Energy Economics

Energy market module (focus on electricity markets)

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Textbook: Perez Arriaga, Regulation of the power sector, pp.341-379

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Agenda: module 4 - electricity markets

The wholesale electricity market:

- Market models and functions
- Unconstrained market clearing
- Constrained market clearing
- Peculiarity of Italian DAM
- Trends in European electricity markets
- Business Game: simulation of DAM

- ***Market models and functions***

Pre-liberalization

Vertically integrated monopolist

- Decision-making in the long term (several years): Investment decisions: coordinated generation and transmission planning
- Decision-making in the medium-term (months to one year)
  - Fuel purchasing plan
  - Maintenance plan
  - Hydro-power scheduling
- Decision-making in the short term (one day)
  - Power plant dispatching
  - Verify transmission constraints
- Decision-making in real time (some minutes)
  - Ancillary services: reserve, balancing

How? Cost minimization, s.t. security constraints (Unit commitment based on costs)

The Necessary Steps Toward Competitive Electricity Markets

1. **Privatization** to enhance performance and reduce the ability of the state to use these companies as a mean to achieve costly political agendas.
2. **Unbundling**: separation of the electricity businesses that can be conducted competitively (generation and retail) from the natural monopolies (transmission and distribution), which must be regulated.
3. **Horizontal restructuring** to ensure competition (otherwise market power may put in danger the whole scheme).
4. **Designation of an Independent System Operator** (ISO). This ISO would be responsible to maintain network stability and should ensure open entry to the wholesale market and full access to the transmission network.
5. **Establishment of a wholesale market** where generators compete to supply electricity on an hourly, daily, weekly, monthly, and annual basis, or longer. This wholesale market also has to suitably integrate market-based mechanisms aimed to acquire operational reserves services
6. **Unbundling of retail tariffs** and rules to enable access to the distribution networks in order to promote competition at retail level. Open access to the retail market, so that all consumers can choose their supplier of electricity

The Liberalization Process in Europe

90's:
1. Segmented nation electricity market not interconnected
2. Limited cross-border capacity between countries

I phase: dir. 96/92/CE

1. Non-discriminatory access
2. Accounting Unbundling for electricity generation, transmission and distribution

II phase: dir. 2003/54/CE

1. Legal and Functional Unbundling of transmission and distribution
2. Regulated access to the grid
3. Opening-up of the retail
4. Market-based mechanisms for allocation of cross-border capacity

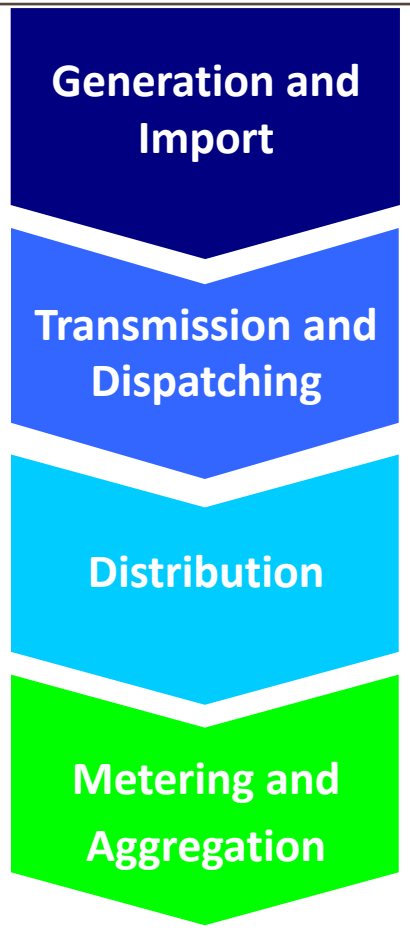
III phase: dir. 2009/72/CE

1. **Ownership Unbundling** or Independent System Operator (**ISO**)
2. Strengthening of the role of energy regulators and establishment of a European Agency

Goals:

