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Fundamentals of power systems 2

Ignacio J. Pérez-Arriaga
Sloan School, MITEI & CEEPR, MIT
Instituto de Investigación Tecnológica (IIT), Comillas University
Florence School of Regulation, European University Institute
Today’s objectives

1. Understand the complexity of the power system business models...
2. ... and the complexity of regulating them & the large variety of situations
Today’s program

1. Quick intro to regulation concept
2. The traditional & market-based regulatory approaches
3. Walkthrough of the regulation of the electricity activities
How much do you know about “regulation”? 
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• “Regulation is a way to control individual and collective human behavior by means of rules and restrictions” (Wikipedia)
How much do you know about regulation?

• “Regulation is a way to control individual and collective human behavior by means of rules and restrictions” (Wikipedia)

  – Examples: Taxes, speed limits in roads, grades in school or university, smoking laws, airports security rules, basketball rules of play, emergency evacuation in buildings, parents with their children, etc.
Power sector regulation

• Regulation of the power sector is the direct &/or indirect control by the Government over the behavior of the private &/or public enterprises in this 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.

  but perhaps they *should not be* regulated

“Material for this transparency has been borrowed from Bernard Tenenbaum, from FERC in the USA."
The regulatory function

- Governments establish regulation to improve the performance of a sector with respect to no regulation.
- What is meant by “improve sector performance”?  
  - Regulation should be intended to improve “welfare”, i.e., the aggregate benefit that the sector services provide to consumers & 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 & rate of innovation.
    - In reality, regulation frequently serves other purposes, typically short-term objectives of a government, typically to gain some political advantage.

“Material for this transparency has been borrowed from “The Body of Knowledge”
Regulatory institutions

Regulatory powers must be allocated among

- Ministries / Government
  - They should establish laws under which the regulator performs her function
- Independent Regulatory Commission
- Competition Authority
- Judiciary

Timewise, those powers may be exercised

- *Ex ante*: e.g., authorize / promote / mandate changes in the power system business structure
- *Ex post*: e.g., penalize anticompetitive behaviors
Typical functions of Regulatory Commissions

- Consultative
- Proposal
- Normative
- Arbitration and conflict resolution
- Executive
  - Setting tariffs
  - Licensing & authorization of facilities
  - Quality supervision & control
  - Supervision of competitive behavior
  - Sanction
- Operative
  - Inspection
  - Request of information
The supply of electricity comprises many activities... ... & each one requires specific regulation
Supply of electricity
Classification of the required activities

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transactions</th>
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<tbody>
<tr>
<td>Electricity Generation</td>
<td>Wholesale Market</td>
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<td>Other services</td>
<td>Free Contracts</td>
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<td>Ancillary services</td>
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<td>Retail market</td>
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<tr>
<td>Network</td>
<td>Supply to qualified consumers</td>
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<td>Transmission</td>
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<td>Investment planning</td>
<td>Additional Activities</td>
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<td>Construction</td>
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<tr>
<td>Maintenance</td>
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<tr>
<td>Operation of transmission network</td>
<td>Operation of the Electric Power System</td>
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<tr>
<td>Distribution</td>
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<td>Investment planning</td>
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<td>Construction</td>
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<tr>
<td>Operation of distribution network</td>
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Two main regulatory paradigms

– **Traditional**
  - Vertically integrated, regulated monopoly, territorial franchise, cost-of-service remuneration, regulated tariffs

– **Market-based**
  - Restructured, unbundled (some activities open to competition with market prices, other natural monopolies subject to regulated tariffs)

– Both seek the **same objective** (*i.e.* maximize social welfare)
  - Conceptually they would result in the same outcome, but they differ much in practice
Traditional regulation

Typical features

- Public **service obligation** in **franchise** territory
- **Regulated monopoly**
  - The electric utility makes all economic & technical decisions: **centralized** planning & operation
  - Under **regulatory review** *(frequent overlap of public ownership & regulation)*
- **Cost-of-service** remuneration
- **Regulated tariffs**
- **Voluntary coordination** transactions of limited importance among utilities
Traditional regulation

Typical structure of the companies

1. Generation
2. Transmission
3. Distribution/Retail
4. Consumers

[Diagram showing the flow of energy from Generation to Transmission, then to Distribution/Retail, and finally to Consumers.]
Market-based regulation

