POLITECNICO DI MILANO





From vertical to liberalised market structure

Cristian Bovo

cristian.bovo@polimi.it

Electric Energy

- The electricity
  - can not be stored

    Supply and demand must match

- The electricity
  - is expensive to be transferred on very long distance

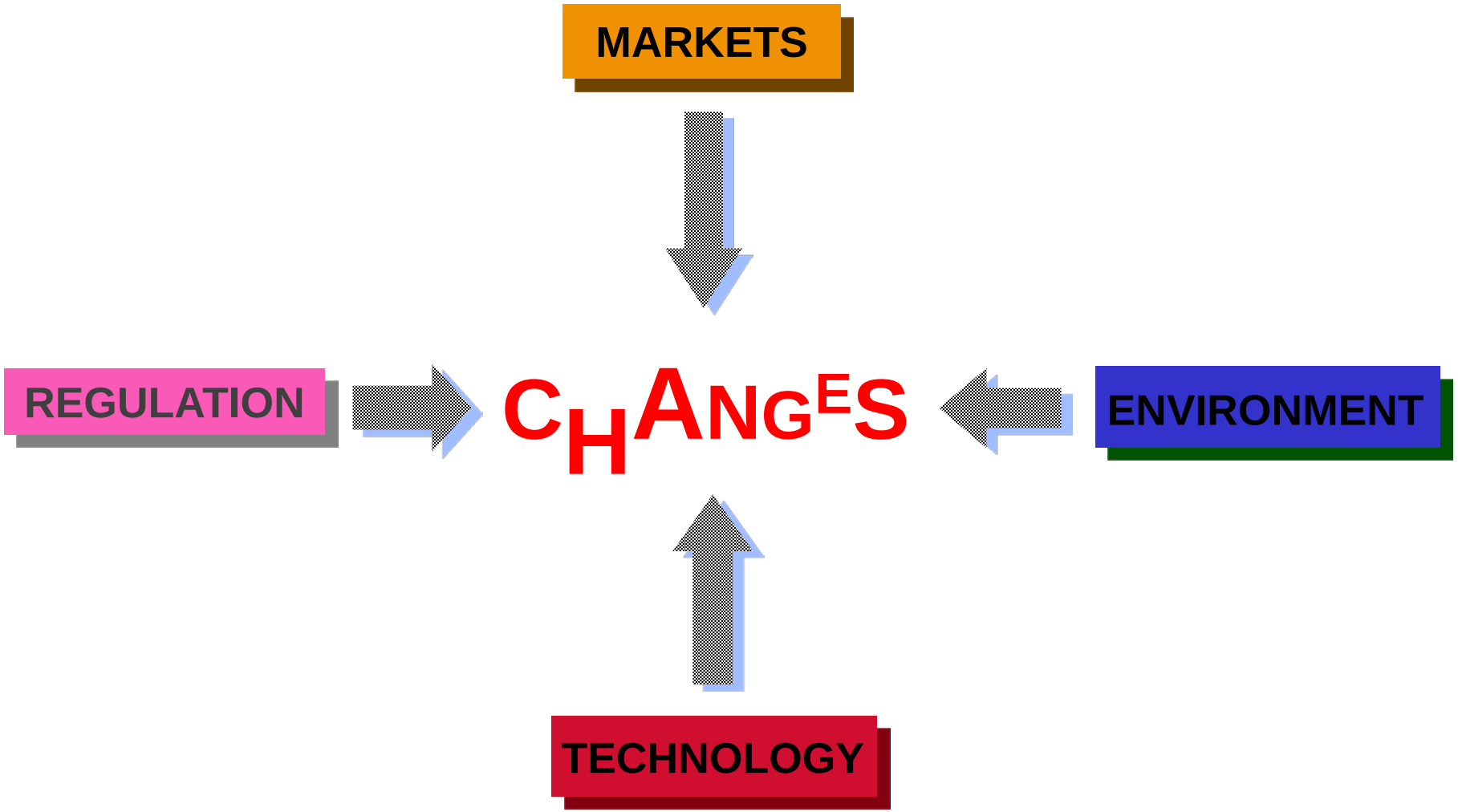
    There are a collection of regional markets with their own characteristics and regulations

