EFFICIENCY AND REGULATION OF THE SLOVENIAN ELECTRICITY DISTRIBUTION COMPANIES

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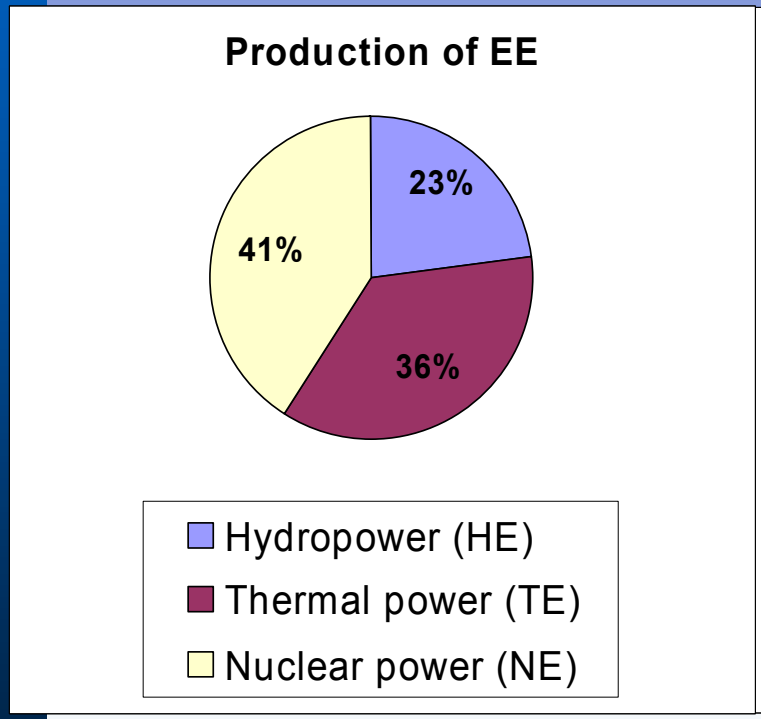
Outline

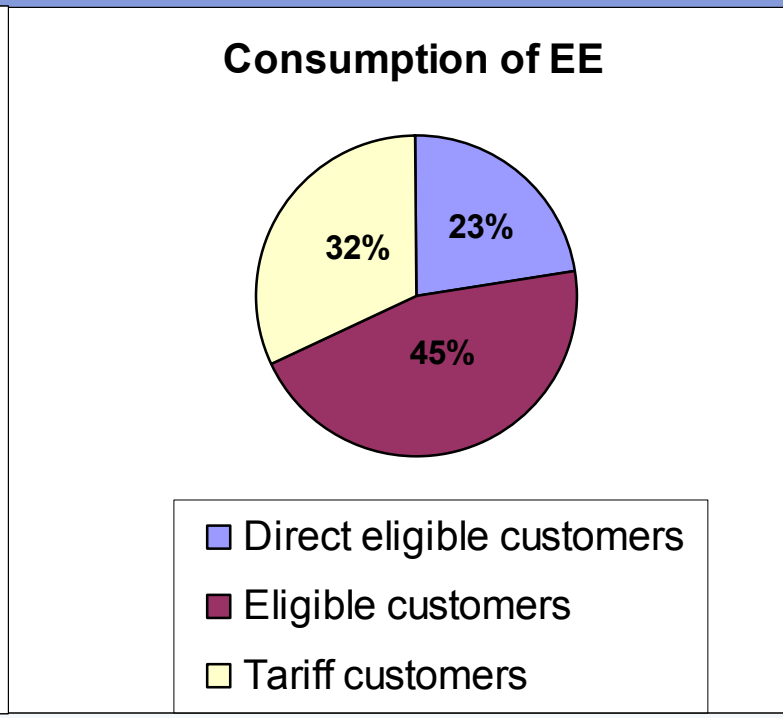
1. Slovenian electricity sector
2. Reforms of the electricity sector
3. Price regulation of electricity distribution utilities
4. Benchmarking of distribution utilities: stochastic frontier analysis (SFA)
5. Efficiency of Slovenian distribution utilities
6. Conclusions

1. SLOVENIAN ELECTRICITY SECTOR

Basic facts	Year 2002
Installed capacity	2,762 MW
Production of electricity	13,012 GWh
Transmission-line length	2,594 km
Distribution-line length	57,839 km
Consumption of electricity	11,315 GWh
Consumption per person	5,761 kWh
Export	2,714 GWh
Import	1,443 GWh
Losses	480 GWh

