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Robert Schuman Centre for Advanced Studies

Florence School of Regulation

The Regulation of Competitive Activities

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Florence School of Regulation
Summer Course
on
Regulation of Energy Utilities
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Outline

- The traditional regulatory framework
 - The structure of the companies
 - Technical and economic functions
 - Remuneration and tariffs
- The process of transition to a competitive framework
 - The reasons for a change
 - The process of change
 - Power sector organisation models

Outline

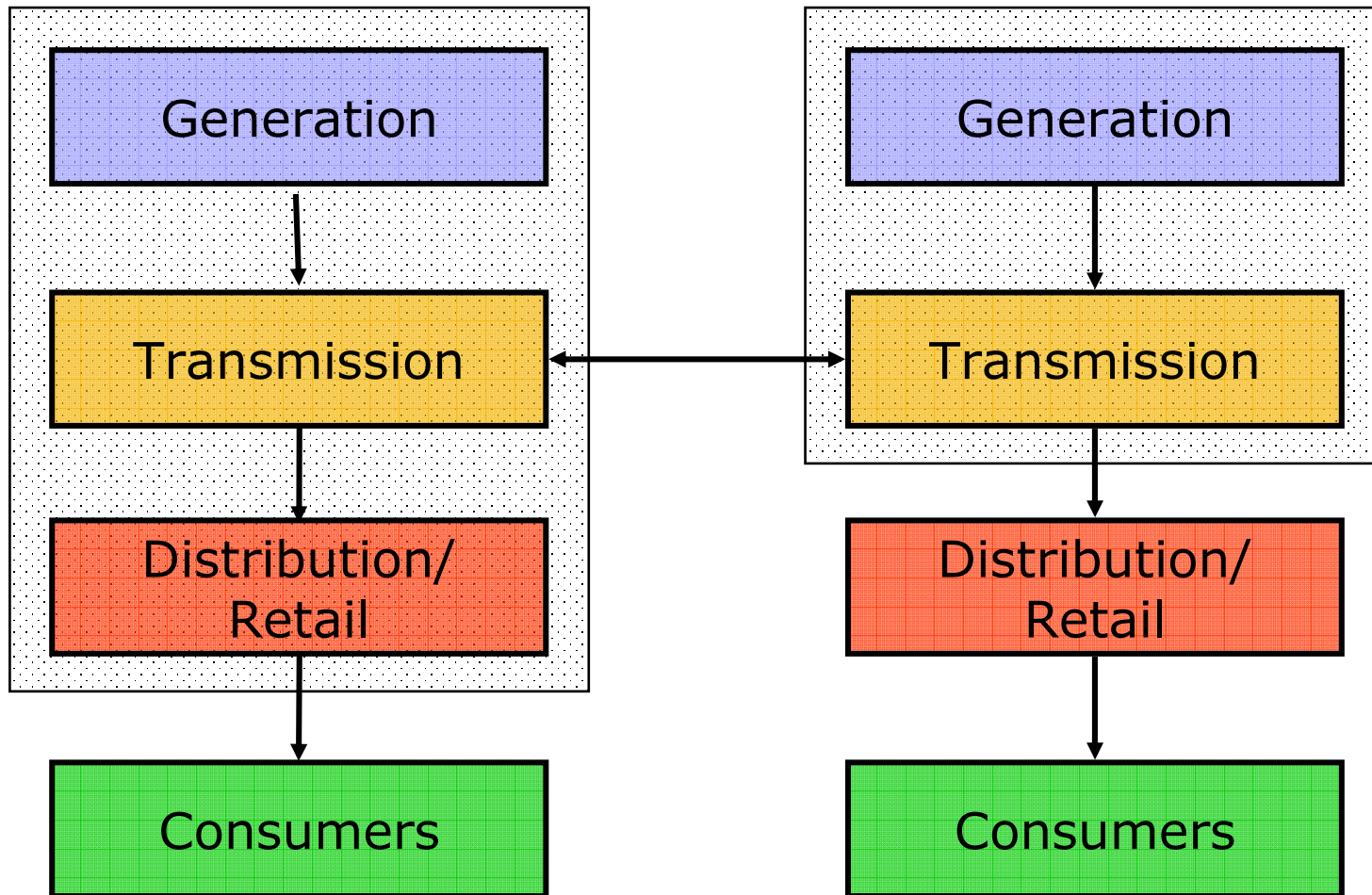
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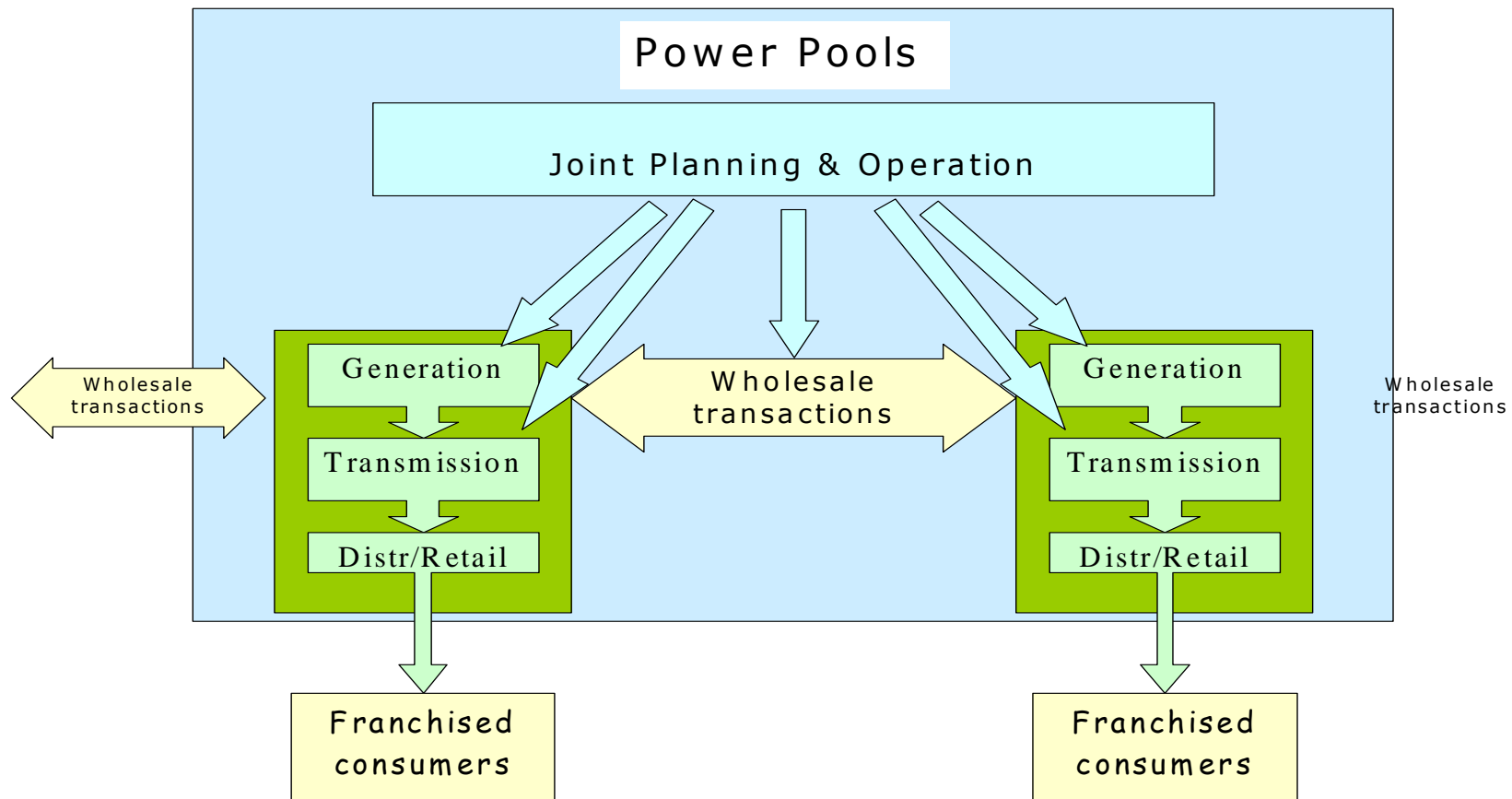
Traditional regulation

