconnections
    - Possibility to remunerate or not the cross-border country
  - Explicit consideration of cross-border resources
    - Different mechanisms
    - There is a cross-border counterparty offering the product (physical generator)
    - Explicit remuneration and commitment
  - Different and isolated national CRM
    - Different mechanisms seeking for energy autarky

# Long Term – CRM mechanisms (xii)

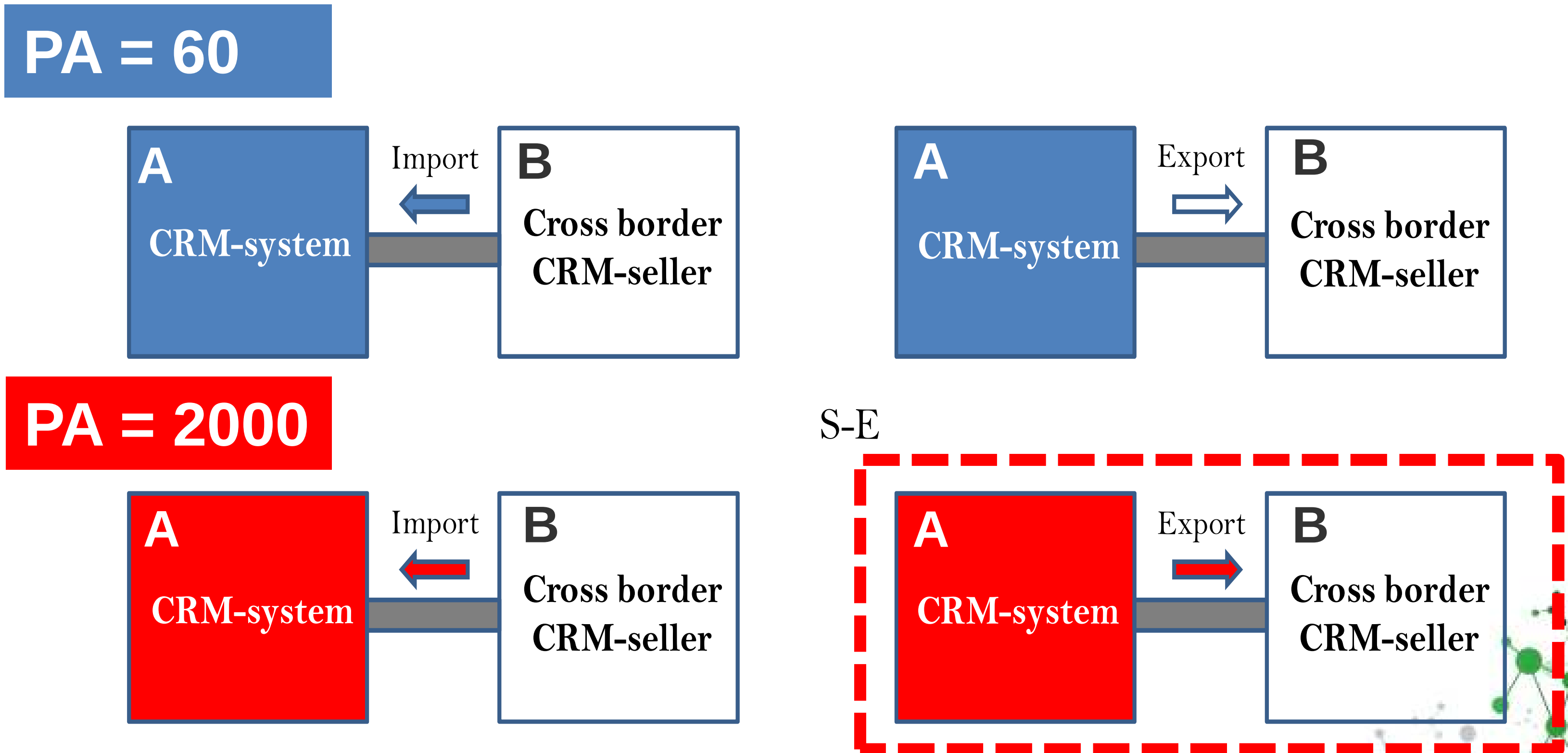
## Cross-border participation (i)

| | Efficiency | Implementability | Simplicity & transparency | Fainess |
|---|---|---|---|---|
| **Single and homogeneous CM for all Europe** | 3 | 1 | 1 | 3 |
| **Statistical account of the interconnections** | 3 | 3 | 4 | 1 |
| **Participation of foreign capacities** | 4 | 2 | 2 | 3 |
| **Different isolated CM** | 1 | 1 | 4 | 1 |