PRODUCTION AND CONSUMPTION OF ELECTRICITY IN 2002





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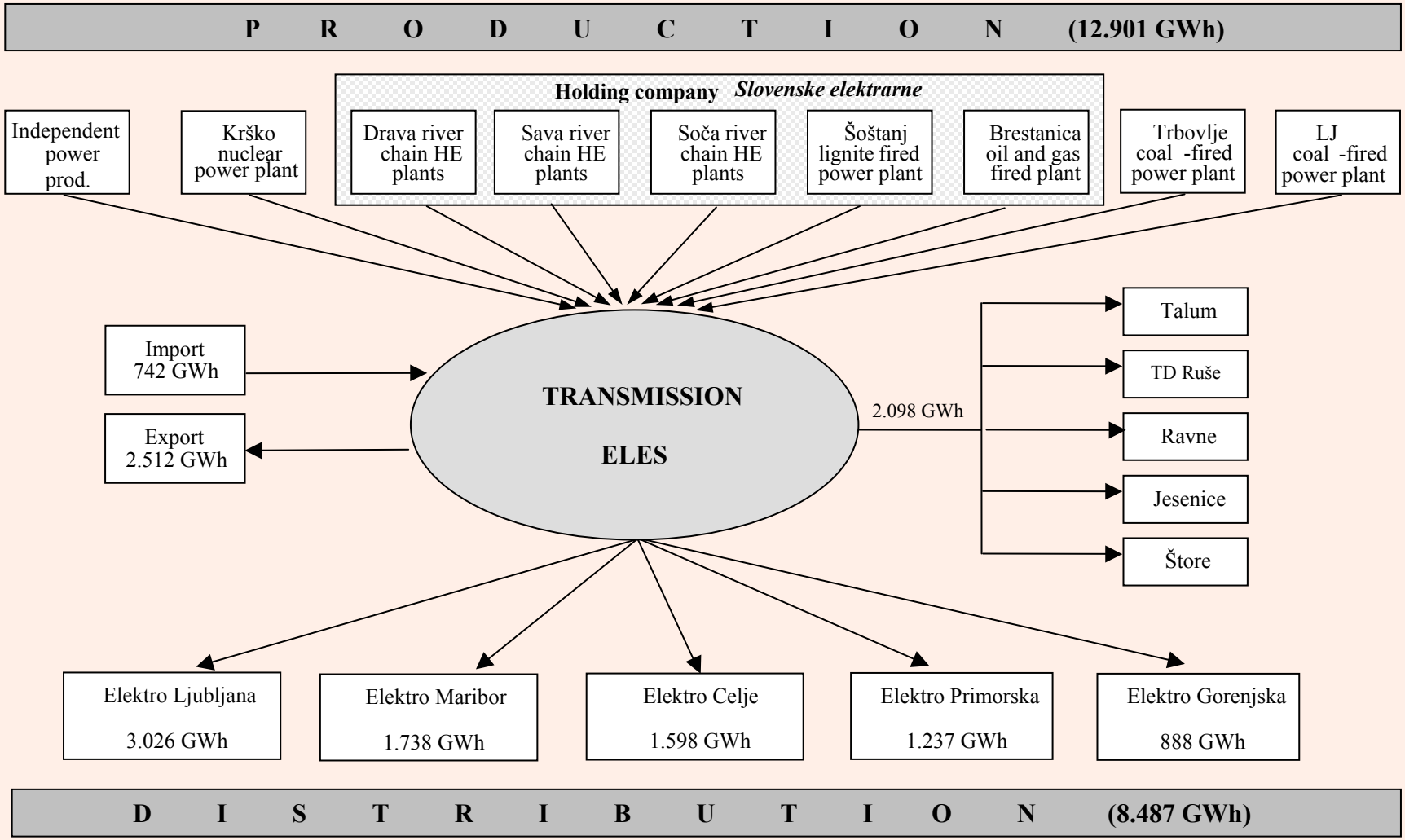
Structure of Slovenian electricity industry in 2001



Source: Hrovatin (1999), modified

2. LIBERALISATION OF SLOVENIAN ELECTRICITY SECTOR (1)

- The EU's Electricity Directive (96/92/EC)
- In 1999 Slovenia adopted new Energy Act
- Objective: to improve efficiency and competitiveness of the power sector
- Power generation and electricity supply became competitive activities
- Power exchange Borzen d.o.o.: 2001