Pre-liberalization: Vertically integrated monopolist

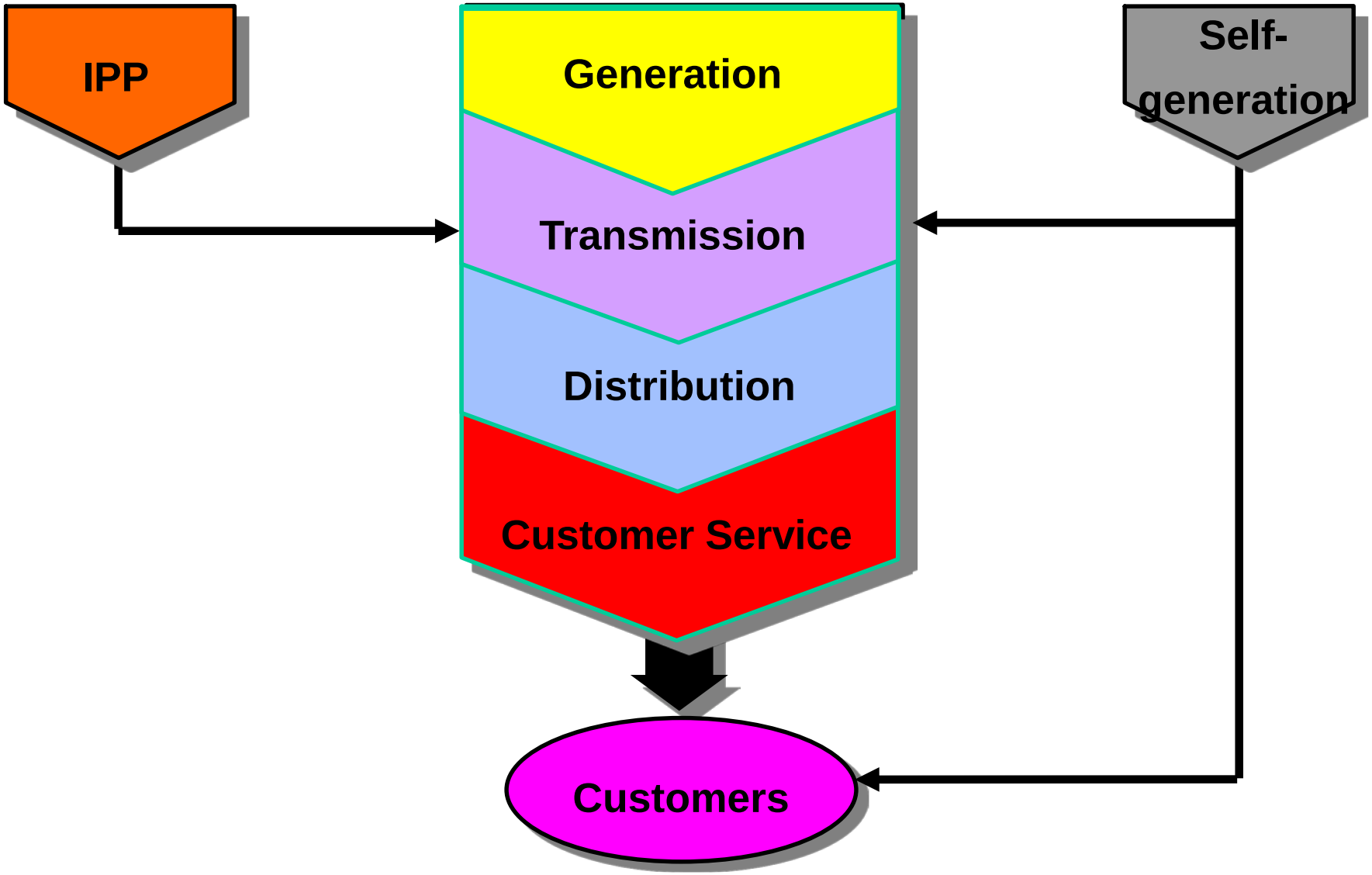
- Decision-making in the long term (several years)
  - Investment decisions: coordinated generation and transmission planning
- Decision-making in the medium-term (months to one year)
  - Fuel purchasing plan
  - Maintenance plan
  - Hydro-power scheduling
- Decision-making in the weekly-term
  - UC problems
  - Reserve problem
- Decision-making in the short term (one day)
  - Power plant dispatching
  - Verify transmission constraints
- Decision-making in real time (15 min. intervals)
  - Ancillary services: reserve, balancing