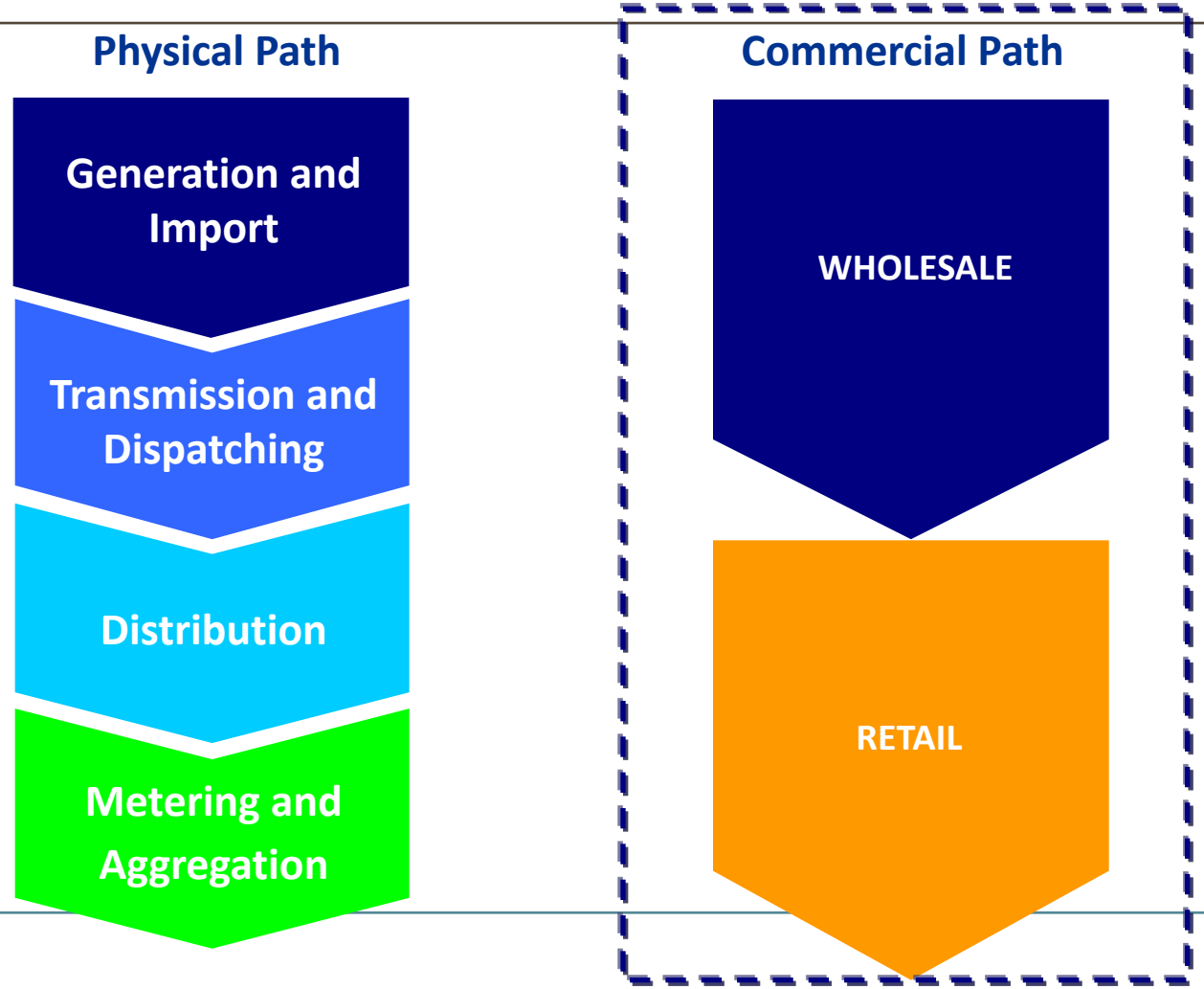
1. **Single European electricity market, fully integrated**
2. **Full integration of renewable sources in electricity markets**
3. **Security of supply**