# Long Term – CRM mechanisms (xiii)

Target model: capacity is optimally allocated in the short-term by the PCR

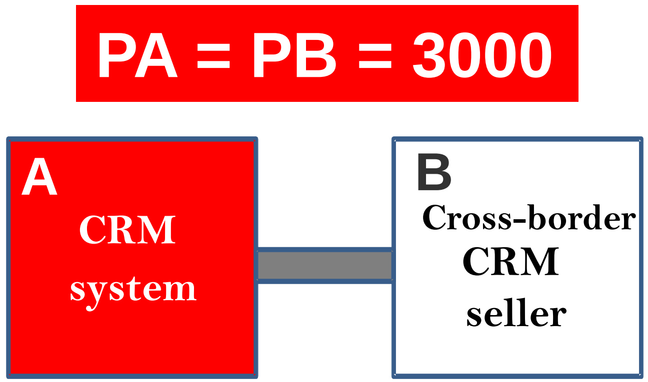
The situation is as follows with a CRM system:



# Long Term – CRM mechanisms (xiv)

## Flows determination in the short-term

- CRM will serve to solve indeterminancies in the PCR




- PCR will have to account for CRM

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# Long Term – Cross border products

- Long-term cross border products

| | TSO | Market agents |
|---|---|---|
| Physical | PTR<br>PTR UIOLI<br>PTR UIOSI | - |
| Financial | FTR option<br>FTR obligation | CfDs |

- Some general comments
  - Physical pros and cons
    - Ensures physical supply. Not needed to purchase the energy in a PX.
    - Market power. Inefficient dispatches
  - Financial pros and cons
    - Do not affect flows (efficient dispatches). Liquidity.

# Long Term – Cross border products

| | | Requires selling energy in the PX | Requires PX (for zonal price computation) | Ensure physical delivery * | Short-term liquidity | Long-term liquidity (attracts speculators) | Market power | Hedging |
|---|---|---|---|---|---|---|---|---|
| TSO | **PTR** | No | No | 4 | 1 | No | 1 | Partial hedge (higher premium) |
| | **PTR with UIOLI** | No | No | 4 | 1 | No | 4 | |
| | **PTR with UIOSI** | No | Yes | 4 | 3 | Yes (lower exposure, no negative payout) | 4 | |
| | **FTR option** max(0, Pa-Pb) | Yes | Yes | 1 | 4 | Yes (lower exposure, no negative payout) | 4 | |
| | **FTR obligation** (Pa-Pb) | Yes | Yes | 1 | 4 | Yes | 4 | Complete hedge (lower prem.) |
| Market agents | **CFDs** (Pa-Pb) | Yes | Yes | 1 | 4 | Yes | 4 | Complete hedge (lower prem.) |

* Useful if scarcity and non-homogenized price caps

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# Long Term – Cross border products

- Other design decissions:
  - TSO provision of the cross border product
    - Voluntary or compulsory
      - Compulsory if non enough liquidity
  - Firmness of the contract (risk exposure of product owner and TSO)
    - Full financial firmness: in case of curtailments after a threshold, capacity owners are compensated by the day-ahead market price differential (except in case of Force Majeure)
    - Capped compensation (same as above, but there is a cap on the price differential)
    - Compensation based on initial payment: for example the 110% rule applied at the FR-IT border
    - No compensations

# Long Term – National forward markets

- Key role of well-functioning long-term markets (security of supply)
  - Liquidity is a major concern in a number of systems (e.g. UK, I-SEM)
- Alternatives to ensure liquidity
  - Market maker (origin in financial markets)
    - Voluntary: financial entity or market agent
    - Mandatory on some market participants (GB or California)
    - Support for smaller parties: ability of smaller agents to request forward contracts
  - Reduce collaterals, transaction costs and transparency
    - Exchange based trading with a clearing house (instead of bilateral or OTC)

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# Timing of markets: intraday markets

- Design alternatives:
  - Continuous trading:
    - Bids can be submitted and matched to PX at any time
  - Intraday discrete auctions:
    - Auctions are called at specific predefined time
  - Hybrid:
    - Continuous trading with possibility of complementing the design with discrete auctions to ensure market liquidity
- Criteria
  - Flexibility to agents
  - Liquidity
  - Efficiency of the dispatch
  - Pricing of cross-border capacity