Typical structure of the companies



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: $G+T+D+S$
 - Partial: Firm sales from $G+T$ to $D+S$
- Transactions
 - $G+T+D+S$ to final consumers under integral tariff
 - $G+T$ to $D+S$ to final consumers under integral tariff
 - Firm transactions among $G+T$ (transit fees)
 - Non firm transactions among $G+T$ (transit fees)

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 and technical decisions: centralised planning and operation
 - Under regulatory review (*frequent overlap of public ownership and regulation*)
- Cost-of-service remuneration
- Regulated tariffs

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Traditional regulation

Technical and 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 optimises its own decisions subject to
 - its own constraints
 - constraints that are imposed from “upstream”

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 |

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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 and maintenance
 - Depreciation
 - Remuneration of capital
 - Taxes
- 4 Determine the average rate (tariff)

Traditional regulation Cost-of-service remuneration (2)

$$\begin{aligned} \textbf{Total cost of service} &= \\ &= \textit{Operation and maintenance costs} + \\ &+ \textit{depreciation} + \\ &+ \textit{rate-of-return on capital} \times \textit{rate base} - \\ &- \textit{additional revenues} + \textit{taxes} \end{aligned}$$

$$\begin{aligned} \textbf{Average cost of service} \textit{ (average rate or} \\ \textit{tariff)} &= \\ &= \textit{total cost of service} / \textit{total energy sales} \end{aligned}$$

Definitions (1)

- **Operation and maintenance costs**
Fuel costs, materials and replacement parts, energy purchases, supervision, personnel and overhead
- **Depreciation**
Typically linear; fixed assets under construction are not depreciated
- **Taxes**
On profit, revenue, property, social security and construction

Definitions (2)

- **Rate base** (*regulated asset base, RAB*)
Net fixed assets (i.e. less the cumulative depreciation) plus current assets (e.g. inventory of fuel and replacement parts, advance payments and deferred revenues)
- **Rate of return**
Average weighted interest rate over the long-term financial resources of the firm
- **Additional revenue**
Expenses and revenues deriving from the sale of the firm's property, revenues from wholesale energy sales, other revenues from non electric activities

Some controversial issues

- Use of actual or estimated values (*the problem of the "regulatory lag" and the "deviations"*)
- Determination of a "fair and 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 under construction

Traditional regulation

Determination of retail tariffs

Typical steps in the process:

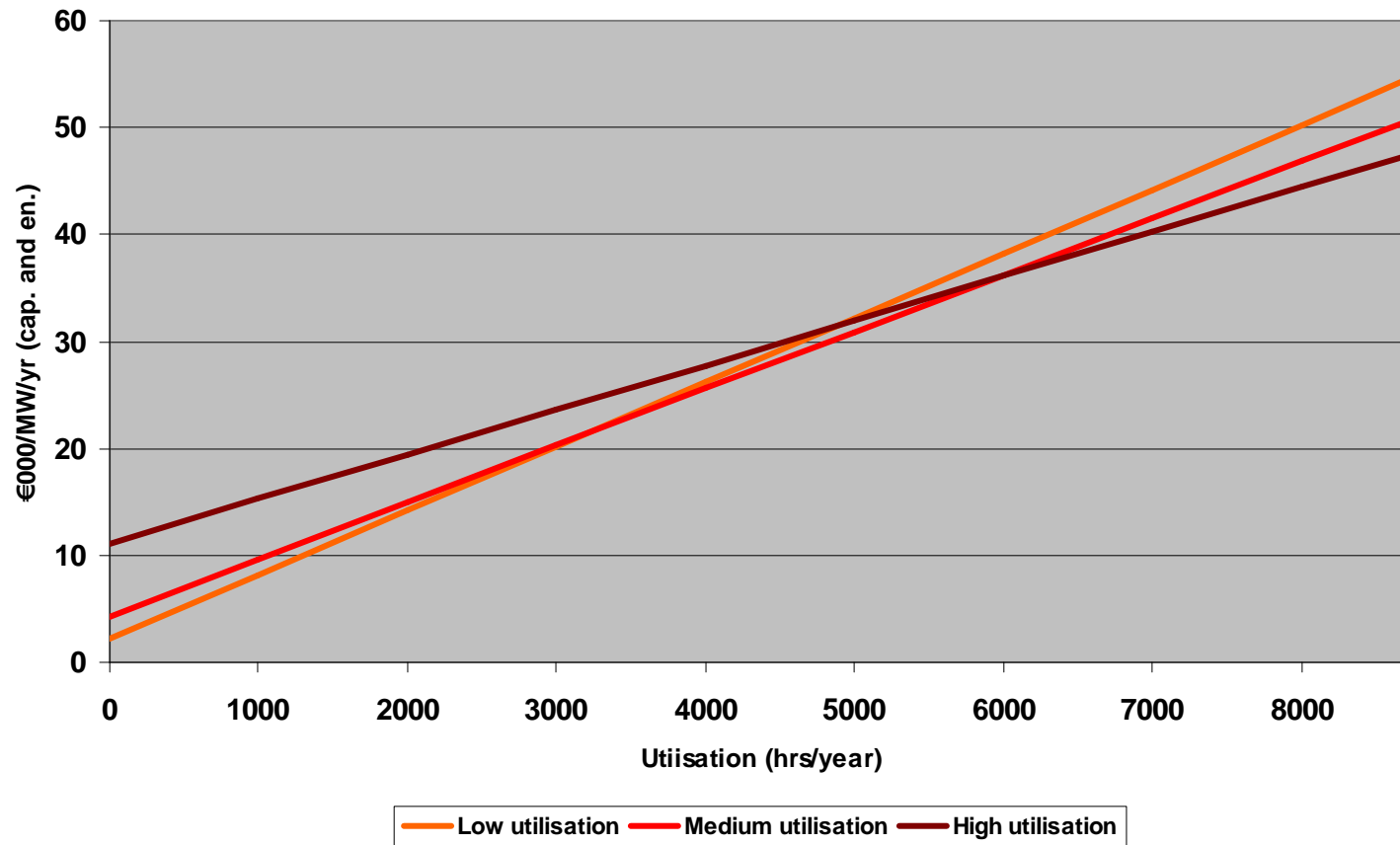
- 1 Classify consumers into homogeneous types (*define the "tariff structure"*)
- 2 Unbundle the total cost of service into generation, transmission, distribution and other
- 3 Further unbundle each element of (2) into a capacity, energy and/or per-consumer component
 - Time periods can also be introduced
- 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