Post-liberalization Electricity Supply Chain: a Physical Perspective



Generation and Import	Process of transformation of **primary energy** into electrical energy	**Competition**
Transmission and Dispatching	Transport and transformation of electricity on **high-voltage** grid	**Natural Monopoly: TSO(s)**
Distribution	Transport and transformation of electricity on the medium-voltage and low-voltage grid for **delivery to final customers**	**Local Monopoly DISTRIBUTORS**
Metering and Aggregation	**Installation** of meters, **metering** and **data aggregation**. These activities may be performed in competition, but Italy opted for keeping the sector as a regulated one: installation and metering are performed by local distributors, while data aggregation is performed by the main distributor (**Enel Distribuzione**)	**Regulated Business**

Post-liberalization
Electricity Supply Chain: the commercial “path”



Post-liberalization

Decision-making in the long and medium term. Two pillars: security and adequacy of electricity system

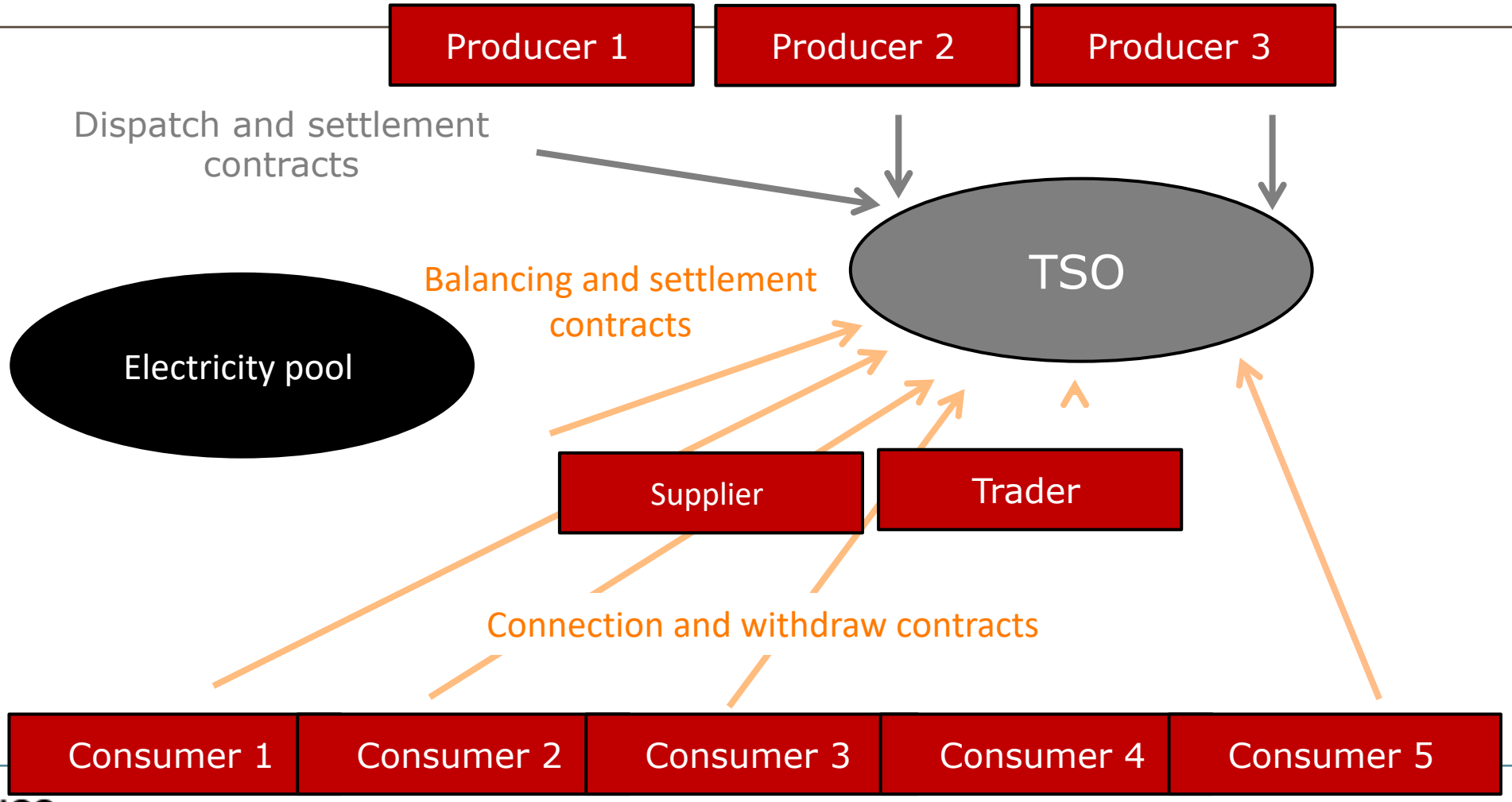
- Decisions made by single generators and by Transmission System
  - Operator - TSO (no coordination)
- Decision-making in the short term and real time
- Organized market: run by Market Operator (MO) together with TSO
  - Power plant dispatching - supply and demand bids and
  - Allocation of Transmission rights (simplified transmission model)
  - Ancillary services: reserve, balancing - supply bids and TSO demand