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# Timing of markets: intraday markets

- Assessment

| | Efficiency | | | | |
|---|---|---|---|---|---|
| | Flexibility to trade | Liquidity | Efficiency of the dispatch | Pricing cross-border capacity | Implementability |
| Continuous | 4 | 2 | 2 | 1-2 (*) | 4 |
| Discrete | 2 | 4 | 3-4 | 4 | 3-4 |
| Hybrid | 3 | 3 | 3-4 | 3 | 3-4 |

(*) Alternatives for enhancing pricing:

- Explicit auctions for cross-border capacity
- Ex-post determination of prices
- Dynamical capacity pricing estimation (proposal APX)

# Timing of markets: reserves

- Co-optimization is not an alternative in the IEM context
  - MO runs energy markets and SO reserve markets
- Timing of procurement
  - Long-term purchasing
    - Efficiency pros: ensures the availability of reserves
    - Efficiency cons: barrier for intermittent resources
  - Short-term purchasing
    - Efficiency pros: allows RES-E to participate
    - Efficiency cons: could be risky depending on the system not to give a longer term signal
  - Very short-term
    - For reconfiguring requirements in the long-term

# Timing of markets: last gate closure

*Between the real time and the longer term there are dividing lines that describe the system operator's diminishing role in forward markets. Where to draw those lines is the central controversy of power-market design.*
(Stoft, 2002)
Each system has traditionally used different criteria to define the point at which the SO takes increasing control of the system so as to ensure security

- RES-E adds to the discussions on where to draw this line
- Two alternatives
  - Bringing it closer to the real time
    - Allows a more efficient participation of RES-E
  - Moving it away from the real time
    - Give further incentives to improve forecasting tools

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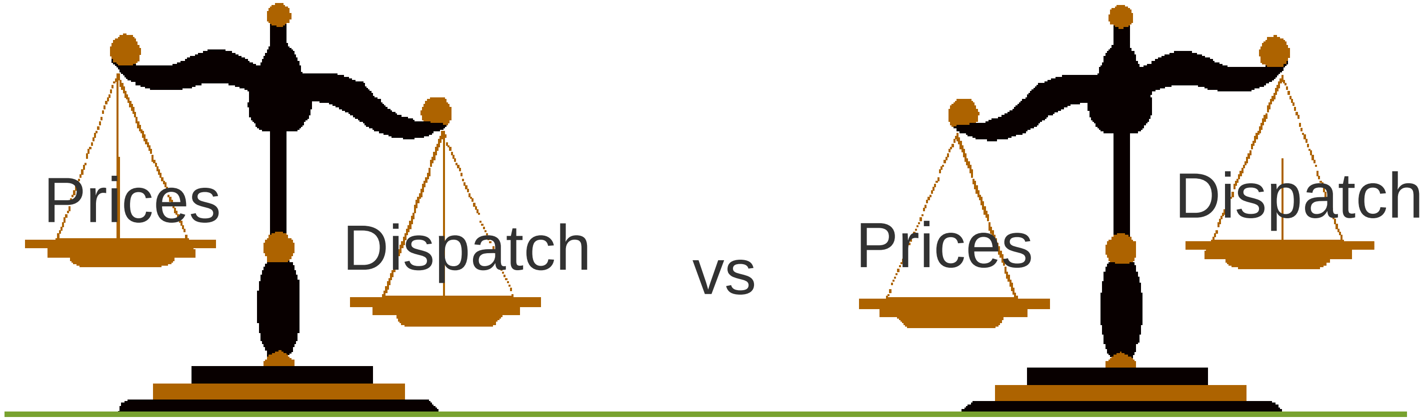
# Pricing rules and clearing in US and Europe

- Obtaining both an optimal dispatch and optimal prices is not possible in the presence of fixed costs (e.g. start up)




Roughly speaking:

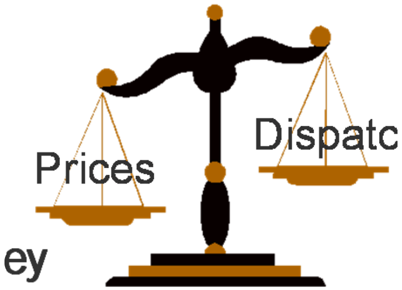
- US (focus on the optimal dispatch–less constr. on prices)
- Europe (focus on linear clearing prices)