- How? Cost minimization, s.t. security constraints

Driving forces for the change



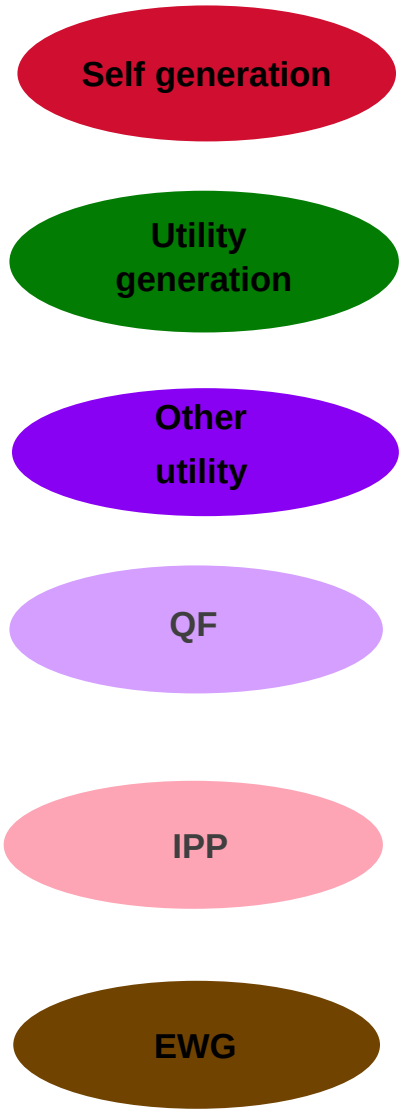
The vertically electric industry structure