How:

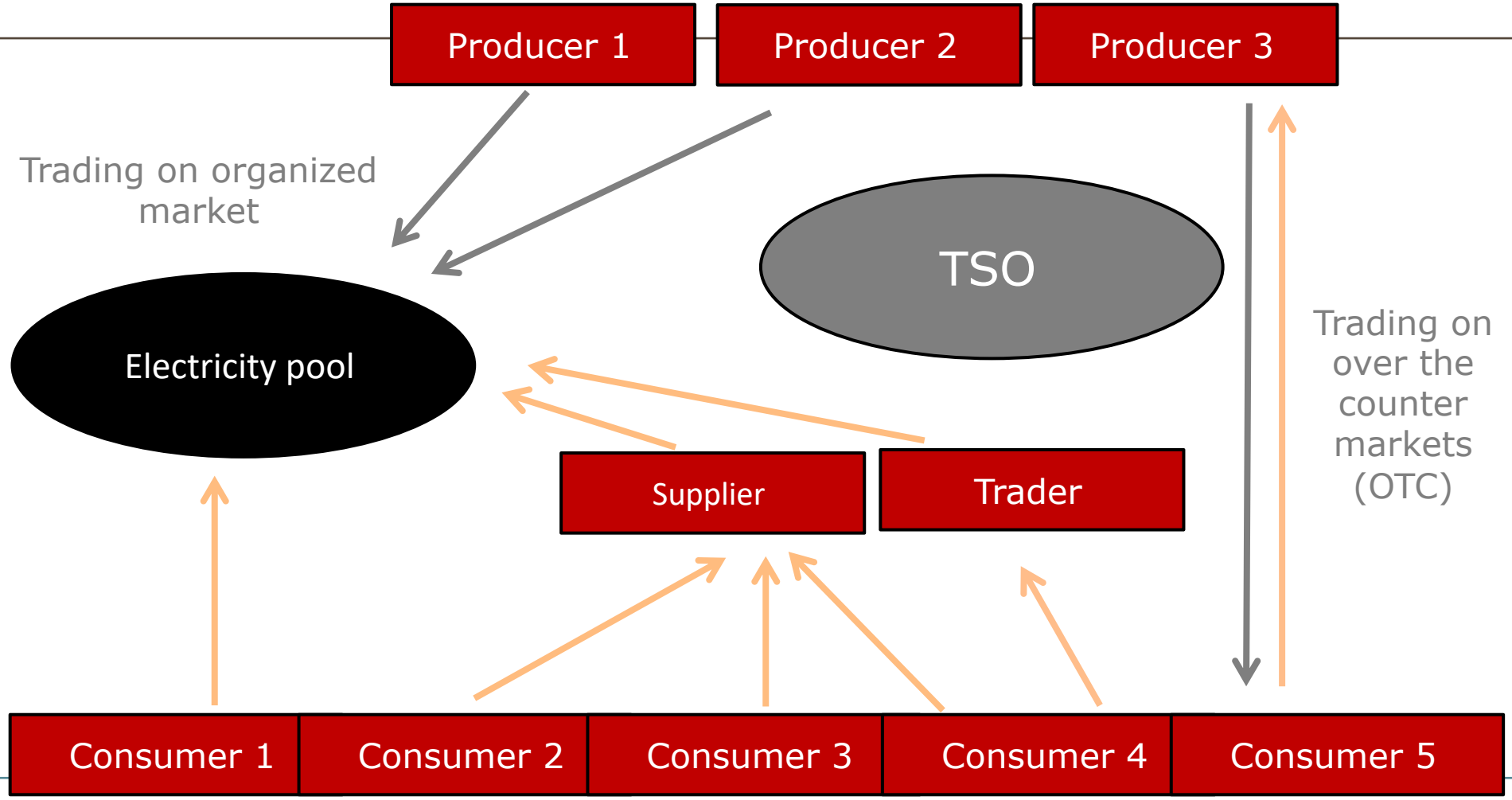
1. **Maximization of gains from trade, s.t. security constraints**
2. **Market price as signal to investors/market partecipants**
3. **Unit commitment based on bids**