# Pricing rules and clearing in US and Europe

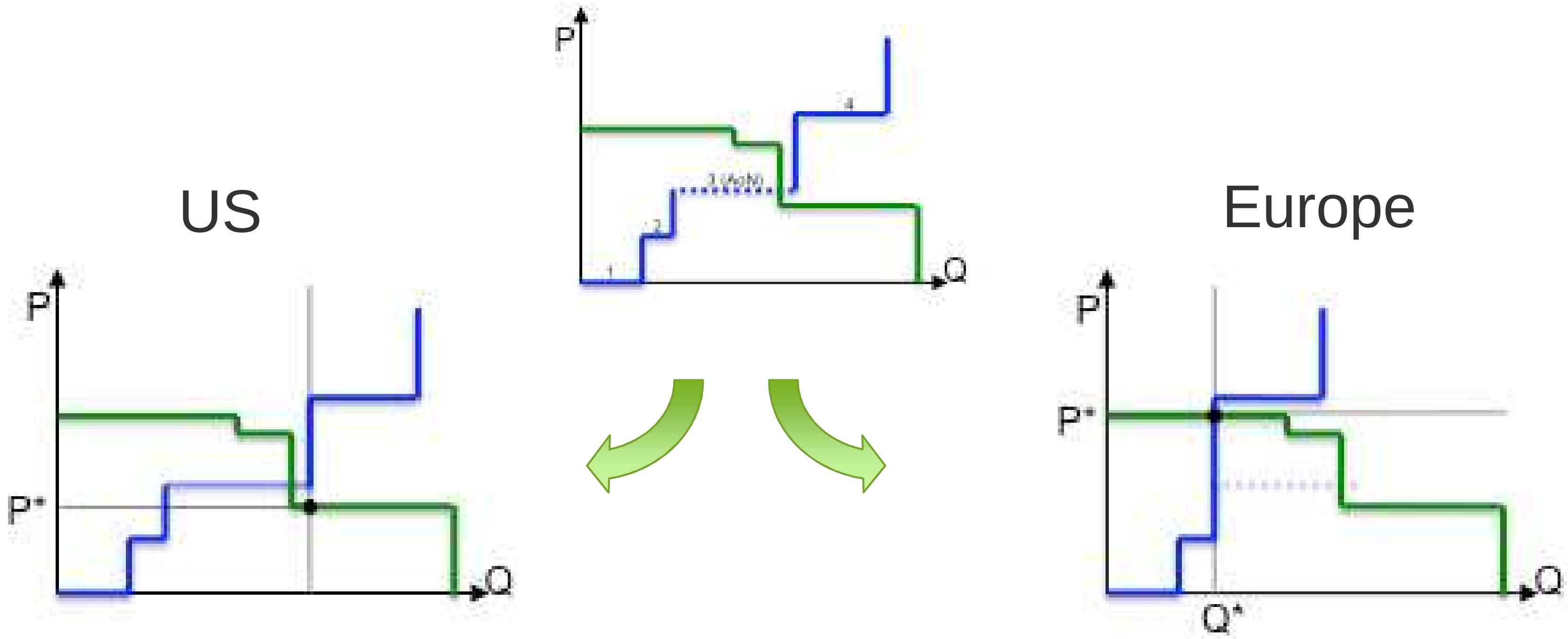
- US (focus on the optimal dispatch)
  - Optimal dispatch (maximize the Social Welfare)
  - Ex-post:
    - Hourly prices (MC)
    - Uplift (discriminatory pricing)
      - Missing money
      - Cost causality
      - Truthtelling
      - Long-term efficiency issues
      - Demand response…

# Pricing rules and clearing in US and Europe

- Europe
  - Calculate a dispatch coherent with prices (single pricing)
    - Simultaneous calculation
  - Max. the SW while complying with PXs rules
    - Rules depend on prices:
      - E.g. A simple bid has to be accepted if in the money
      - E.g. All bids accepted have to be in the money
  - Drawbacks:
    - More constraints on prices affect the objective function (SW)
    - Clearing the market is a more complex



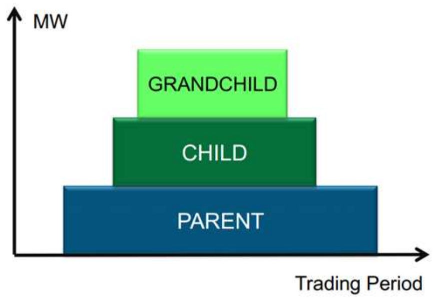
# Pricing rules and clearing in the US and Europe

