

Engineering, Economics & Regulation of the Electric Power Sector

ESD.934, 6.974

Sessions 3 & 4, February 10 & 16, 2010

Module B

The regulatory function & the process of change of the traditional utility regulation

Prof. Ignacio J. Pérez-Arriaga

"There is a growing consensus that the successful development of utility infrastructure – electricity, natural gas, telecommunications & and water – depends in no small part on the adoption of appropriate public policies and the effective implementation of these policies.

Central to these policies is development of a regulatory apparatus that provides stability, protects consumers from the abuse of market power, guards consumers and operators against political opportunism, and provides incentives for service providers to operate efficiently and make the needed investments."

Source: "The Book of Knowledge", www.purc.org

Study material



- Florence School of Regulation (FSR), Case example of traditional regulation
- P. Joskow, "The difficult transition to competitive electricity markets in the US", 2003

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

3

Readings



General introductory reading to regulation

- "The Body of Knowledge", Chapters I-VII
- "The Body of Knowledge", Chapter VIII

On regulatory authorities

- C. Ocaña, "Regulatory institutions", 2002
(conceptually good, information getting dated, consult IERN website in "Resources")

Review of some international experiences

- A. Al.Sunaidy, "Electricity deregulation in OECD countries", 2006

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

4

Outline

→ ☐ The regulatory function

- ☐ The change of regulatory paradigm in the 90's
 - ◆ traditional regulation
 - ◆ characterization & motivation for a change
 - ◆ transition to liberalized regulatory frameworks
- ☐ Annexes
 - ◆ industry organization models
 - ◆ regulation of individual electrical activities

5

The regulatory function

- ☐ Regulation is the direct &/or indirect control by the Government over the behavior of private &/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.

but perhaps they *should not be* regulated

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

6

The regulatory function

- Regulation occurs when the government believes that the operator, left to its own devices, would behave in a way that is contrary to the government's objectives
- In many countries an early solution to this perceived problem was government provision of the utility service
- Frequent failure of this approach has led to other solutions
 - ◆ Private participation in service provision under a "regulated monopoly" scheme
 - ◆ Unbundling & liberalization of some activities that are left to competition forces

"Material for this transparency has been borrowed from "The Body of Knowledge"

7

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 may also serve 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"

8

The regulatory function Objectives

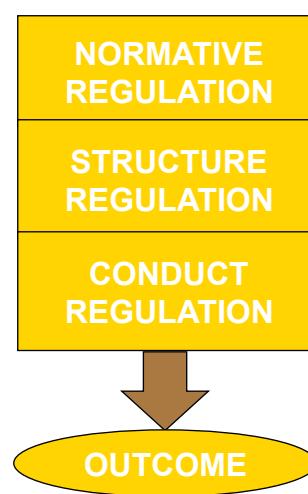
- Consumer protection
 - ◆ From high prices &/or low quality resulting from utilities' market power &/or neglect
- Shareholders protection
 - ◆ From arbitrary &/or opportunistic regulatory changes
- Firms protection
 - ◆ From unnecessary interference in their operating & investment decisions
 - ◆ From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

9

Different aspects of regulation

□ 3 BASIC ELEMENTS:

- ◆ NORMS:
 - DESIGN OF THE RULES TO BE FOLLOWED BY ALL PARTICIPANTS
- ◆ POWER SECTOR STRUCTURE:
 - ADEQUATE TO THE ADOPTED REGULATORY MODEL
- ◆ SUPERVISION OF AGENTS' BEHAVIOR:
 - WHAT KIND OF BEHAVIOR SHOULD NOT BE ALLOWED?



Typical regulatory concerns

- Prices / tariffs to consumers
- Quality of service
- Economic viability of the firms
- Environmental impact of the activities of the sector
- Policies for services to the poor or those without access
- Market structure & market power
- Adequacy of investment, as well as its efficient operation, to meet demand
- Information asymmetry of regulator & firms

11

Typical regulatory instruments

- Cost-of-service subject to regulatory oversight
- Price cap or revenue cap
- Unbundling of activities
- Subjecting agents to competitive pressures
 - ◆ Competition "in the market"
 - ◆ Competition "for the market"
 - ◆ Benchmarking of regulated monopolies
- Application of economic (or other) incentives
- Use of command & control (*standards, targets, penalties, etc.*)
- Conditions in licenses to operate
- Conditions in authorization of mergers & acquisitions
- Obtaining & analyzing information
- Monitoring market behavior

12

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*: Authorize / promote / mandate changes in the power system business structure
- ◆ *Ex post*: Penalize anticompetitive behaviors

13

Regulatory institutions

□ The regulatory function is frequently organised at several levels:

- ◆ In the US there are state regulators (PUC, Public Utility Commissions) and one federal regulator (FERC)
- ◆ In the EU there are member state regulators represented in the ERGEG, cooperating with the European Commission (DG TREN), as required by the 2003 EU directives for gas & electricity
 - The new Energy regulatory package will create a European Regulatory Agency (ACER)

□ Regulators are organised in regional associations such as: CEER and ERRA in Europe, NARUC in North America, ARIAE in South America

14

Massachusetts Department of Public Utilities

DPU Mission Statement

The Department is responsible for oversight of investor-owned electric power, natural gas, and water industries in the Commonwealth; developing alternatives to traditional regulation; monitoring service quality; regulating safety in the transportation and gas pipeline areas; and for the siting of energy facilities. The mission of the Department is to ensure that utility consumers are provided with the most reliable service at the lowest possible cost; to protect the public safety from transportation and gas pipeline related accidents; to oversee the energy facilities siting process; and to ensure that residential ratepayers' rights are protected.

15

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

18

16

Topics for discussion

Are sectoral regulators really needed?

- The Competition Authority could:
 - prevent and repress abuse of dominant position by the network (system) operators
 - ensure competition in the commercial activities
- & technical regulation could be left to the companies themselves
- This does not appear to be a good solution since:
 - Technical regulation can be biased
 - The Competition Authority intervenes only ex-post and typically has trouble in gathering evidence of violations & understanding the complex issues involved

19

Topics for discussion

Is regulation a temporary activity?