What is an organized market? Why an organized market is important for energy trading?

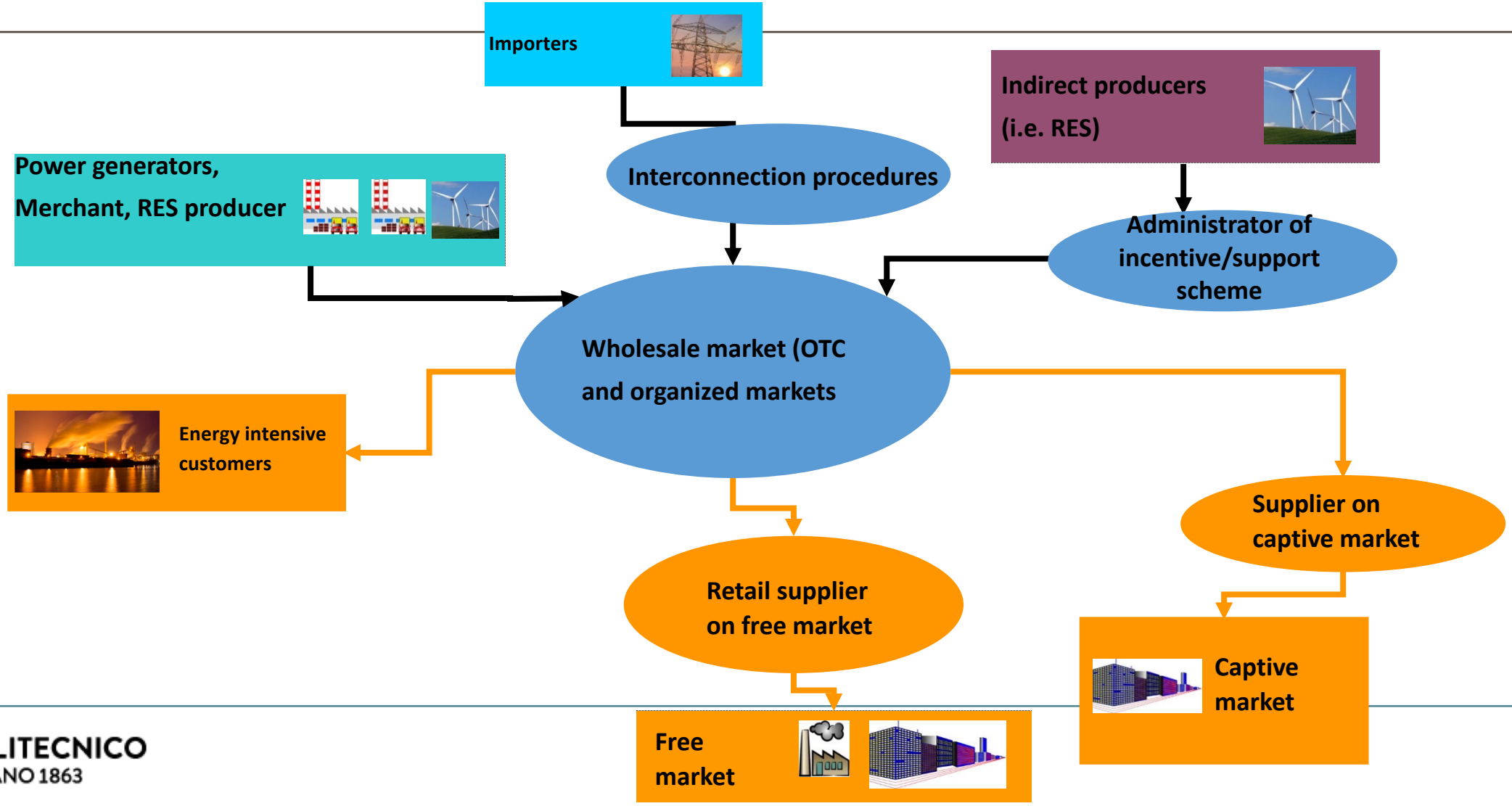