How to liberalize the sector

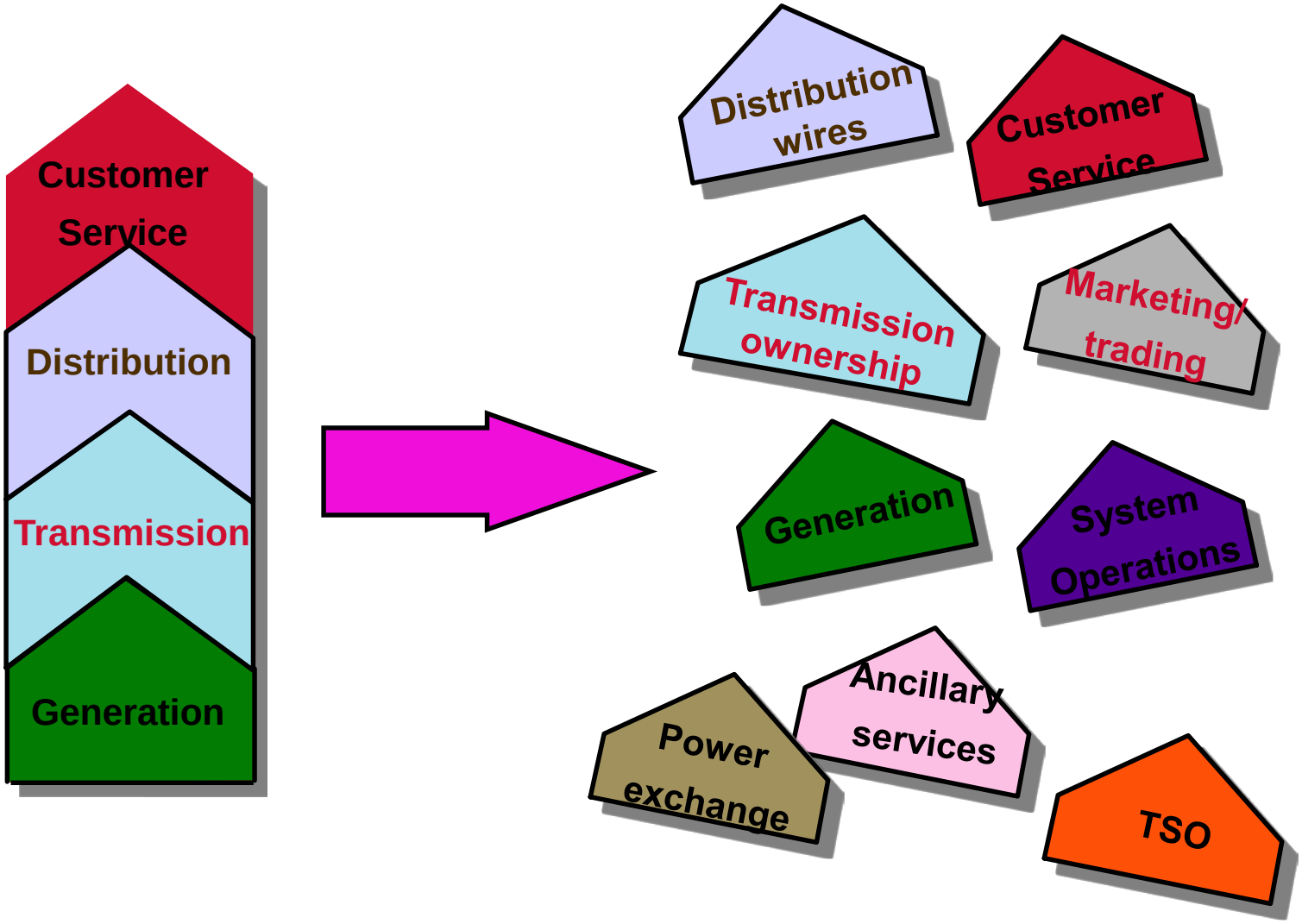
- Disaggregated structure
- Competitive sectors in generation, marketing, ancillary services, customer services
- Market-driven business
- Market-based prices
- Customer choice
- Contractual obligations

Players competing for additional markets



- **Increasing number of players creates real competition in electric generation markets**
- **Diversity in contractual arrangements is growing**
- **All the players are looking for transmission to get their production to markets outside of their immediate reach**