- Does the need for regulation decrease after the first phase of restructuring / liberalisation?
 - Regulation is still required both for the networks (*natural monopolies*) and for the competitive markets (*like in the case of financial markets*)
 - The trend happens to be just the opposite. In the power sector the content of the regulatory activity has changed, but the volume has probably increased
 - Long-term issues (climate change, energy security, provision of universal access) require regulatory intervention in the power sector

20

Design of regulatory agencies

Basic issues

- ❑ Activities that should / should not be regulated
- ❑ Division of responsibilities between government, competition authority, sectoral regulators & judiciary
- ❑ Jurisdiction of regulator over one or more sectors
- ❑ Responsibility in creation & enforcement of norms
- ❑ Level of regulator's independence of Government
- ❑ Accountability of the regulator
- ❑ Single regulator versus a commission
- ❑ Codes of ethical conduct
- ❑ Use of advisory boards with stakeholders & public hearings

21

Design of regulatory agencies

Basic issues

- ❑ The institutional arrangements in the design of regulatory agencies should encourage
 - ◆ **Independence**
 - ◆ **Transparency** (*so regulator can be held accountable*)
 - ◆ **Predictability** (*consistency over time so stakeholders can anticipate how the regulator will resolve issues*)
 - ◆ **Legitimacy** (*regulator is not captured by special interests*)
 - ◆ **Credibility** (*stakeholders can trust that commitments will be kept*)
- of the regulatory system

22

Design of regulatory agencies

Basic issues (detail)

□ Structure: single regulator vs. a board

- ◆ Board (3, 5, 7, 9!): more plural & stable
- ◆ Single regulator: more swift & flexible & less costly

□ Jurisdiction

- ◆ Sectorial: more specialized
- ◆ Common to several sectors: less costly, synergies & more independent

□ Review & appeal

- ◆ Ministry review → politicize regulation
- ◆ Judicial review → preferably if courts can overrule regulator only on procedural grounds & not on the substance of the regulatory decision

23

Design of regulatory agencies

Basic issues (detail)

□ Regulatory processes: Administrative mechanisms to receive stakeholders' inputs & to solve stakeholders' complaints

- ◆ Advisory boards
- ◆ Public hearings
- ◆ Transparent, well-established administrative procedures
- ◆ Negotiated settlements & arbitration

24

Design of regulatory agencies

Basic issues (detail)

- Independence and democratic legitimacy
 - **Legitimacy** is based on:
 - Legal basis, mandate, limitations
 - Appointment procedure
 - Accountability to Parliament
 - Judicial review
 - Linked to transparency & predictability
 - The **independence** of the regulator varies according to national approaches and traditions
 - E.g.: A minimum of independence is required by the EU Directives, but countries differ widely

25

Design of regulatory agencies

Basic issues (detail)

- How to achieve **independence**?
 - ◆ The goal is to minimize the influence of short-term pressures from government, parties or other lobbying groups & from the regulated agents
 - ◆ Transparent selection process of Board members, with final proposal by Government & approval (*would just a hearing be enough?*) by Parliament
 - ◆ Single mandates, without renewal
 - ◆ Need for stable & sufficient financing of the institution
 - ◆ Restrictions in the exercise of professional activity after the term of appointment expires (avoid “revolving doors”)

Required skills in regulation (i)

Engineering (examples)

- Technical & economic management of a power system
 - ◆ Basic understanding of the technologies involved
 - ◆ Sequence & inter-relation of the multiple operation & economic activities
- Network implications in market functioning
 - ◆ Issues in priority of access, network charges, locational signals
- Reliability aspects of electricity supply
 - ◆ Security & adequacy

27

Required skills in regulation (ii)

Economic (examples)

- Electricity supply costs
- Price control of regulated monopolies (*e.g. principles of incentive-based regulation*)
- Microeconomic principles applied to the electric power sector (*e.g. monopolistic vs. competition models, short & long-term costs & prices, economies of scale, demand response, market power abuse & control*)
- Financial & accounting aspects of firms
- Environmental costs & constraints

28

Required skills in regulation (iii)

Legal (examples)

- Defense of competition
 - ◆ Principles
 - ◆ Domestic & international legislation (*e.g. in the EU*)
- The regulatory institutions & norms
 - ◆ General purpose institutions
 - ◆ Sectorial regulatory institutions
 - ◆ Electricity (& gas) Acts plus secondary regulation
- Criteria to authorize acquisitions, mergers & diversification of companies
- Administrative procedures

29

Required skills in regulation (iv)

Other aspects (examples)

- Communication techniques, relations with the media
- Interrelations with other industrial sectors:
e.g. gas & electricity
- Environmental regulation
- Inspections

30

Outline

- The regulatory function
- **The change of regulatory paradigm in the 90's**
 - ➡♦ traditional regulation
 - ♦ characterization & motivation for a change
 - ♦ transition to liberalized regulatory frameworks
- Annexes
 - ♦ industry organization models
 - ♦ regulation of individual electrical activities

31

“All competition is imperfect; the preferred remedy is to try to diminish the imperfection. Even when highly imperfect, it can often be a valuable supplement to regulation.

But to the extent that it is intolerably imperfect, the only acceptable alternative is regulation. And for the inescapable imperfections of regulation, the only available remedy is to try to make it work better”

*Alfred Kahn, “The economics of regulation”
MIT Press, 1988*

Traditional regulation

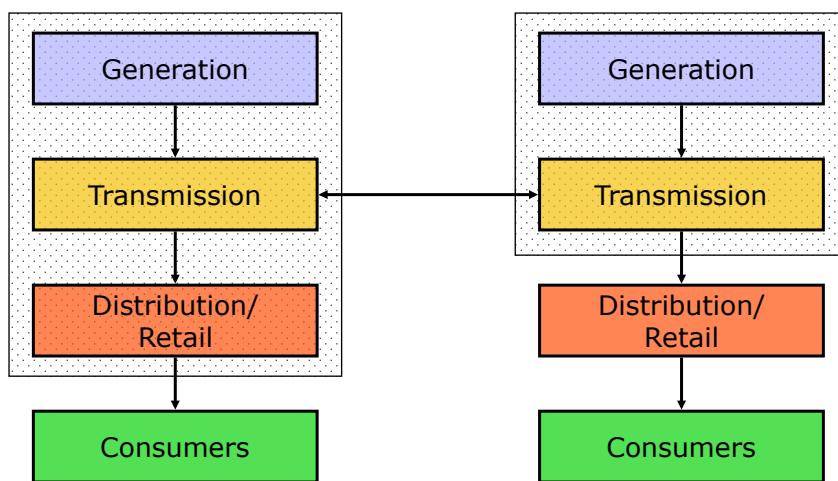
Typical features

- ❑ Public service obligation in franchise territory
- ❑ Voluntary coordination transactions of limited importance among utilities
- ❑ 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