Electricity pool: physical chain



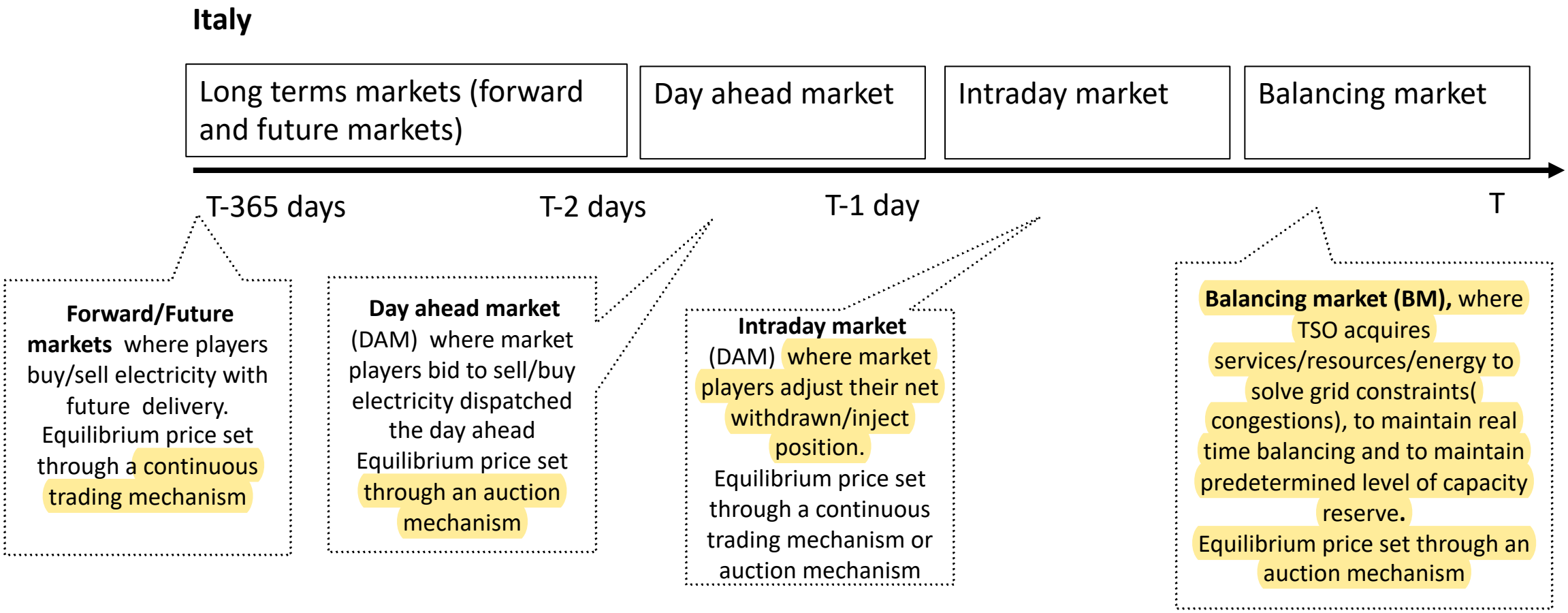