Electricity tariff structure (Spain, 1996)

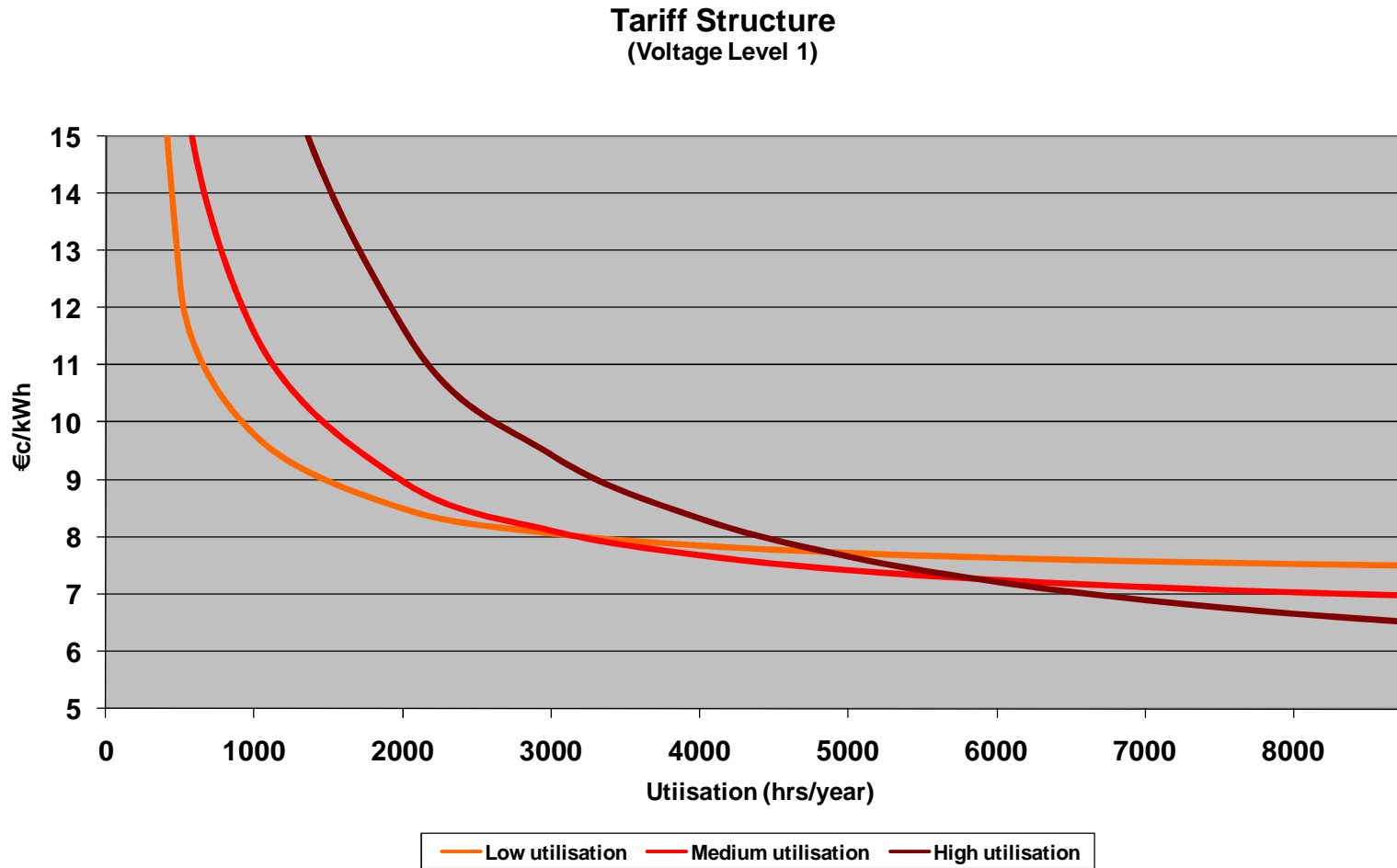
| | <i>Capacity</i> cents€/KW.month | <i>Energy</i> cents€/KWh |
|--|------------------------------------|-----------------------------|
| LOW VOLTAGE (supply < 1 kV) | | |
| 1.0 Contracted capacity below 770 W | 30.05 | 6.71 |
| 2.0 Contracted capacity below 15 kW | 169.49 | 9.63 |
| 3.0 General low voltage tariff | 160.47 | 9.37 |
| 4.0 High utilization factor in low voltage | 254.83 | 8.55 |
| R.0 Irrigation in agriculture | 0 | 7.82 |
| B.0 Public lighting | 35.46 | 7.83 |
| HIGH VOLTAGE (supply > 1 kV) | | |
| <i>Voltage level 1 (1 to 36 kV)</i> | | |
| 1.1 Low utilization | 214.56 | 7.21 |
| 2.1 Medium utilization | 430.32 | 6.38 |
| 3.1 High utilization | 1110.07 | 5.00 |
| <i>Voltage level 2 (36 to 72 kV)</i> | | |
| 1.2 Low utilization | 197.13 | 6.77 |
| 2.2 Medium utilization | 405.68 | 5.97 |
| 3.2 High utilization | 1038.55 | 4.70 |
| <i>Voltage level 3 (72 to 145 kV)</i> | | |
| 1.3 Low utilization | 197.13 | 6.57 |
| 2.3 Medium utilization | 392.46 | 5.79 |
| 3.3 High utilization | 1006.09 | 4.53 |
| <i>Voltage level 4 (above 145 kV)</i> | | |
| 1.3 Low utilization | 191.12 | 6.34 |
| 2.3 Medium utilization | 382.24 | 5.61 |
| 3.3 High utilization | 976.04 | 4.40 |
| Special tariffs | | |
| Traction | 63.71 | 7.13 |
| Distribution utilities | 239.80 | 5.07 |
| Irrigation for agriculture | 57.70 | 7.13 |
| Very large consumers | 993.47 | 1.09 |