Vertically integrated utility structure is disintegrated

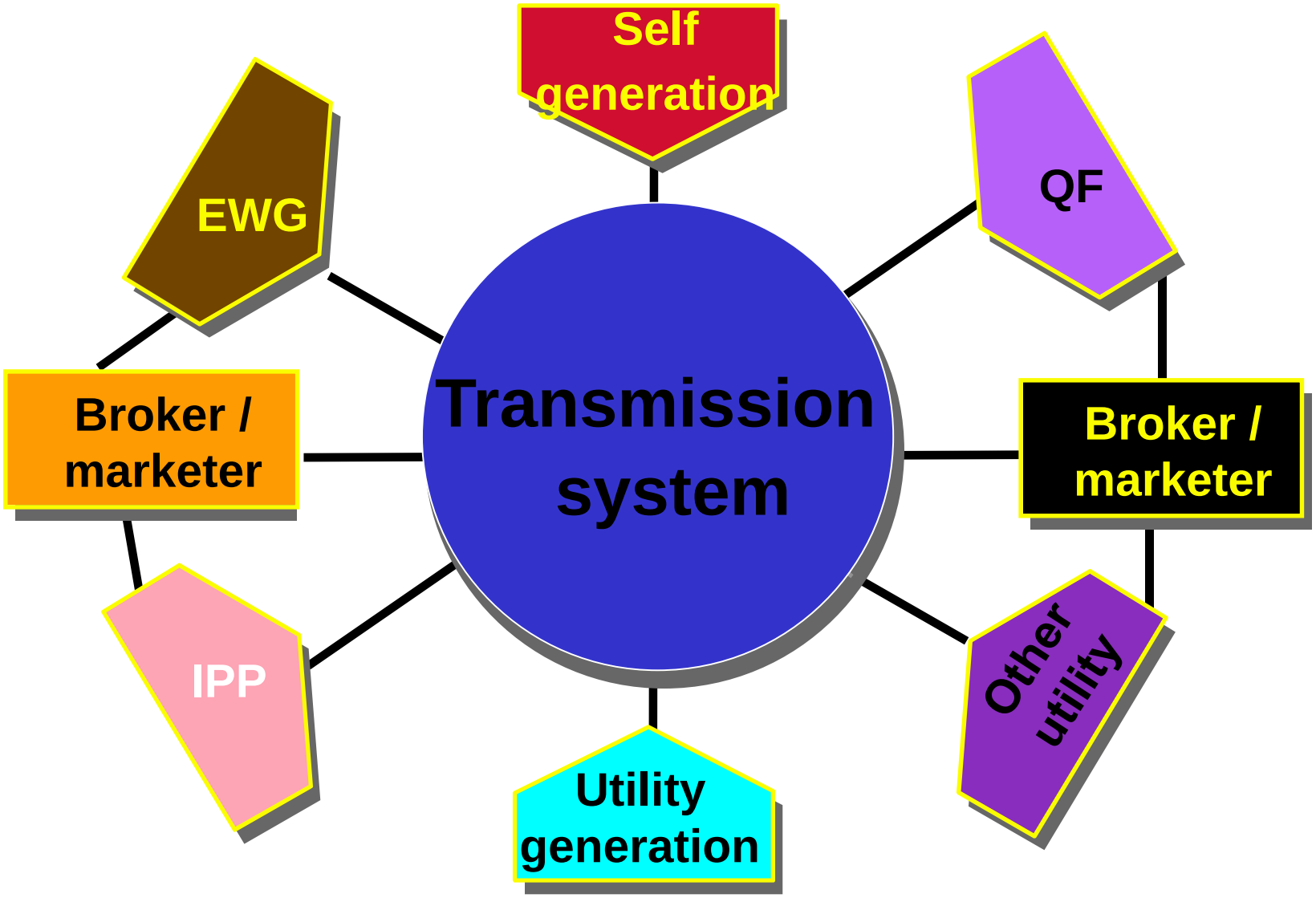


The problem of Transmission System

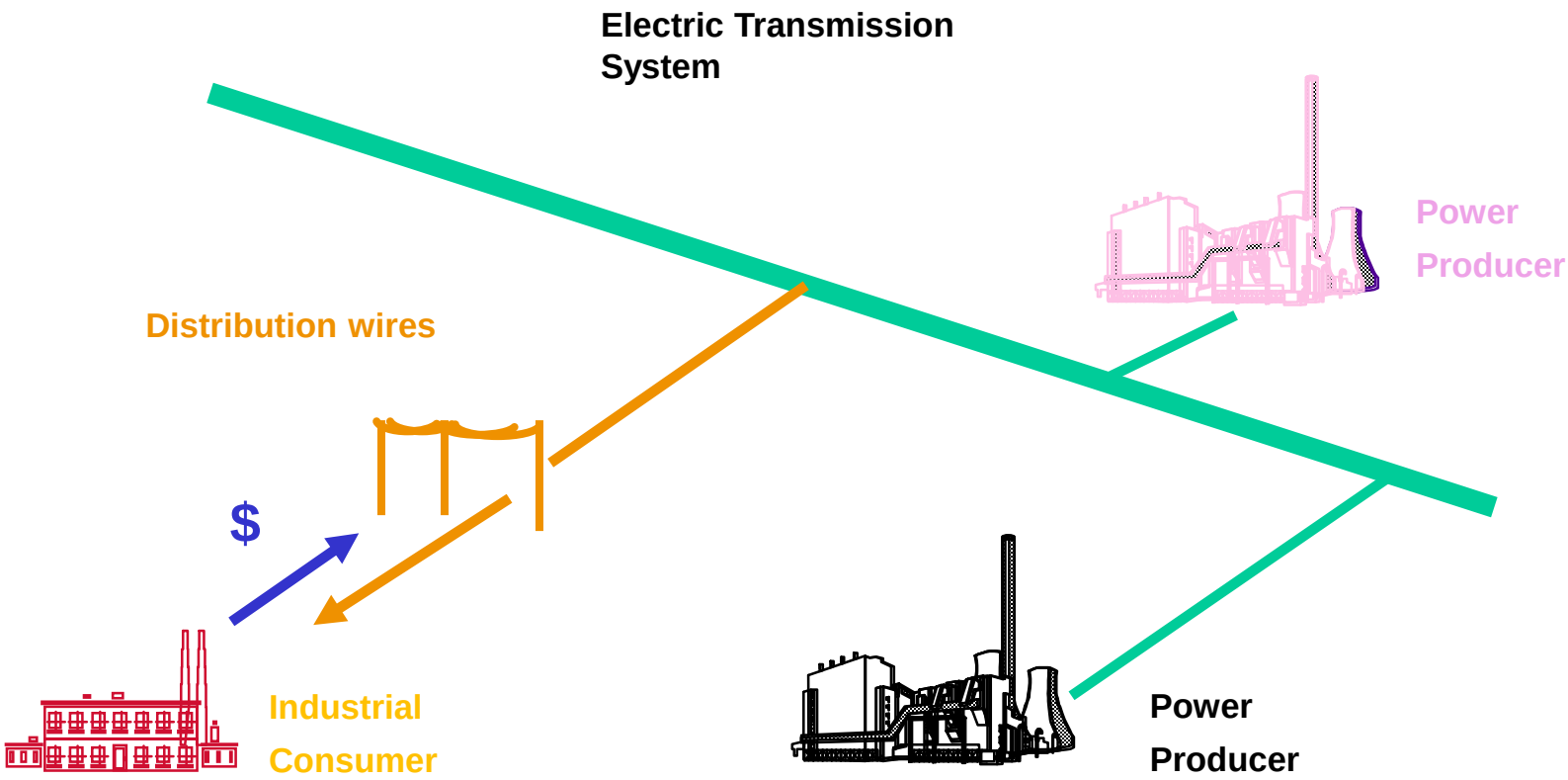
- The Transmission System is necessary to transfer power from power plants to load centers
- The TS is necessary to all players of the market

- Comparability requires a transmission owning utility to offer access to third parties "on the same or comparable basis, and under the same or comparable terms and conditions, as the transmission provider's uses of its system"
- Comparability aims at eliminating any competitive advantage that a utility may have because it owns transmission
- Comparability is the cornerstone of all new open access transmission tariffs