33

Traditional regulation

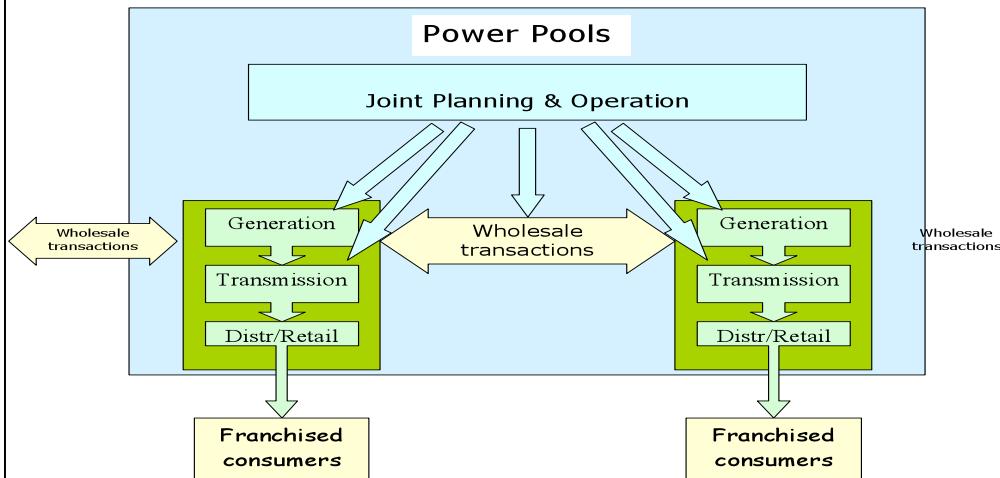
Typical structure of the companies



34

Power pools: A higher form of organization

- Centralized control of the decision-making processes
- Centralized authorization for all commercial transactions



Traditional regulation Transactions

- Vertical integration
 - ◆ Total: G+T+D+R
 - ◆ Partial: Firm sales from G+T to D+R
- Transactions
 - ◆ G+T+D+R to final consumers under integral tariff
 - ◆ G+T to D+R to final consumers under integral tariff
 - ◆ Firm transactions among G+T
 - ◆ Non firm transactions among G+T

36

Traditional regulation

Technical & economic functions

□ How can the traditional utility manage to meet the demand at any time, **efficiently** and **reliably**, for an infinite time horizon and under **uncertainty**?

→ Use a **temporal hierarchy of decisions**

- ◆ Decision functions hierarchically chained
- ◆ Each function optimizes its own decisions subject to
 - its own constraints
 - constraints that are imposed from “upstream”

Note: slides repeated here so that the presentation is self contained.

38

Time scales (1)

	Horizon	Functions
Expansion Planning	Very long term 10 to 25 years	<ul style="list-style-type: none"> • Expansion of generation & network facilities • New power plants & lines / Retirement of existing plants
Operation Planning	Long term 2 to 5 years	<ul style="list-style-type: none"> • Establish long-term contracts • Nuclear fuel management • Management of multi-year reservoirs
	Medium term from 1 month to 2 years	<ul style="list-style-type: none"> • Maintenance scheduling • Annual management of reservoirs • Production cost & reliability models

Time scales (2)

	Horizon	Functions
Planificación Operación	Short term 1 to 4 weeks	<ul style="list-style-type: none"> • Pumping storage plants • Schedule weekly shut-downs & start-ups of thermal plants
	Very short term < 1 week	<ul style="list-style-type: none"> • Unit commitment of all generation units • Detailed decisions of starting-up & shutting-down plants
Operación	Real time < 1 hour	<ul style="list-style-type: none"> • Economic dispatch • Load/frequency & voltage control • Protection

Traditional regulation **Cost-of-service remuneration (1)**

Typical steps in the process ("revenue requirements" in the US):

- 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

41

Traditional regulation **Cost-of-service remuneration (2)**

Total cost of service =

$$\begin{aligned} &= \text{Operation \& maintenance costs} + \\ &+ \text{depreciation} + \\ &+ \text{rate-of-return on capital} \times \text{rate base} - \\ &- \text{additional revenues} + \text{taxes} \end{aligned}$$

Average cost of service (average rate or tariff) =

$$= \text{total cost of service} / \text{total energy sales} (*)$$

(*) This is just an indicative figure, which does not apply to any specific consumer type

42

Definitions (1)

Rate base (*regulated asset base, RAB*)

Net fixed assets (i.e. less the cumulative depreciation) plus current assets (e.g. inventory of fuel & replacement parts, advance payments & deferred revenues)

Rate of return

Average weighted interest rate over the long-term financial resources of the firm

Depreciation

Typically linear; each type of asset is assigned an economic life

43

Definitions (2)

Operation & maintenance costs

Fuel costs, materials & replacement parts, energy purchases, supervision, personnel & overhead

Taxes

On profit, revenue, property, social security & construction

Additional revenue

Expenses & revenues deriving from the sale of the firm's property, revenues from wholesale energy sales, other revenues from non electric activities

44

Some controversial issues

- Use of actual or estimated values (*the problem of the "regulatory lag" & the "deviations"*)
- Determination of a "fair & reasonable" rate of return on equity
- Adequate method to determine the value of the assets (*historic cost, replacement value, "fair" value*)
- Treatment of the fixed assets in progress
- Accounting treatment of deferred taxes (*when accelerated depreciation is used*)

46

Traditional regulation **Determination of retail tariffs**

Typical steps in the process:

- 1 Classify consumers into homogeneous types (*define the "tariff structure"*)
- 2 Unbundle the total cost of service into generation, transmission, distribution & other
- 3 Further unbundle each element of (2) into a capacity, energy &/or per-consumer component
 - ◆ Time periods can also be introduced
- 4 Assign each element in (3) to each consumer type
- 5 Adjust the charges in (4) to the actual metering capabilities of each consumer type

47

Tariffs of wholesale power sales (1)

Classification (US):

- Sales to distribution utilities
 - ◆ There is obligation of supply
 - ◆ Tariff is determined with a similar process to retail tariffs
- Coordination transactions (*all the others*)
 - ◆ many kinds, depending on the product
 - ◆ The selling utility has to submit the tariffs to the regulator for approval

50

Tariffs of wholesale power sales (2)

Determination of tariffs for the coordination transactions:

- Many possible kinds of transactions
 - ◆ Short, medium or long-term firm power / firm power from a plant / system firm power / diversity interchanges / reserves / maintenance / emergency / economic transactions/ etc.
- Criteria to compute the tariff
 - ◆ Assign to capacity (\$/kW), energy (\$/kWh) or per customer (\$) depending on the cost component

51

Strong points in the traditional regulatory framework

- Regulatory stability
- Guarantee of cost recovery (*with adequate remuneration*) →
 - ◆ Favorable climate for investment
 - ◆ Reduce capital costs
 - ◆ High guarantee of supply for the consumers
- Makes it easier to incorporate “social obligations”
 - ◆ Social tariffs
 - ◆ R&D
 - ◆ Protection of domestic fuels
 - ◆ Energy diversification
 - ◆ Environmental protection

52

Weak points in the traditional regulatory framework

- Consumers absorb most of the risk
 - ◆ Planning errors, demand forecast, technological obsolescence, etc.
- Abuse of public service obligations (*the electric utility as tax collector*)
 - ◆ Domestic fuels, energy diversification, nuclear moratorium, tariff discounts, local taxes, etc.
- Incentivates excessive investment
- Regulatory risk for shareholders
 - ◆ “regulatory lags” & “prudent expenditures”

53

Traditional regulation Additional comments

- It is possible to use advanced tariffication schemes that are based on marginal pricing principles (“*real time pricing*”)
 - ◆ To make this compatible with cost-of-service remuneration, some “revenue reconciliation” scheme has to be applied
- It is possible (*easier than within the competitive framework*) to make the utilities incorporate energy policy objectives & constraints in their planning & operation functions, e.g.:
 - ◆ “integrated resource planning”
 - ◆ load management

54

Outline

- The regulatory function
- **The change of regulatory paradigm in the 90's**
 - ◆ traditional regulation
 - ◆ **characterization & motivation for a change**
 - ◆ transition to liberalized regulatory frameworks
- Annexes
 - ◆ industry organization models
 - ◆ regulation of individual electrical activities

55

The new regulation

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 (in theory)

56

Details

Advances in generation technology (1)

60's - 80's

- ◆ typical capacity of coal-fired & nuclear units: 600 to 1000 MW
- ◆ long construction time: 6 to 10 years
- ◆ decisions on generation expansion were taken long before the capacity was needed
- ◆ very large investments and frequent cost overruns
- ➔ only large, vertically integrated utilities under cost-of-service remuneration were able to make the necessary investments

57

Details

Advances in generation technology (2)

90's - 00's (CCGT technology)

- ◆ optimal plant capacity may be less than 300 MW
- ◆ construction time may be less than 2 years
- ◆ much smaller investment per installed kW than other base-load technologies
- ◆ wide availability of natural gas
- ◆ lower environmental impact / regulatory uncertainty
- ➔ investment decisions can be made by smaller agents

58

The new regulation

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

59

The new regulation

Why? (3)

- Shortcomings of the traditional model
 - ◆ Excessive governmental intervention
 - ◆ Conflictive role of Government as owner & regulator
 - ◆ Inefficient management (in general)
 - ◆ Lack of public investment capacity (in some specific cases)

60

The new regulation 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

61

The new regulation: How? Specific regulation of each activity

Generation

Ordinary Generation
Special Generation
Ancillary services

Network

Transmission
Investment planning
Construction
Maintenance planning
Maintenance
Operation of transmission network

Distribution

Investment planning
Construction
Maintenance planning
Maintenance
Operation of distribution network

Transactions

Wholesale Market
Free Contracts
Standardized Contracts
International Exchanges
Retail market
Supply to qualified consumers
Supply to captive consumers
Complementary Activities
Settlement
Billing
Metering

Coordination

Operation of the Electric Power System
Operation of the Organized Market

62

The new regulation

Basic 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

63

The new regulation

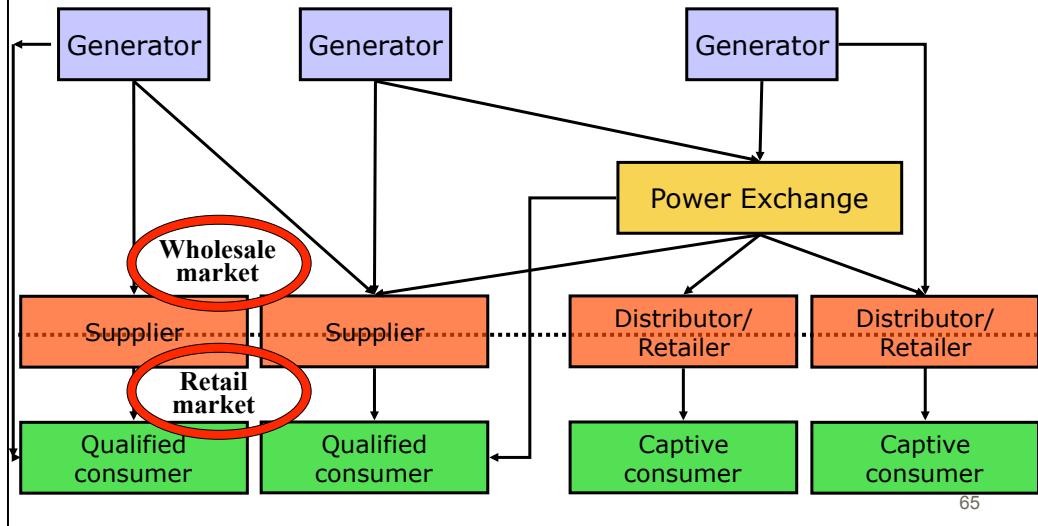
Basic policies

- ❑ **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

64

The new regulation

The structure of markets



The new regulation

Structural aspects of the power industry

- 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
 - ◆ Horizontal concentration in generation
 - What matters is the size of the relevant market
 - Interconnection capacity may be a critical issue
 - ◆ Vertical integration
 - Between regulated & non regulated activities →
 - cross subsidies may occur
 - self dealing (generation, distribution with captive consumers)
 - Between regulated activities → conflicts of interest