Typical features

• **Unbundling** of activities
  – generation & retailing are open to competition
  – transmission & distribution remain regulated
  – diverse alternatives with system & market operation

• End consumers can **choose supplier** (retail market)

• **Wholesale market**: organized &/or bilateral

• Diverse **contracts** (*physical, financial*) to hedge the risk

• Operation & investment **planning** is **no** longer a **centralized** activity

• Independent **regulator**
Market-based regulation

The structure of markets
Power sector regulatory frameworks
Traditional regulation
Traditional regulation
Cost-of-service remuneration (1)

Typical steps in the process:

1. Establish the **Regulated Asset Base** *(RAB or "rate base")*
2. Establish the **rate-of-return** on capital
3. Determine the **incurred costs**
   - Operation & maintenance
   - Depreciation
   - Remuneration of capital
   - Taxes
4. Determine the **tariff to be paid by each consumer type**, so that total costs are recovered
Allowed revenues under cost-of-service regulation

- Approved capital investment

- Rate base

- Rate of return

\[ \text{Rate base} \times \text{Rate of return} + \text{Approved capital investment} \]

\[ \text{Allowed revenues under cost-of-service regulation} = \text{Rate base} \times \text{Rate of return} + \text{Approved capital investment} - \text{Operating costs} - \text{Depreciation} - \text{Allowed returns} - \text{Others} \]
Strong points in the traditional regulatory framework

• Regulatory stability
• Guarantee of cost recovery (*with adequate remuneration*)
• Makes it easier to incorporate “social obligations”
A question for you

Why to abandon this “wonderful regulatory approach”?

A. It is inherently inefficient
B. Introducing competition is possible and always preferable
C. Consumers pay for all the errors of the decision makers
D. Need for external investment
E. Need to reduce the tariffs for the existing consumers
Weak points in the traditional regulatory framework

• Consumers absorb most of the risk
• Abuse of public service obligations (the electric utility as tax collector)
• It may incentivize excessive investment
• Regulatory risk for shareholders
• Why to regulate what can be done without regulation?
Power sector regulatory frameworks
Market-based regulation & the transition processes
The new regulation
Basic features

• Unbundling of activities
  – generation & retailing are open to competition
  – transmission & distribution remain regulated
  – diverse alternatives have been adopted regarding system & market operation & network ownership

• End consumers can choose supplier (retail market)

• Wholesale market: organized &/or bilateral

• Diverse contracts (physical, financial) to hedge risk

• Operation & investment planning is no longer a centralized activity

• Independent regulator
The new regulation

The structure of markets
Basic policies for the change to market-based regulation

• Liberalization
  – of the wholesale market
  – of the retail market

• Restructuring
  – unbundling of vertically integrated activities
  – action (if needed) on horizontal concentration

• Privatization

• The need for transition measures
The new regulation
Structural aspects of the power industry

– Horizontal concentration in generation
– Vertical integration
– Level of elegibility of consumers
– Diagonal integration

When the structure of the industry is inadequate for competition, the solution is not a better set of rules, but a structural change, or gradual / partial liberalization, or stay with the traditional framework
The new regulation

Unbundling of activities

• Accounting, legal or ownership unbundling
• A regulation open to competition requires unbundling of
  – Regulated from liberalized activities
  – Regulated activities with conflicts of interest
• Analysis of the transaction costs
  – unbundling + commercial transactions *versus* implicit internal transactions
The new regulation
Why?

• Competition is possible in generation (wholesale market)
• Competition is possible in supply (retail market)
• Favorable economic climate
• Shortcomings of the traditional model
• Additional goals
The new regulation (details)
Why? (1)

• Competition is possible in generation (wholesale market)
  – Enhanced transmission network capacity ➔ larger relevant markets ➔ no economies of scale in generation
  – New generation technologies (CCGT) ➔ smaller size, shorter installation time, reduced environmental impact ➔ long-term marginal costs smaller than average generation costs (1990s) ➔ good perspectives with new capacity
The new regulation *(details)*
Why? (2)

• Competition is possible in supply (retail market)
  – Technological advances in metering, communications & information processing ➔ facilitate multiplicity of commercial transactions

• Favorable economic climate
  – Global trend towards liberalization
  – Interest to facilitate privatization
The new regulation *(details)*
Why? (3)