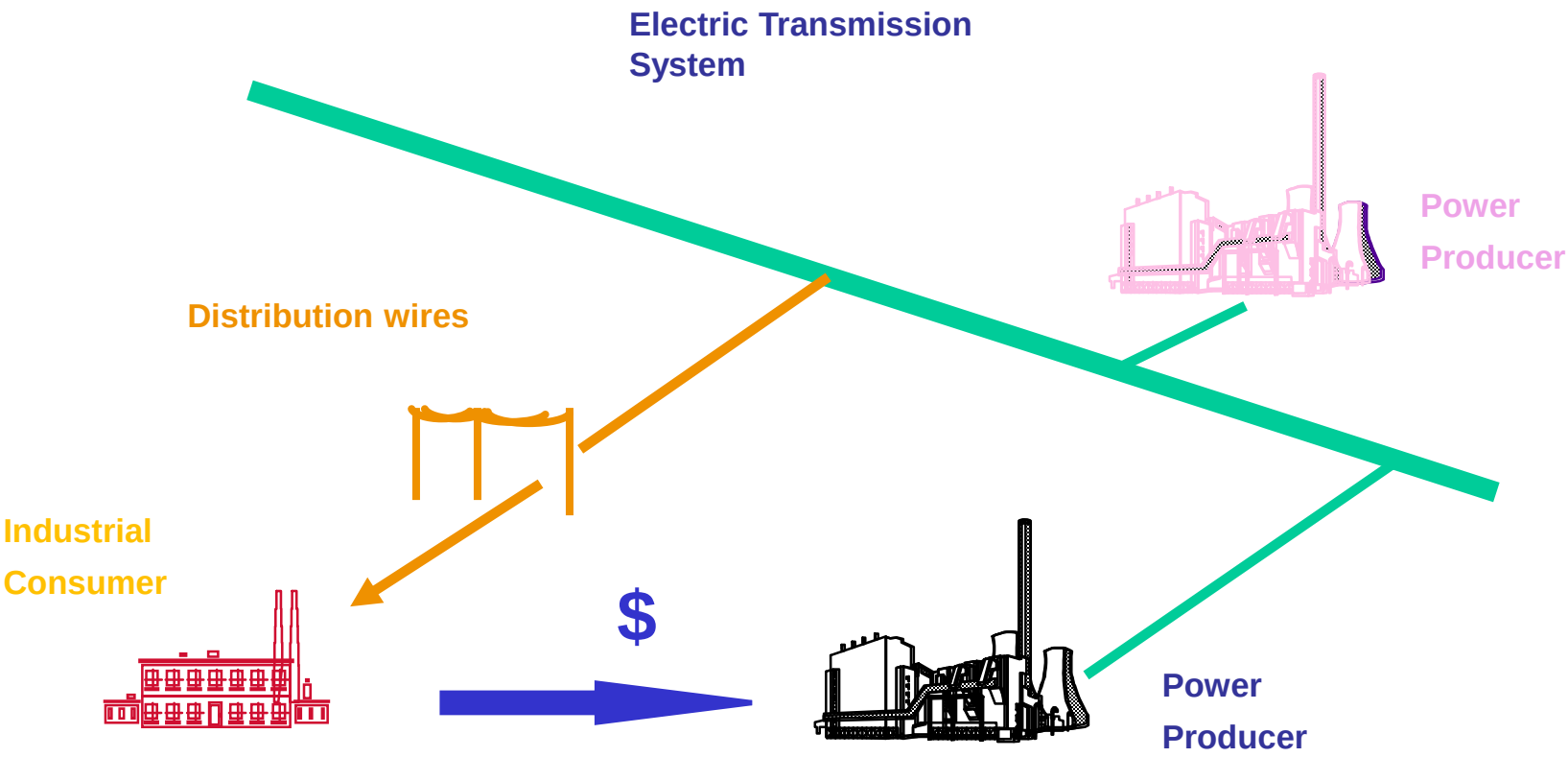
“Common carrier” transmission service



Non deregulated market



Deregulated market



New paradigms for electricity

- Basic requirements
  - compatibility with the physics/engineering of electricity
  - customer choice
  - economic efficiency goals
  - market innovation
- Prime mover is the introduction of the market
- Main design issues
  - accommodation of economic decisions made by individual suppliers and
  - attainment of the economic efficiency goals through the appropriate level of centralization/decentralization

Paradigms for electricity

- Key issues
  - maintenance of system security/reliability
  - availability of firm transmission rights
  - meeting coordination requirements in a competitive environment

TSO/RTO/ISO

- Each regional market is coordinated by its own
  - Transmission Service Operator (TSO): government sponsored monopolies
  - Independent Service Operator (ISO)
  - Regional Transmission Operator (RTO)

  ISO and RTO maintain the power grid in areas where the government-sponsored monopoly has been disbanded

ISO and RTO

- ISO is limited to doing service in a single State
- RTO does business across several States

Liberalized Market

- It is a service area where a TSO/ISO/RTO coordinates the participants and transmission
- Anyone can own a power plant and connect it to the network to sell energy (seller)
- Any wholesale consumer can connect to the network and buy energy (buyer)
- Equal access to the transmission network is guarantee to each participants

Daily energy auction

- The daily auction is the most important characteristic of a liberalized market
- It is a non discriminatory auction
  - All winning bidders get paid the same price regardless of their bids
- It sets the price and the quantity of the electricity
  - The price of energy for every producer and every wholesale consumer is set to a single price called the clearing price

Marginal price

- The power plants are activated in order of their bids (lowest to highest) until the total demand is met
- The last power plant activated sets the clearing price
- The cost of bringing the last unit of electricity activated plant is called marginal price of energy and the last activated plant is the marginal producer
- The clearing price is set by the marginal price of energy

The day-ahead auction

- The day-ahead auction sets the price of energy for each hour of the following day
- This auction is completed generally in the early afternoon on the day before the delivery
- This allows power producers time to arrange fuel and operating schedules for the delivery day