66

(continuation)

- ◆ Level of eligibility of consumers
 - Complete eligibility reduces the problem of vertical integration and also of horizontal concentration in the distribution + retail business
- ◆ Diagonal integration
 - Integration between electricity companies & fuel suppliers will be questionable if the fuel supply market is not fully competitive

67

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

68

Some difficulties

Stranded generation costs

□ Stranded costs (*or Competition Transition charges, CTC*)

- ◆ Conceptually: Difference between an estimate of generation remuneration with previous regulation & the new market-based regulation
- ◆ Note that:
 - Market revenues are uncertain
 - Frequently there are discrepancies with respect to future regulated revenues
- ◆ In practice the amount & conditions for CTC recovery have been the outcome of a negotiation process

69

Some difficulties

Stranded benefits

□ Stranded benefits: public goods that may be lost because of a regulatory change

- ◆ Environmental protection
 - Since the market price does not include most environmental costs
- ◆ Vulnerable consumer protection (social tariffs)
- ◆ Universal extension of access to electricity
- ◆ Other (technological diversification, R&D, etc.)

70

Outline

□ The regulatory function

□ The change of regulatory paradigm in the 90's

◆ traditional regulation

◆ characterization & motivation for a change

 ◆ transition to liberalized regulatory frameworks

□ Annexes

◆ industry organization models

◆ regulation of individual electrical activities

71

Gradual liberalization of generation

- 1) "External generation" (*Non Utility Generation*, NUG) with "avoided cost" remuneration ("qualifying facilities")
- 2) BOO contracts (*build-operate-own*) / BOT (*build-operate-transfer*) after sporadic public auctions
- 3) Competitive bidding after systematic public auctions & remuneration according to contracts
- 4) Independent generators (*independent power producers* or IPPs) with limited access to the network or to consumers
- 5) Independent generators (IPPs) with complete access to the network and to consumers

72

1) "Qualifying facilities" (US)

- The term *qualifying facilities* appears in the PURPA Act (US) in 1978
 - ◆ Objective: to promote cogeneration & renewables
 - ◆ Mechanism: guarantee of energy acquisition by the electric utility by means of a long-term contract
 - ◆ Price: "avoided cost" for the utility
 - ◆ Requirements:
 - Cogenerators (any size) & small generators (< 80 MW) with > 75% from renewable energy sources
 - < 50% of ownership of the generating company

73

2) BOO/BOT supply contracts

- The contractor is selected via an ad hoc competitive bidding process that is organized by the utility itself
- The contractor has to build, operate & own (BOO) &/or transfer the plant (BOT)
- Contract to purchase the energy
 - Power Purchase Agreement (PPA)
- Remuneration according to the terms of the contract & independent from the process of determination of the regulated tariffs (*although tariffs values are affected by this*). Typically it includes:
 - Energy payment
 - Capacity payment

74

3) Competitive bidding

- ❑ Mechanism to add new generation. This is an extension of the energy contracts BOO or BOT
- ❑ Remuneration according to the terms that are established in the accepted bid
- ❑ Standard procedure:
 - Step 1: Estimation by the utility of the needs of new capacity
 - Step 2: Estimation of the avoided cost (optional)
 - Step 3: Preparation of the request for bids
 - Step 4: Evaluation & selection of bids
 - Step 5: Negotiation & signature of the contract

75

4) IPPs (limited access)

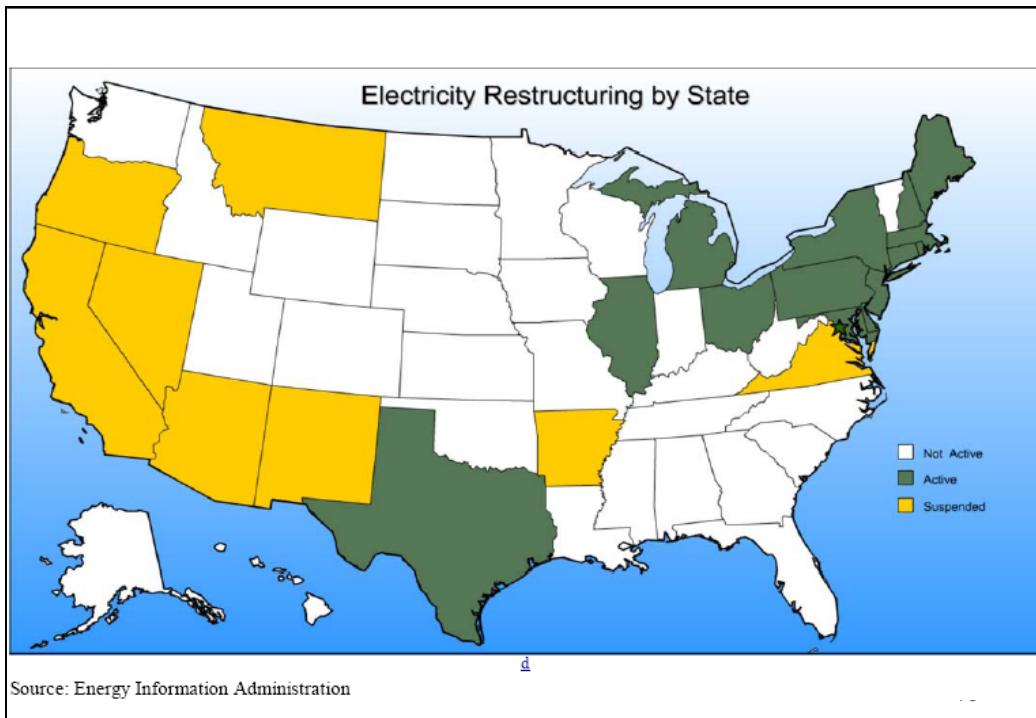
- ❑ The plants are built by initiative of the IPPs, & they are typically backed by electricity sale contracts
- ❑ There are no standard formats for the contracts
- ❑ The financial risk has been passed from the consumers to the IPPs
- ❑ Direct sales of IPPs to generating &/or distributing companies are forbidden (e.g., EEUU Energy Policy Act, 1992). Limited access to the network