Electricity tariff structure for HV Customers (Spain, 1996)

Tariff Structure
(Voltage Level 1)

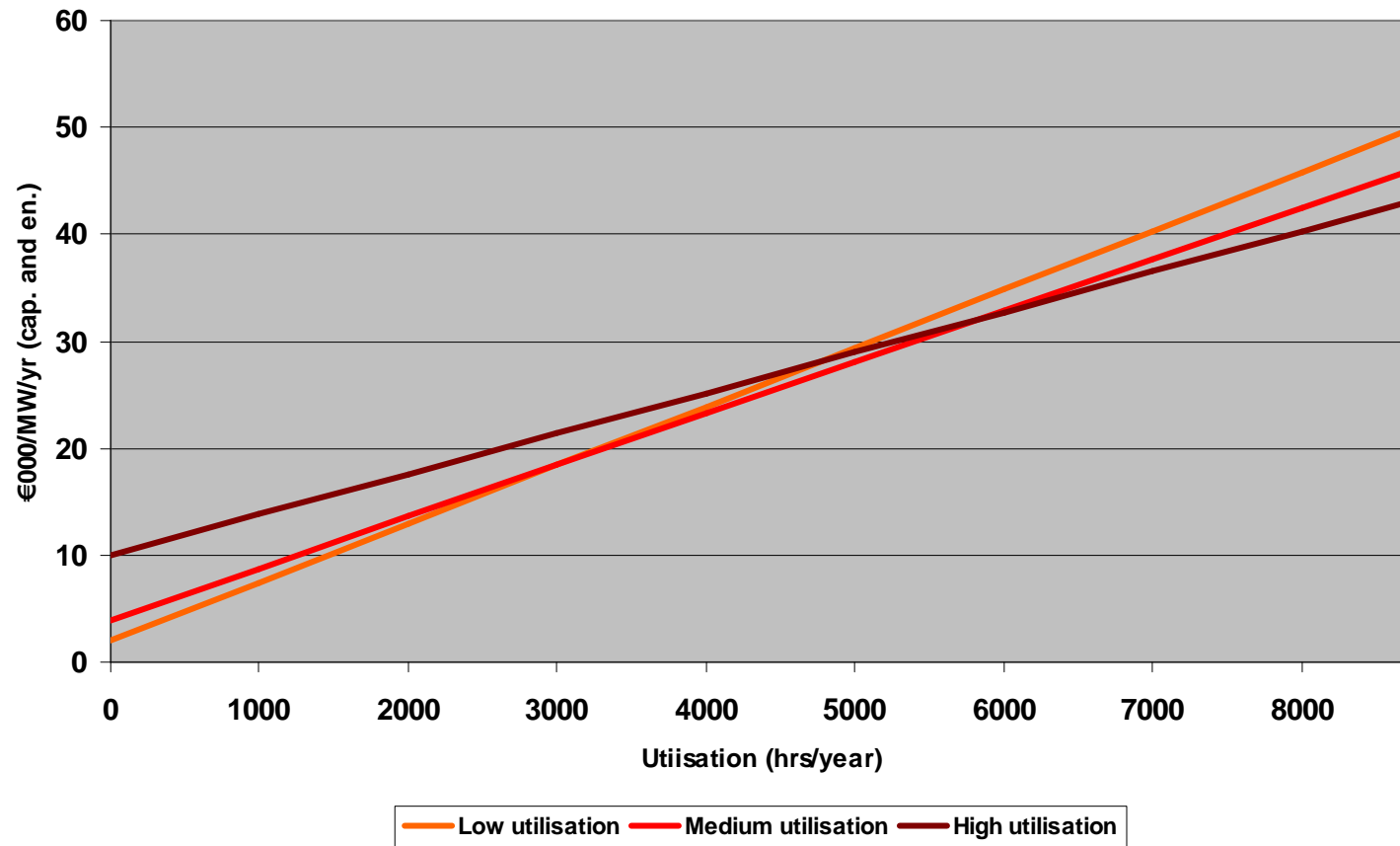


Electricity tariff structure for HV Customers (Spain, 1996)