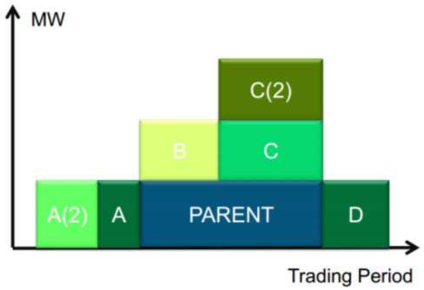


# Bidding protocols in EU versus US

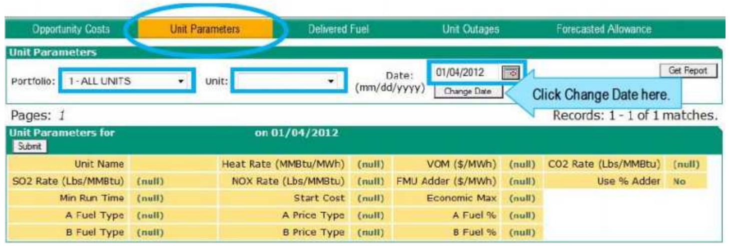
- Bidding protocols are conditioned by the clearing rules

Simple bids (p-q)
Block and complex orders




Multi part bids


Opportunity Costs | Unit Parameters | Delivered Fuel | Unit Outages | Forecasted Allowance

**Unit Parameters**

Portfolio: 1 - ALL UNITS   Unit:   Date: (mm/dd/yyyy) 01/04/2012   Change Date   Get Report

Click Change Date here.

Pages: 1   Records: 1 - 1 of 1 matches.

**Unit Parameters for on 01/04/2012**

Submit

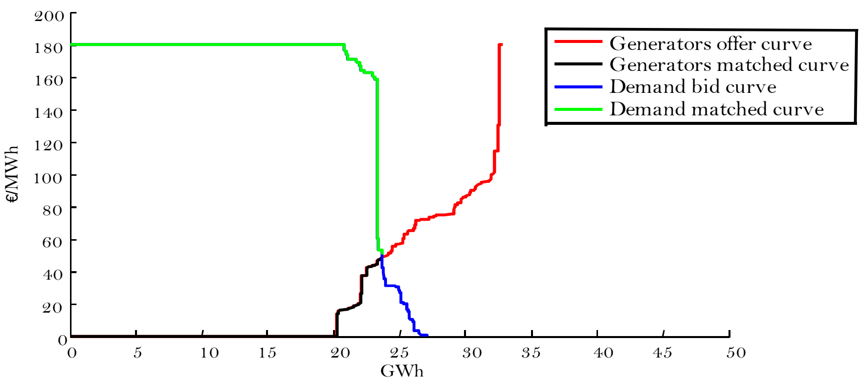
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Unit Name | | Heat Rate (MMBtu/MWh) | (null) | VOM ($/MWh) | (null) | CO2 Rate (Lbs/MMBtu) | (null) |
| SO2 Rate (Lbs/MMBtu) | (null) | NOX Rate (Lbs/MMBtu) | (null) | FMU Adder ($/MWh) | (null) | Use % Adder | No |
| Min Run Time | (null) | Start Cost | (null) | Economic Max | (null) | | |
| A Fuel Type | (null) | A Price Type | (null) | A Fuel % | (null) | | |
| B Fuel Type | (null) | B Price Type | (null) | B Fuel % | (null) | | |

Variable cost (heat rate)
Different fuels
Start up cost
Minimum output
Minimum run time
Ramps
…

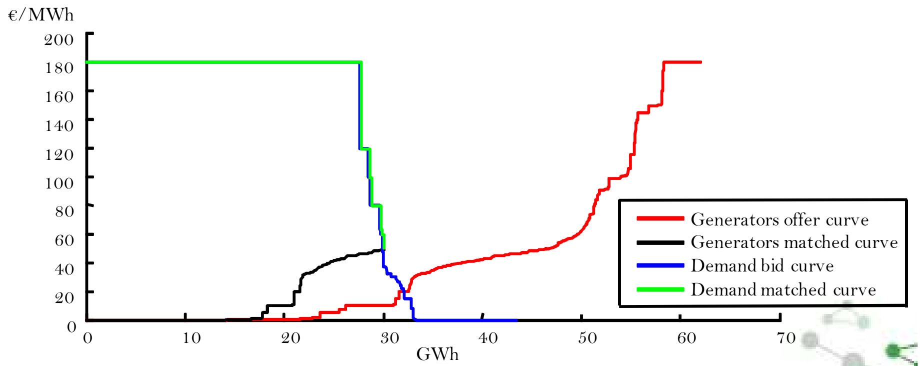
# Bidding protocols in EU versus

- Increasing need for complex conditions (e.g. Spain)
  - Increased number of killed offers