76

5) IPPs (complete access)

- ❑ Similar to case 4
- ❑ Now it is possible the direct sale to the final consumer (& also to the utility, as before)
- ❑ Full access to the transmission network is mandatory
- ❑ It implies the complete liberalization and unrestricted entry into the generation business

77



Outline

□ The regulatory function

□ The change of regulatory paradigm in the 90's

◆ traditional regulation

◆ characterization & motivation for a change

◆ transition to liberalized regulatory frameworks

□ Annexes

→ ◆ industry organization models

◆ regulation of individual electrical activities

79

The new regulation Power sector organization models

□ Four representative models (*)

◆ abstractions; they do not describe specific systems & reality has created a diversity of models that do not fit well into these categories

□ Correspond to varying degrees of monopoly, competition & choice

□ Public or private ownership is ignored

◆ Model 1: monopoly at all levels

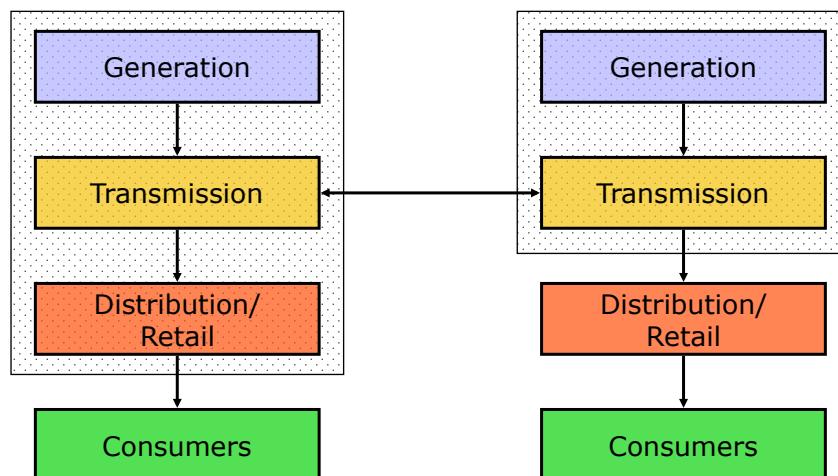
◆ Model 2: purchasing agency

◆ Model 3: wholesale competition

◆ Model 4: wholesale & retail competition

(*) From "Competition & choice in electricity", S. Hunt & G. Shuttleworth, John Wiley, 1996 80

Model 1: Monopoly



81

Model 1: Monopoly Description

- ❑ Full vertical integration
 - ◆ Some distribution companies may be unbundled
- ❑ Central planning of generation & network
- ❑ Cost-of-service remuneration of each vertically integrated utility → regulated tariffs
- ❑ Wholesale transactions
 - ◆ between vertically integrated utilities
 - ◆ between a distributor & a vertically integrated utility with wheeling transmission charges
- ❑ Limited incentive regulation is possible
- ❑ Social policy obligations

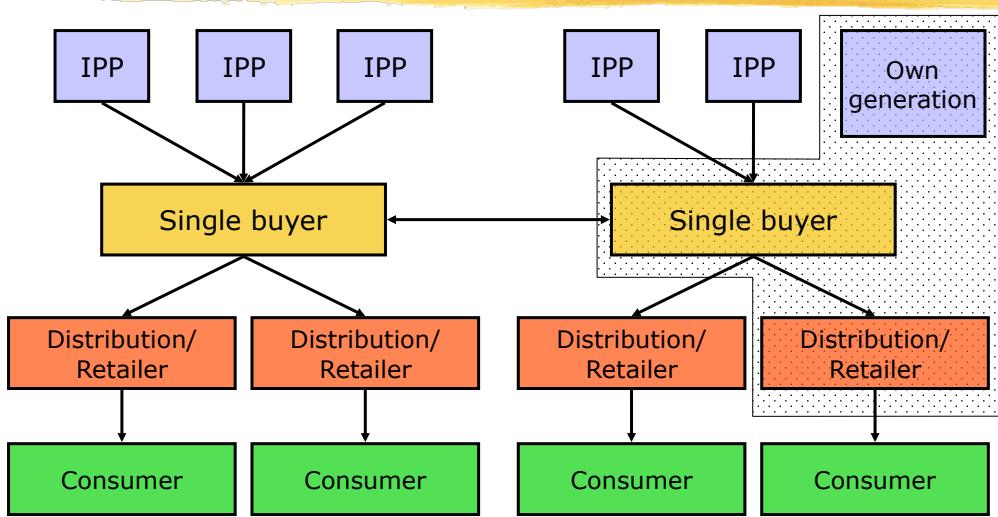
82

Model 1: Monopoly Comments

- Most risks are passed to consumers
 - ◆ mistakes in investment, demand forecast, technological obsolescence, etc.
- Frequent abuse of social policy obligations (utility as tax collector)
 - ◆ indigenous fuels, fuel diversity, nuclear moratoria, electricity discounts, local taxes, etc.
- Regulatory lag & “prudent expenditures”
 - ◆ adequate rate of return to investors
- Pressure from cheap potential new entrants

83

Model 2: Purchasing agency (*single buyer*)



84

Model 2: Purchasing agency Description (1)