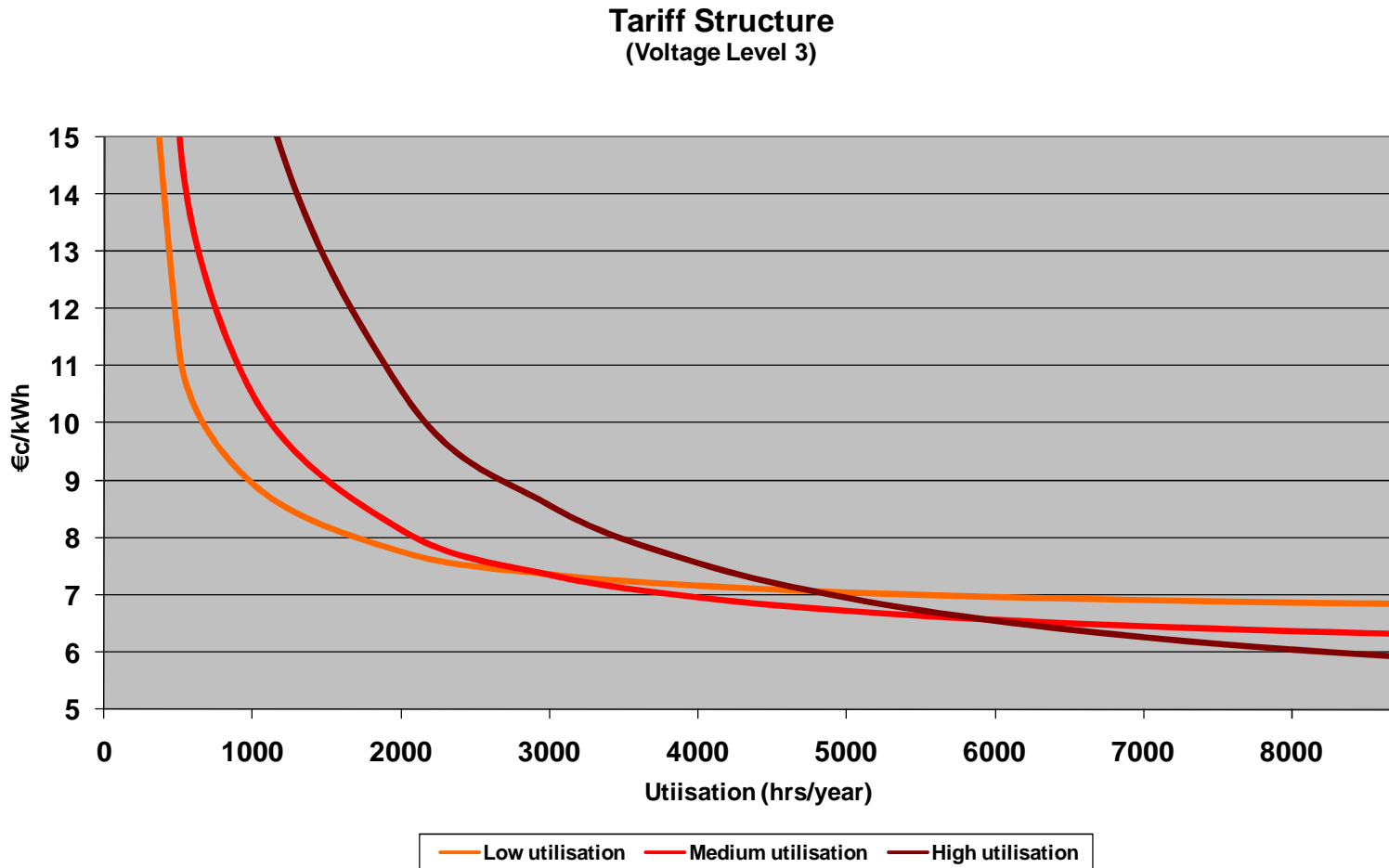


Electricity tariff structure for HV Customers (Spain, 1996)

Tariff Structure
(Voltage Level 3)



Electricity tariff structure for HV Customers (Spain, 1996)



Tariffs of wholesale power sales

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

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

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.
- Promote excessive investment
- Regulatory risk for shareholders
 - “regulatory lags” and “prudent expenditures”

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 and constraints in their planning and operation functions, e.g.:
 - "integrated resource planning"
 - load management

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Traditional regulation Basic features

- Monopolistic geographic franchises
- Pervasive public ownership of power utilities
- Legal planning and supply obligations
- Vertical integration of activities
- Centralised economic dispatch
- Regulated retail prices based on cost-of-service
- Voluntary coordination transactions of limited importance among utilities

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 → good perspectives with new capacity (in theory)

Details

Advances in generation technology (1)

- 60's - 80's
 - typical capacity of coal-fired and 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

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

The new regulation Why? (2)

- Competition is possible in supply (retail market)
 - Technological advances in metering, communications and information processing → facilitate multiplicity of commercial transactions
- Favorable economic climate
 - Global trend towards liberalisation

The new regulation Why? (3)

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

The new regulation Why? (4)

- Additional goals
 - Reduce prices (more developed countries) and better align prices with costs (less developed ones)
 - Stimulate retail and demand-side activities
 - Market-driven retirement of old, dirty and costly generating plants
 - Competition for competition's sake

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

The new regulation

Basic features

- Unbundling of activities
 - generation and retailing are open to competition
 - transmission and distribution remain regulated
 - diverse alternatives with system and market operation
- End consumer can choose supplier
- Wholesale market: organised and/or bilateral
- Diverse contracts (physical, financial) to hedge the risk
- Operation and investment planning is no longer a centralised activity
- Independent regulator