Electricity pool: commercial chain



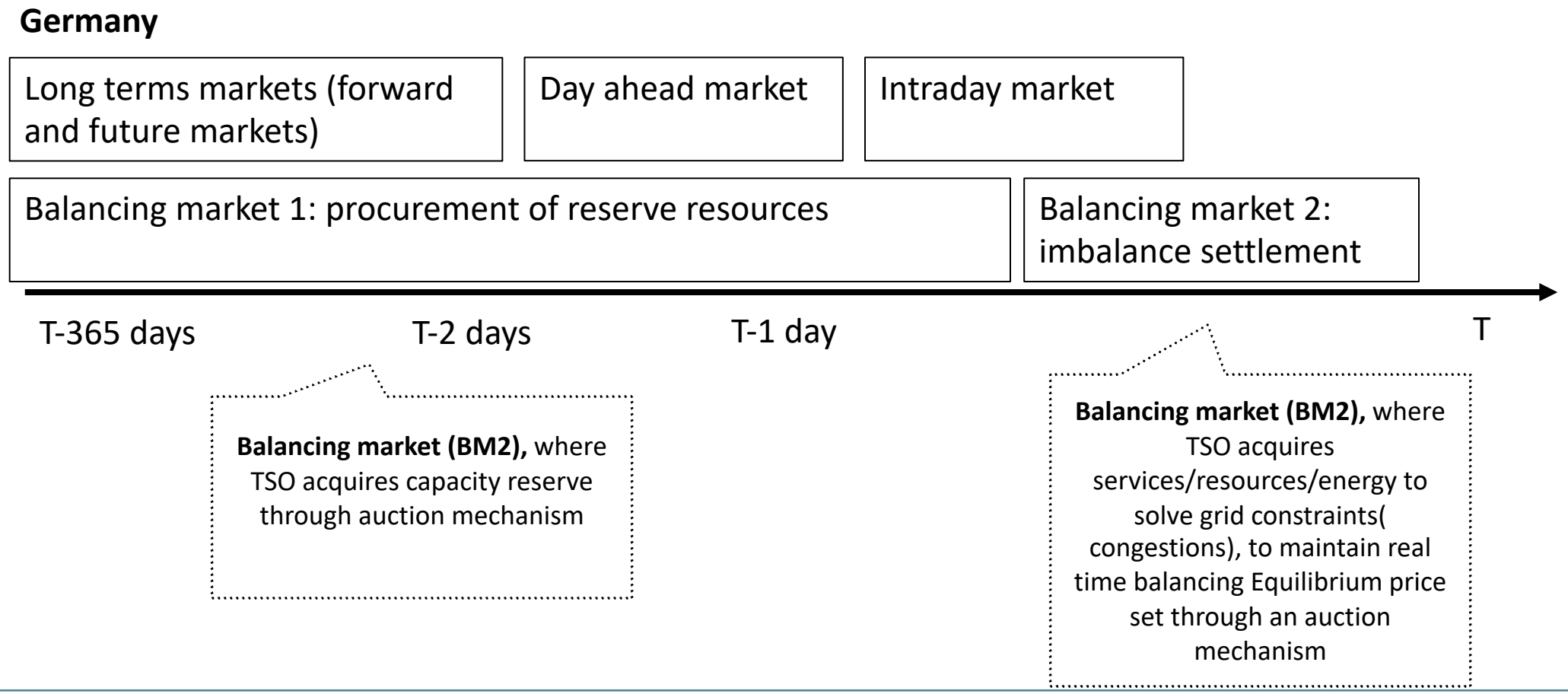
Structure of organized markets (or pools)