The real-time auction

- The real-time auction is run continuously throughout the actual delivery day
- This auction balances the actual demand against the predictions made the previous day
- If a power plant is not chosen in the day-ahead auction, it can still participate in the real time auction
  - But, the real time auction requires power plants to turn on and off quickly, and not every plants has this capability

The market and the transmission system

- Transmission lines can become overloaded and may require electricity to be routed around the congestion
- The primary way to reroute power is to activate power plants closer the high demand areas
- As low cost generators are normally activated first, turning on a generator closer to the demand means that a higher cost plant is being activated out of merit order
- If the price was allowed to set the clearing price of power for the whole grid, there would be a step in everyone's costs for the sake of a small minority of customers
- Because this price only occurs for a single location, this is known as a Locational Marginal Price (LMP)

Post-liberalization

- Decision-making in the long and medium term
  - Decisions made by single GenCos and by Transmission System Operator TSO (no coordination)
- Decision-making in the short term (one day: day-ahead energy market and real time (real time market)
- 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? Welfare maximization, s.t. security constraints

Electricity industry reform and regulation

- The reform of electricity markets encompasses a wide range of measures.
- In general electricity industry restructuring implied:
  - a separate transmission company;
  - partially or totally privately owned generation companies;
  - competition in generation;
  - retail supply opened to competition;
  - transmission and distribution network with third party access based on published and non-discriminatory terms and conditions.
- Electricity industry restructuring has been accompanied also by the reform of the institutional design resulting in a set of institutional bodies:
  - ministry handling most regulatory responsibilities directly;
  - independent regulatory authority separate from ministry taking care of some particular responsibilities operating on the base of public consultation and other procedures meant to enhance transparency;
  - regulatory authority operate autonomously in the management of regulatory affairs

The electricity value chain has regulated and competitive elements

Market participants	Market facilitators	Products and services
Producer (generator) Trader Supplier (retailer, marketer, load-serving entity etc.) Consumer	Transmission System Operator (TSO) Distribution System Operator (DSO) Market Operator (Market Exchange)	Energy (MWh) Generation capacities (MW) Transport capacities System/ancillary services

Italian unbundling: example

- Enel Distribuzione S.p.A. → Distribution System Operator
- Enel Energia S.p.A. → Gas and electricity supplier on the free market
- Enel Factor → Financial Service Factoring
- Enel Green Power S.p.A. → Renewable energy
- Enel Produzione S.p.A. → Production and power generation
- Enel Servizi Srl
- Enel Servizio Elettrico S.p.A.
- Enel Sole → Public lighting
- Enel Green Power Retail → Services, products and integrated solutions for energy saving

The regulatory function

- Regulation is the direct and/or indirect control by the Government over the behavior of private and/or public enterprises in a particular sector
- Items that can be regulated are
  - Revenues, tariffs, quality of service, operating decisions, investment decisions, obligation to supply or buy, entry & exit rights, etc.
- Regulation occurs when the government believes that the operator would behave in a way that is contrary to the government's objectives
- Governments establish regulation to improve the performance of a sector with respect to no regulation
- What "improving sector performance"?
  - Regulation should be intended to improve "welfare", i.e., the aggregate benefit that the sector services provide to consumers and operators, including also the externalities
  - "sector performance" can be measured in terms of consumer surplus, service availability, cost efficiency, affordability of prices, range of services offered, quality and rate of innovation

The regulatory function: objectives

- Consumer protection
  - From high prices and/or low quality resulting from utilities market power and/or neglect
- Shareholders protection
  - From arbitrary and/or opportunistic regulatory changes
- Firms protection
  - From unnecessary interference in their operating & investment decisions
  - From anti-competitive behavior of competitors in the market

Natural monopoly regulation: transmission & distribution

- Liberalisation entailed functional decomposition of electricity supply industry.
- Existence of natural monopoly conditions, externalities and public good characteristics make necessary the introduction of a regulatory function.
- T&D are recognised to be natural monopolies because competition in T&D would result in duplication of the existing network (increasing total T&D costs).