- ❑ Less vertical integration than model 1
- ❑ Independent Power Producers (IPPs) compete to sell to the single purchasing agency
 - ◆ competition (e.g. bids) in construction, operation & negotiation of contracts (PPAs) with the single buyer
 - ◆ mandatory purchase at “avoided cost” (questionable)
- ❑ Purchasing agency is responsible for generation adequacy
- ❑ Limited economic incentives in PPA contracts
 - ◆ availability payments, indexation of variable costs⁸⁵

Model 2: Purchasing agency Description (2)

- ❑ Cost-of-service, PPA contracts & social policy obligations → regulated tariff
- ❑ Wholesale transactions: as in model 1. IPPs do not have retail access
- ❑ Purchasing agency (via consumers’ tariffs) takes the generators’ risk in the PPA contracts
- ❑ Independence of the purchasing agency becomes a critical issue (economic dispatch)

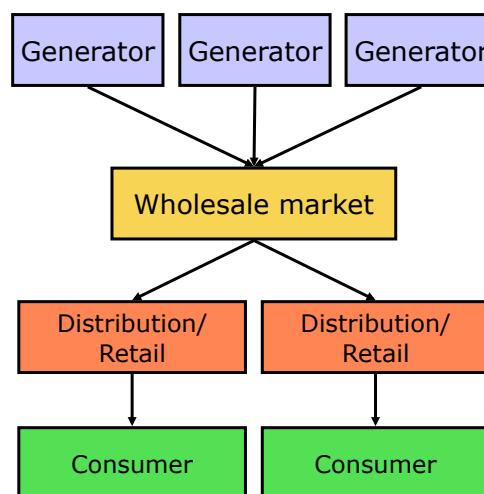
86

Model 2: Purchasing agency Comments

- ❑ Some competition on the generation side, while the purchasing agency keeps centralized strategic control
- ❑ Typical drawbacks of centralized planning
- ❑ Risk of IPPs is passed to consumers → lower capital costs & easier to raise capital
- ❑ Exquisite control of PPA contracts is needed (corruption)

87

Model 3: Wholesale competition



88

Model 3: Wholesale competition

Description (1)

- ❑ Free transactions between distributors & generators, thus sharing risks
- ❑ Distributors (now multiple purchasing agencies) maintain a monopoly over final consumers → regulated tariffs
- ❑ Social policy obligations must be charged via regulated tariffs
- ❑ No central planning of generation, free entry
- ❑ Generation stranded costs & benefits appear

89

Model 3: Wholesale competition

Description (2)

- ❑ Trading arrangements
 - ◆ open access & ancillary services → system operator
 - ◆ organized markets (spot, derivatives) → market operator (not a single buyer, but an auctioneer)
 - ◆ bilateral wholesale contracts
 - ◆ IPPs may choose between contracts & the spot market
 - ◆ regulated network access charges

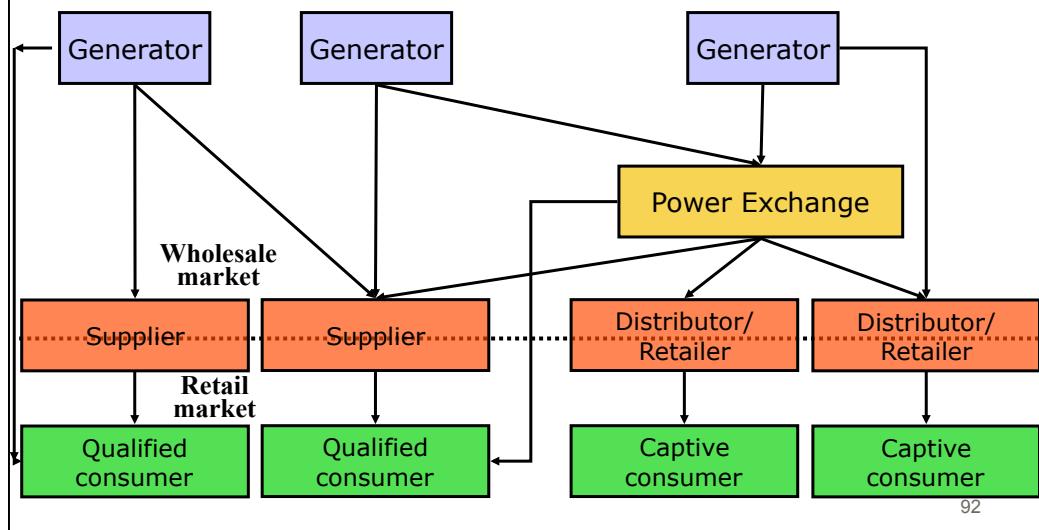
90

Model 3: Wholesale competition Comments

- ❑ IPPs may / may not be vertically integrated with distributors (risk of self dealing)
- ❑ Issues of market power are now relevant
- ❑ Long term guarantee of supply is in principle left to the market
- ❑ Strong incentive to efficiency in generation
- ❑ Pressure from consumers to arrive at retail competition

91

4: Retail & wholesale competition



92

Model 4: Wholesale & retail competition. Description (1)

- ❑ All customers have access to competing generators either directly or through their choice of retailer → regulated tariffs only as a back-up option
- ❑ Social policy obligations only via access tariffs
- ❑ Complete separation of generation & retailing from the networks (transmission & distribution)

93

Model 4: Retail & wholesale competition. Comments (1)

- ❑ The short-term energy market (day-ahead, balancing) becomes essential as a reference for the transactions
- ❑ Advantages of more precise metering
- ❑ Generation stranded costs & benefits appear →
 - ◆ gradual eligibility of consumers may help
 - ◆ vesting contracts may help
 - ◆ levies via access charges may help
- ❑ Issues of market power are now relevant
- ❑ Long term guarantee of supply is in principle left to the market
- ❑ Strong incentive to efficiency in generation

94

Model 4: Retail & wholesale competition. Comments (2)

- ❑ Integration of generation & retailing is no longer a problem (consumer may choose supplier)
- ❑ But integration of distribution & retailing has to be closely supervised
- ❑ Stand-alone retailing is high-risk / low-return
- ❑ Demand may respond to market prices
- ❑ New retailing-like opportunities appear: energy service companies
- ❑ General arguments for competition favor model 4