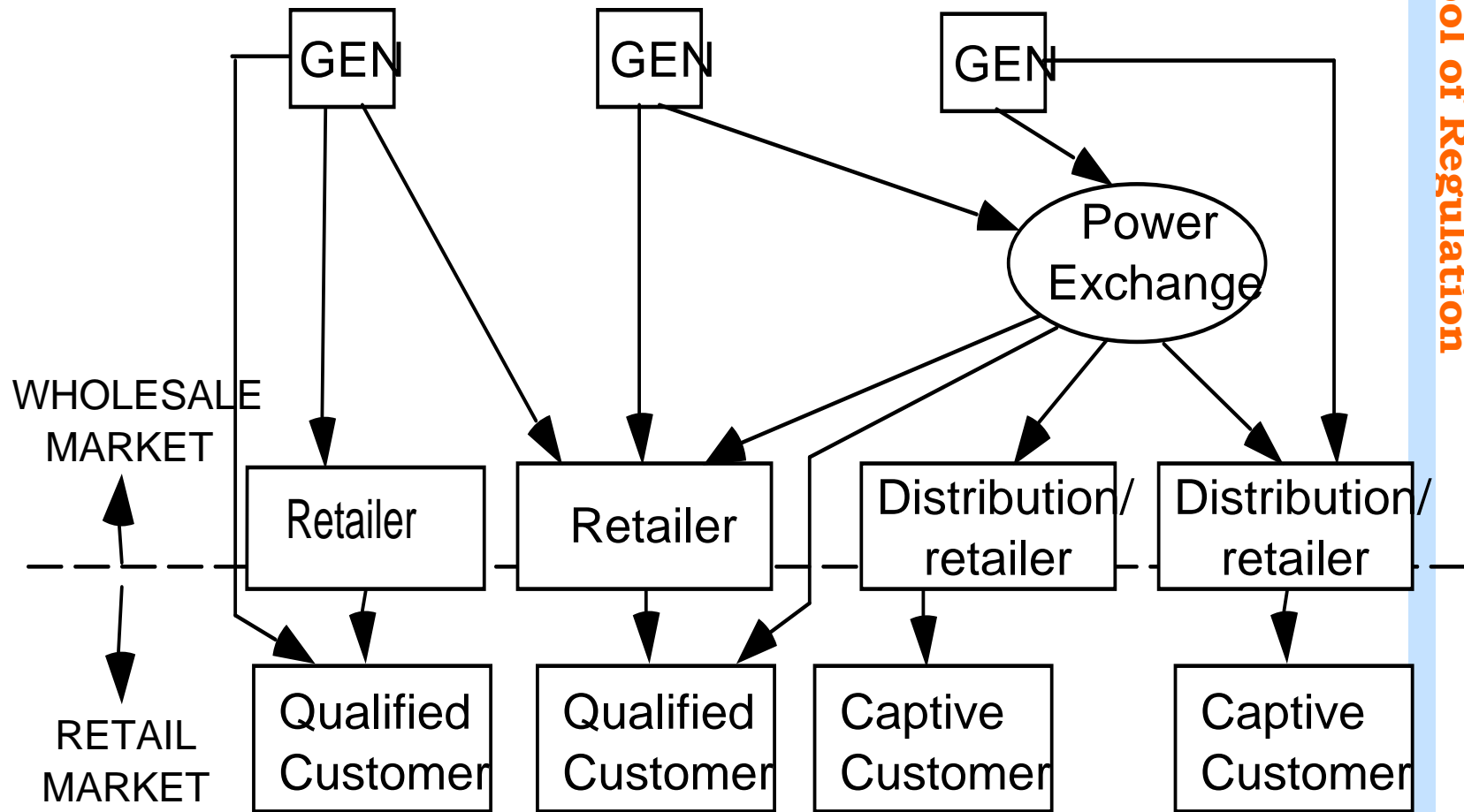
The new regulation

Basic policies

- **Liberalisation**
 - of the wholesale market
 - of the retail market
- **Restructuring**
 - unbundling of vertically integrated activities
 - action (if needed) on horizontal concentration
- **Privatisation**
- The need for **transition** measures

The new regulation

The structure of markets



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Gradual liberalisation 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 and 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

1) "Qualifying facilities" (US)

- The term *qualifying facilities* appears in the PURPA Act (US) in 1978
 - Objective: to promote cogeneration and 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) and small generators (< 80 MW) with > 75% of renewables
 - < 50% of ownership of the generating company

2) BOO/BOT supply contracts

- The contractor is selected via an ad hoc competitive bidding process that is organised by the utility itself
- The contractor has to build, operate and own (BOO) and/or transfer the plant (BOT)
- Contract to purchase the energy
 - Power Purchase Agreement (PPA)
- Remuneration according to the terms of the contract and independent from the regulated tariffs. It has to include:
 - Energy payment
 - Capacity payment

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 costs (optional)
 - Step 3: Preparation of the request for bids
 - Step 4: Evaluation and selection of bids
 - Step 5: Negotiation and signature of the contract

4) IPPs (limited access)

- The plants are built by initiative of the IPPs, and 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
- Sales of IPPs to generating and/or distributing companies are forbidden (e.g., EEUU Energy Policy Act, 1992). Limited access to the network

5) IPPs (complete access)

- Similar to case 4
- Now IPP can sell directly to the consumers (and 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

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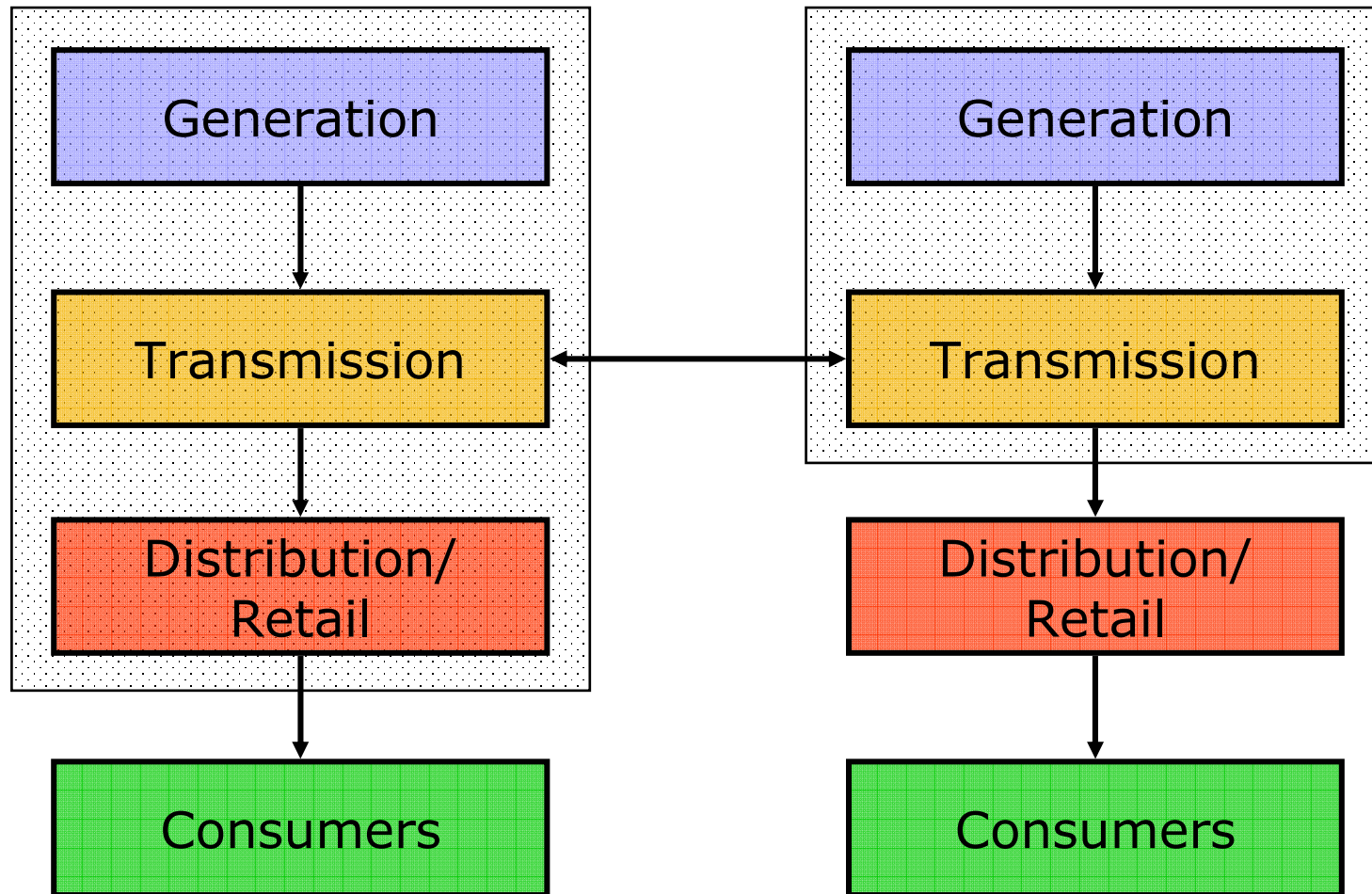
The new regulation