2003




2014

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# Bidding protocols in EU

- Increasing need for complex conditions (e.g. Spain)
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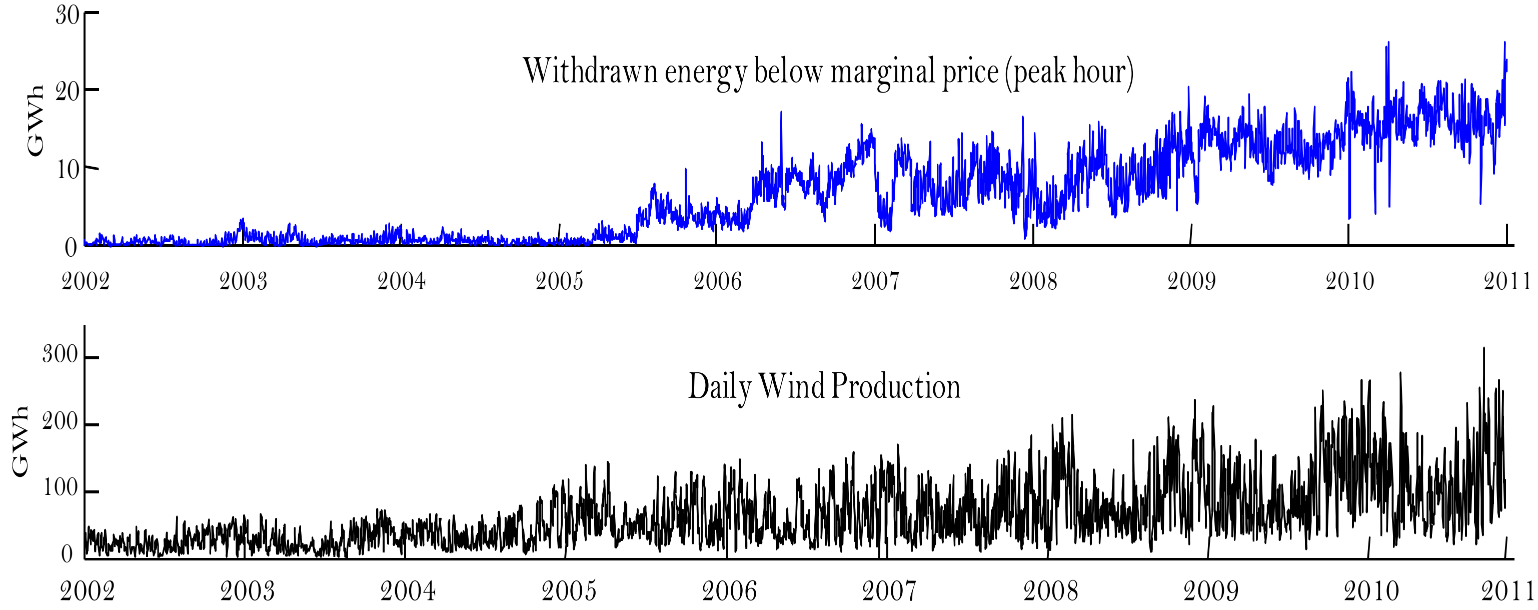


Source: Vázquez, S., Rodilla, P., Batlle, C., 2014. “Residual demand models for strategic bidding in European power exchanges: revisiting the methodology in the presence of a large penetration of renewables”. Electric Power Systems Research, vol. 108, pp. 178-184, 2014

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# European approach versus US approach

## • Overall assessment

| | Efficiency | | Robustness | | Implementability | |
|---|---|---|---|---|---|---|
| | Efficiency prices (cost reflectivity) | Bidding protocols and dispatch | Robustness against RES penetration | Robustnesss against market power | Implementability: computability | Implementability in Europe |
| European approach | 3 | 2 | 3 | 3 | 2 | 4 |
| US approach | 2 | 3 | 3 | 1-2 | 3 | 2 |

Very high rate High rate Medium rate Low rate

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Programme of the European Union

Thank you very much for your participation, discussion and inputs

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