- Shortcomings of the traditional model
  - Excessive governmental intervention
  - Conflicting role of Government as owner & regulator
  - Inefficient management (in general)
  - Lack of public investment capacity (in some specific cases)
The new regulation (details)
Why? (4)

• Additional goals
  – Reduce prices (more developed countries) & better align prices with costs (less developed ones)
  – Stimulate retail and demand-side activities
  – Market-driven retirement of old, dirty & costly generating plants
  – Competition for competition’s sake
The new regulation
Walkthrough of the main electrical activities

• Generation
• Transmission
• Distribution
• Retailing (*commercialization, supply*)
• System Operation
• Market operation
Generation

• Non regulated, free entry / exit, network access
  – most generation technologies receive some support, in one way or another

• Generation can provide multiple services
  – energy production
  – ancillary services
    o market mechanisms, whenever possible
    o charge costs to responsible parties

• Successful markets require an adequate structure & supervision
Generation planning?

• At the individual generators’ level
  – market price is the basic uncertainty, also demand growth, fuel prices & competitor behavior
  – investment planning is an exercise in financial risk
  – decision-making can be aided by models

• At system’s level
  – indicative planning at most
  – Issue: long-term guarantee of supply
Transmission

• Regulated natural monopoly (as distribution)
• Regulatory differences with distribution network
  – Reduced amount of new major facilities ➔ an individualized supervision is possible
• Generation expansion is unknown ➔ uncertainty
• Typically centralized planning under supervision of regulator and cost-of-service remuneration
• Transmission network is “the meeting point” in a competitive market at wholesale level ➔ its regulation (investment, access, & cost allocation) is critical for the wholesale market efficiency
Distribution

• Distribution is a network activity (*network planning & construction, maintenance scheduling & work, & operation*), different from retail
  – Distributor decides & manages these activities in its franchised territory
  – Distributor is subject to quality of service conditions & regulated remuneration
  – Recent developments (*strong presence of distributed resources*) require an in-depth regulatory review

• Major regulatory issues in distribution
  – Access, investment, pricing
What is particular about distribution regulation?

• Distribution must be regulated as a natural monopoly
• Distribution must be regulated separately from transmission
  – very large number of facilities prevents individualized treatment ➔ regulation must be based on global performance
  – directly connected to final users ➔ quality of service becomes a critical issue
• Objective: optimal trade-off between cost (investment, operation, losses) & quality of service
Retail (supply, commercialization)

• Retailing for *non qualified* (captive) consumers
  – Regulated activity
    o cost-of-service regulation
    o standards of quality of service
  – Business risk depends on the specific regulation
    o from full pass-through to a priori regulated tariff
    o desirable a moderate incentive to efficient purchasing
Retail (supply, commercialization)

- Retailing for **qualified** consumers
  - Non regulated activity
  - Business of high risk, high turnover & small margin
    - association with a generation company reduces risk
  - Adequate regulatory supervision is needed to prevent discriminatory behavior by any associated distribution company
System Operation

• Coordination activity at system level: To guarantee system security while meeting the market requirements

• System Operator (SO) implements the dispatch of generation & determines the network operation, subject to prescribed technical rules

• SO applies prescribed criteria for network access & informs about estimated access conditions in the short, medium & long run
System Operation

- Regulated coordination activity
  - Cost-of-service remuneration
  - Specific performance-based incentives are possible
- Independence with respect to the agents of the system is critical
- Pros & cons of the diverse options of governance
  - system operator / market operator / transmission
  - both synergies & conflicts of interest exist
Market Operation (Power Exchanges, PEX)

- Coordination activity, regulated (under cost-of-service remuneration) or not (charges for services provided)
- Multiple market operators are possible
- Must be independent with respect to the agents of the system
- Manages diversity of markets & contracts, both for system agents & external arbitrageurs
Readings
Suggested readings


Also suggested

General introductory reading to regulation (see the “Resources” document in Stellar)

• “The Body of Knowledge”, Chapters I-VII
• “The Body of Knowledge”, Chapter VIII
• “Case example of traditional regulation”, Annex 1 of the same textbook above
Further reading

*Introduction to the power sector in Sub-Saharan Africa*

Websites of interest

See the “Resources” document in the Stellar website

• The Internacional Energy Regulatory Network provides information on electricity & gas regulation & it is maintained by the energy regulatory commissions:  
  http://www.iern.net/


• International Directory of Utility Regulatory Institutions
Comments & questions?