Power sector organisation models

- Four representative models (*)
 - abstractions, do not describe particular systems
 - intermediate cases and variations are possible
- Correspond to varying degrees of monopoly, competition and choice
- Public or private ownership is ignored
 - Model 1: monopoly at all levels
 - Model 2: purchasing agency
 - Model 3: wholesale competition
 - Model 4: wholesale and retail competition

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

Model 1: Monopoly



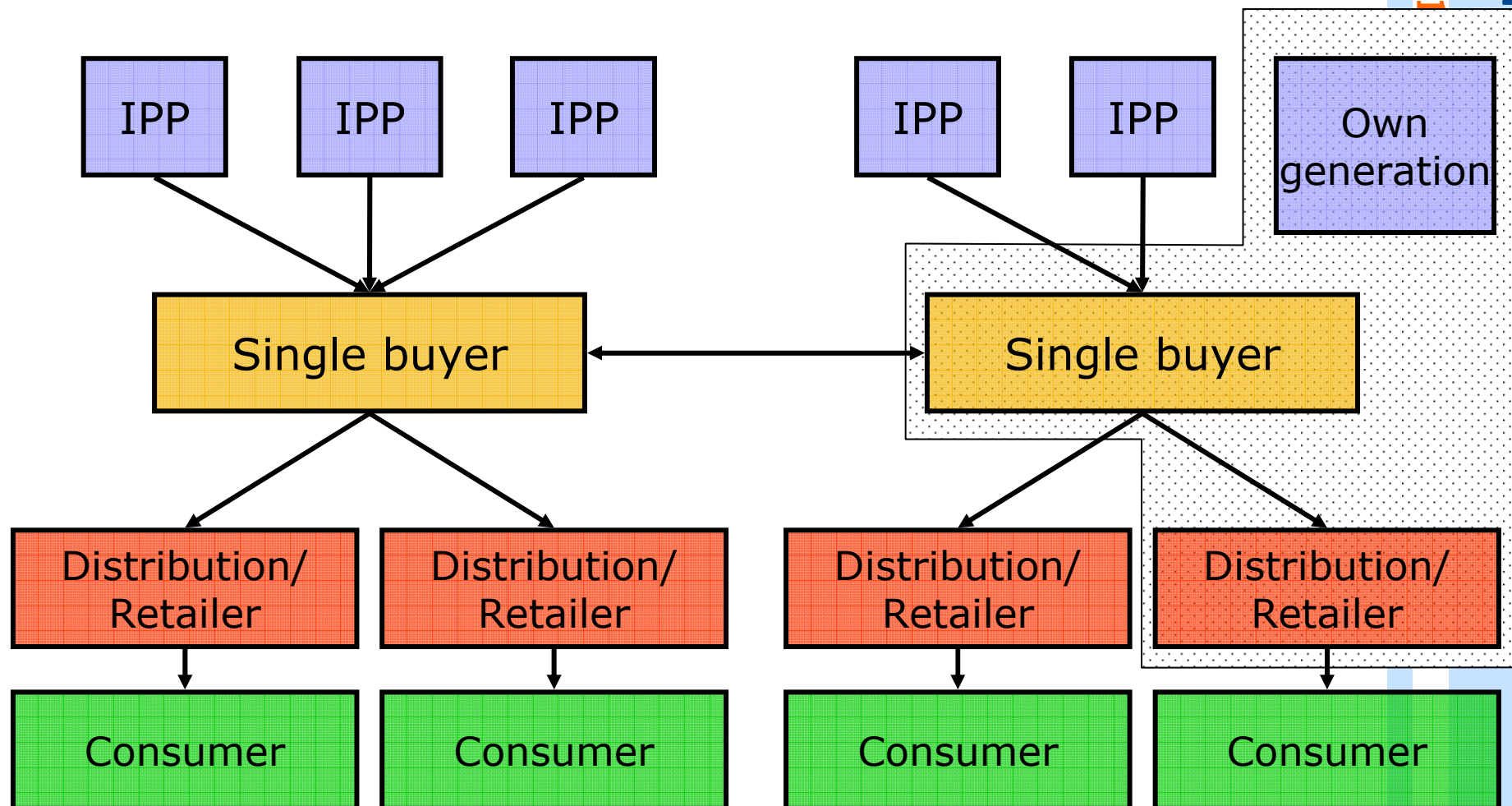
Model 1: Monopoly Description

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

Model 1: Monopoly Comments

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

Model 2: Purchasing agency (*single buyer*)



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 and 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 costs