95

Outline

- ❑ The regulatory function
 - ❑ **The change of regulatory paradigm in the 90's**
 - ◆ traditional regulation
 - ◆ characterization & motivation for a change
 - ◆ transition to liberalized regulatory frameworks
 - ❑ Annexes
 - ◆ industry organization models
- ◆ regulation of individual electrical activities**

96

The new regulation

Regulation of electrical activities

- Generation
 - ◆ ordinary generation
 - ◆ renewable energy sources & cogeneration
- Transmission
- Distribution
- Retailing (*commercialization, supply*)
- System Operation
- Market operation

97

Regulation of electrical activities

Generation (*ordinary*)

- Non regulated, free entry / exit, network access
- Multiple services
 - ◆ energy production
 - ◆ ancillary services
 - market mechanisms, whenever possible
 - charge costs to responsible parties
- Major regulatory issue: horizontal & diagonal concentration & evaluation of market power
 - E.g. acceptable national concentration level vs. interconnector capacity
 - E.g. commercial agreements between national & foreign utilities
 - E.g. commercial agreements between gas & electricity companies₉₈

Regulation of electrical activities

Generation (*renewable*)

- Renewable energy sources & cogeneration
- Reason for existence of supporting mechanisms
 - ◆ compensate the lack of internalization of environmental costs in electricity price
- Diversity of regulatory instruments
 - ◆ mandatory targets with or w/o green certificate markets
 - ◆ subsidies (technology dependent) in euro/(kWh produced)
 - ◆ tax exemptions
 - ◆ direct dedicated R&D aids
 - ◆ voluntary purchases of more expensive "green electricity"

99

Regulation of electrical activities

Generation planning?

- At the individual generators' level
 - ◆ market price is the basic uncertainty
 - ◆ 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

100

Long term guarantee of supply

□ Relevant issues

- ◆ Responsibility for guarantee of supply
- ◆ Adequacy of market economic signals in relation with reliability & security of the power system
 - Market price when there is loss of supply
 - Adequacy of market prices for peaking units
 - Risk aversion & adequate generation investment levels
- ◆ Consumers' choice of level of guarantee of supply

□ Basic options

- ◆ Leave it to the market
- ◆ Regulated economic incentives
- ◆ Mandatory contract cover
- ◆ Availability markets

101

Regulation of electrical activities Transmission (1)

- Regulated natural monopoly (*as distribution*)
- Regulatory differences with distribution network
 - ◆ reduced amount of new major facilities → an individualized supervision is possible
 - ◆ small impact on the final quality of service for the small customers, in general
- Transmission network is “the meeting point” in a competitive market at wholesale level → its regulation is critical for the wholesale market efficiency

102

Regulation of electrical activities Transmission (2)

- Comparatively low cost in general
 - ◆ the larger the costs & the need for new costly investments, the higher the regulatory complexity should be
- Unbundling from system operation
 - ◆ synergies vs. conflicts of interest
- Major regulatory issues
 - ◆ Access, investment & pricing

103

Regulation of electrical activities Transmission (3)

TRADITIONAL

- Restricted access
- Cost of service remuneration
- Centralized optimal planning
- Pricing is a non issue

COMPETITIVE MARKET

- Open access
- Same, with more emphasis on efficiency & performance incentives
- Increased user participation based on adequate economic signals
- Pricing is a critical issue since it affects competition

104

Regulation of electrical activities Transmission (4)

□ Access

- ◆ From priority rules for capacity reservation to purely market-based mechanisms in the short-term to solve for congestions

□ Investment

- ◆ From central planning to authorization of proposals submitted by coalitions of agents to light handed supervision with price control & grid code requirements

□ Pricing

- ◆ From nodal pricing to uniform market prices. A large variety of methods to allocate transmission sunk costs

105

Regulation of electrical activities Distribution

□ Distribution is a network activity

- ◆ network expansion planning
- ◆ line construction
- ◆ maintenance scheduling
- ◆ maintenance work
- ◆ network operation

Retailing is a different activity

□ Major regulatory issues in distribution

- ◆ Access, investment, pricing

106

What is particular about distribution regulation?

- Distribution must be regulated as a natural monopoly
- Distribution must be regulated separately from transmission
 - ◆ little significance (so far) for the wholesale market
 - ◆ 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) and quality of service

107

Distribution investment

- The remuneration scheme must incentivize that the regulatory objective is achieved
- There is no widely accepted approach
- How to deal with distribution losses?
 - ◆ Economic incentives to achieve a prescribed target level of losses
- How to deal with quality of service?
 - ◆ Economic incentives to meet minimum levels of quality of service
 - continuity, voltage distortions, client attention

108

Distribution pricing

- ❑ Objective: To allocate the global remuneration of the distribution network to the individual customers
- ❑ Distribution charges are a component of
 - ◆ the integral tariff (for non-qualified consumers)
 - ◆ the access tariff (for qualified consumers)
- ❑ Distribution charges should
 - ◆ be cost reflective
 - ◆ completely recover the network costs

109

Distribution access

- ❑ Objective: To establish the rules of use of the distribution network so that
 - ◆ no agent is discriminated
 - ◆ there is no abuse of the monopolistic power of the distributor
- ❑ Adequate procedures & network charges for
 - ◆ connection to the network
 - ◆ use of the network

110

Distribution

Other regulatory issues

- ❑ Metering
- ❑ Multiutilities
- ❑ Embedded generation
- ❑ Non-ohmic losses
- ❑ The use of uniform tariffs

111

Regulation of electrical activities

Supply (retailing) (1)

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

112

Regulation of electrical activities Supply (retailing) (2)

- 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
- Supply of *last resort*

113

Regulation of electrical activities 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

114

Regulation of electrical activities Market Operation (*Power Exchanges*)

- 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
- Diversity of markets & contracts, both for system agents & external arbitrageurs

115

Websites of interest

- The International 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
www.worldbank.org/html/fpd/psd/ifur/directory/index.html

116

MIT OpenCourseWare
<http://ocw.mit.edu>

ESD.934 / 6.695 / 15.032J / ESD.162 / 6.974 Engineering, Economics and
Regulation of the Electric Power Sector
Spring 2010

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.