Electricity wholesale market sequence (1/2)



Electricity wholesale market sequence (2/2)



DAM: European comparison

	MGP - Italy	EPEX - Germany, France, United Kingdom, the Netherlands, Belgium, Austria, Switzerland and Luxembourg	OMIE – Spain - Portugal	Nordpool - Scandinavian Area
Delivery	Physical delivery	Physical delivery	Physical delivery	Physical delivery
Pricing mechanism	SMP	SMP	SMP	SMP
Congestion mechanism	Market splitting (with asymmetric pricing mechanism)	No (within country)	No	Market splitting (with symmetric pricing mechanism)
Bids options	• Simple bids • Multiple	• Simple bids • Block bids (portfolio bids) • Complex bids	• Single hourly orders • Complex bids, Indivisibility,.Load gradients, minimum income, scheduled stop.	• Single hourly orders • Block orders • Exclusive groups • Flexi orders
Min/max bidding price	0-3000 €/MWh	-500/+3000 €/MWh	0/180 €/MWh	-500/+3000 €/MWh
Gate closure	9:15 d-1	12:00 d-1	12:00 d-1	12:00 d-1

Rationale for organized markets (or pools)

An organized market designed to trade physical or financial products is a:

- Multilateral platform
- Improve (facilitate) matching of demand and supply
- Standard contracts
- Anonymous participation
- Same participation requirements for all market participants (non discriminatory rules)
- Central counterparty:
  - Guarantee mechanism
  - Clearing house
  - Contract execution guarantee

Rationale for organized markets (or pools)

Standardization

Wholesale electricity contract can be traded through :

- **Bilateral contracts (OTC)**
  - All contract characteristics agreed between the two parties
- **Bilateral platform (OTC)**
  - Bilater negotiations with predefined level of contract standardization (set by each platform)
  - No clearing mechanism
  - Main European electricity platforms: TFS, ICE, RWE Essent, ICAP
- **Organized market (power exchange)**
  - Voluntary participation
  - Centralized mechanism for pricing setting
  - Characteristics: non discrimination, impartial rules, market liquidity, no counterparty risk
  - Targets: improve competition, Entry barrier reduction, definition of economic merit order

Complexity and costs

Properties	Trading method	
	Over-the-counter	Power exchange
Anonymity of trading	No	Yes
Counterparty	Bilateral	Central counterparty
Counterparty risk	Yes, unless cleared	No
Trading method	Continuous trading	Either continuous or central auction

Evolution of trading floors – organized market

Open outcry market

https://www.youtube.com/watch?v=RLySXTIBS3c

Computerized trading floor (electronic market exchanges)

http://fortune.com/2016/04/14/cme-new-york-trading-floor/

Evolution of trading floors – OTC markets

Face to face negotiation

Electronic brokerage platform

Market price mechanisms

- **Auction:** market mechanism where bidding and execution (price setting) are phases are distinct. In bidding phase all market participants bid a buying/selling price (sealed bid if bidding of competitors are not known), modify or cancel it. In the execution phase market participant cannot modify no more their bids, market price is determine by matching procedure of buying/selling bid through the determination of supply/demand curves and equilibrium price/prices

- **Continuous trading** : buy and sell orders are executed as soon as they are received (and matched). Market players can input modify or cancel and order in every moment (within trading period). Market orders bids to buy/sell in descending/ascending order, whenever two opposite offers match a new market price is determined

Why does auction mechanism is adopted by all organized DAM around the world?

What does auction mechanism ensure?