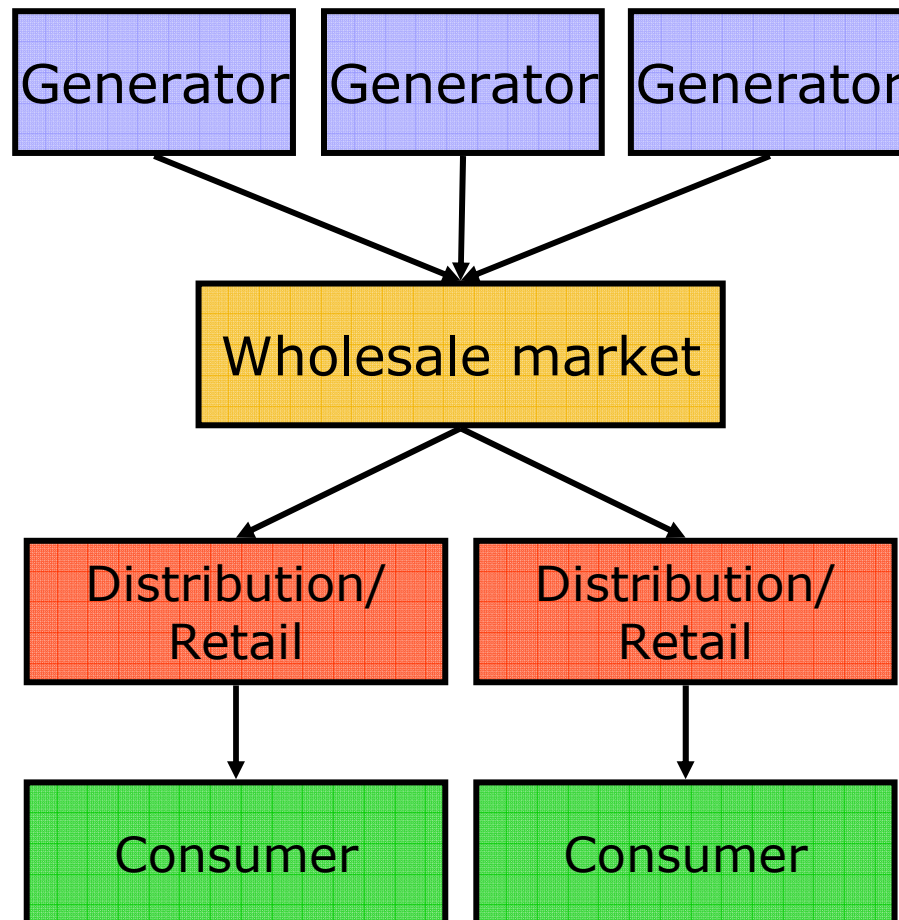
Model 2: Purchasing agency Description (2)

- Cost-of-service, PPA contracts and 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)

Model 2: Purchasing agency Comments

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

Model 3: Wholesale competition



Model 3: Wholesale competition Description (1)

- Free transactions between distributors and 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 and benefits appear

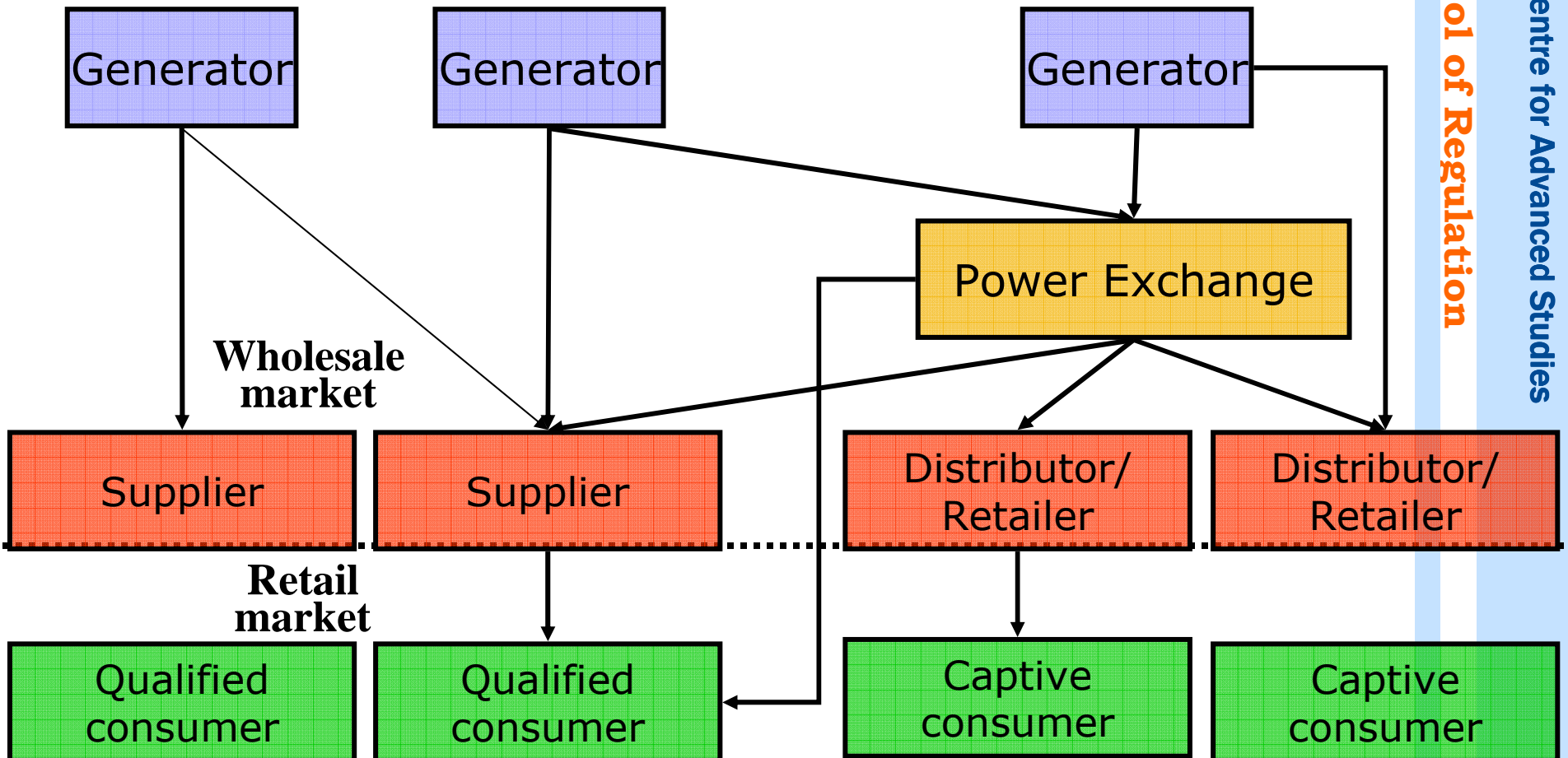
Model 3: Wholesale competition Description (2)

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

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

Model 4: Retail and wholesale competition



Model 4: Wholesale and 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 and retailing from the networks (transmission and distribution)

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

- The spot market becomes essential
- Metering becomes a major issue/problem
- Generation stranded costs and 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

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

- Integration of generation and retailing is no longer a problem (consumer may choose supplier)
- But integration of distribution and retailing has to be closely supervised
- Stand-alone retailing is high-risk / low-return
- Demand may respond to market prices
- General arguments for competition favor model 4



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End of the Presentation
Thank you for your attention