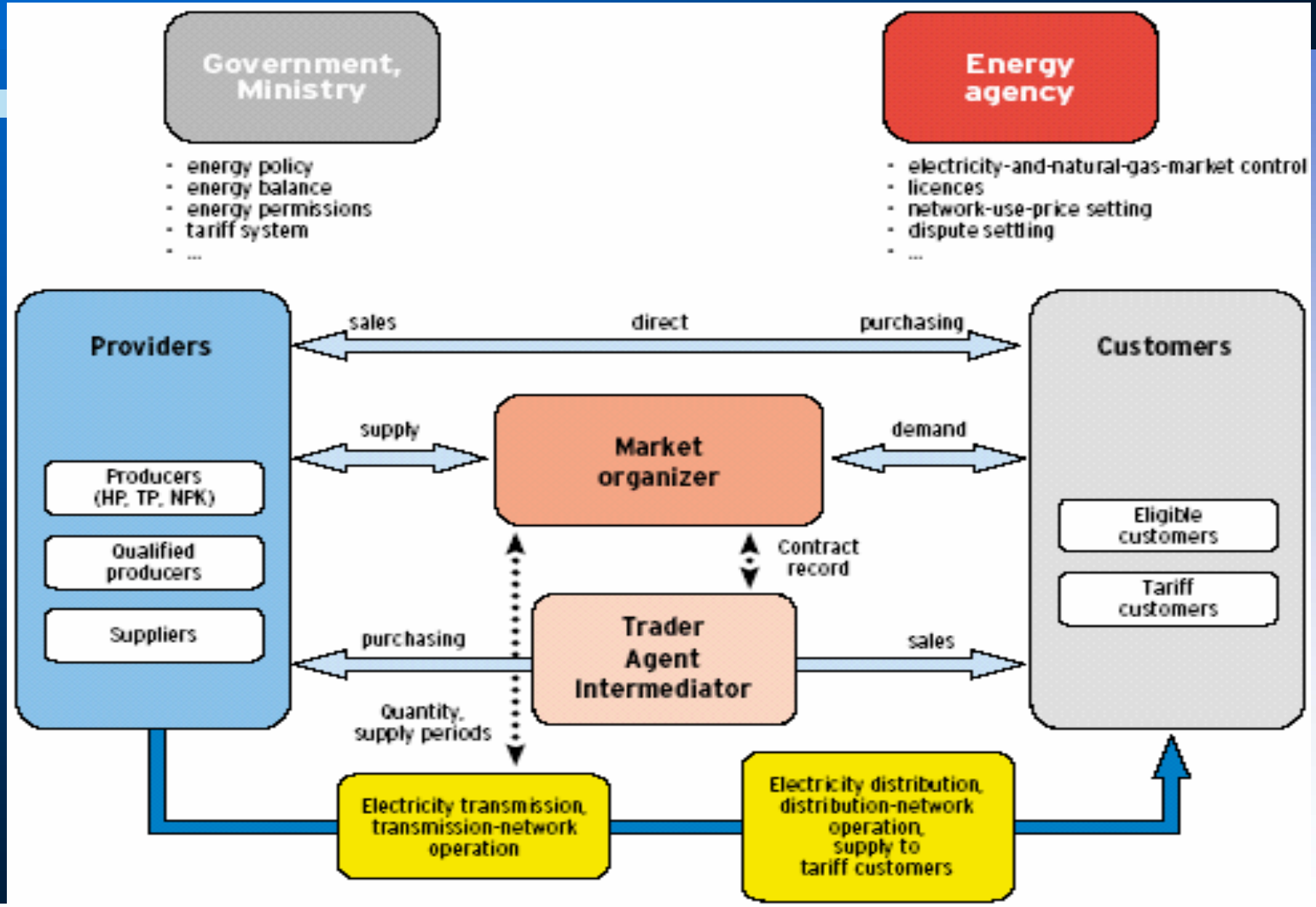
LIBERALISATION OF SLOVENIAN ELECTRICITY SECTOR (2)

- Gradual market opening:
  - 2001-2003: domestic purchases (of eligible customers)
  - In 2003: electricity market was fully opened for domestic and foreign purchases
- Threshold for defining eligible customers: connected capacity of more than 41kW
- 65% of final electricity consumption was opened up to competition (EU average)

OWNERSHIP

- Current ownership structure:
  - Generation: majority state-owned (nuclear power: 100%)
  - Transmission: 100% state owned
  - Distribution: majority state owned (cca. 80%)
- Energy Law (1999):
  - nuclear power plant, transmission: 100% state owned
  - generation, distribution: 51% state owned until 2003, single owner (foreign strategic owner): not more than 25%

PARTICIPANTS IN THE ELECTRICITY MARKET



Source: AERS, 2003

3. REGULATION OF SLOVENIAN ELECTRICITY SECTOR

- Transmission and distribution regulated
- 2001: Energy Agency established as an independent regulator
- Principal task: regulation of network prices in transmission and distribution
- Problem: government retained control over prices for tariff customers which are set too low

(25-30% below the EU average)

REGULATORY AUTHORITY: Energy Agency of RS

- Regulates access prices (rTPA access)
- Starting regulatory period: 2003-2005
- Accountable to the government (annual reports) and to the Ministry (appeals)
- Staff: civil servants (21)
- Financing: access prices (government)
- General director: 5 years

Regulatority authorities in EU 15 and Slovenia in 2002

Country	Number of employees	Budget (mio EUR)
Austria	45	9
Belgium	68	15
Denmark	30	3
Finland	15	1
France	80	9
Germany	n.a.	n.a.
Greece	43	4
Ireland	31	6
Italy	86	18
Luxembourg	2	n.p.
Netherlands	55	6
Portugal	52	7
Spain	153	19
Sweden	33	3
UK	330	58
EU average	68	10,5
Slovenia	21	1,4

PRICE REGULATION OF DISTRIBUTION UTILITIES (1)

- Methodology: incentive-based price-cap regulation (RPI-X regulation)
- Prices are to be determined in a way that stimulates efficiency
- To set efficiency factor X, the Energy Agency plans to use benchmarking
- Main frontier benchmarking methods:

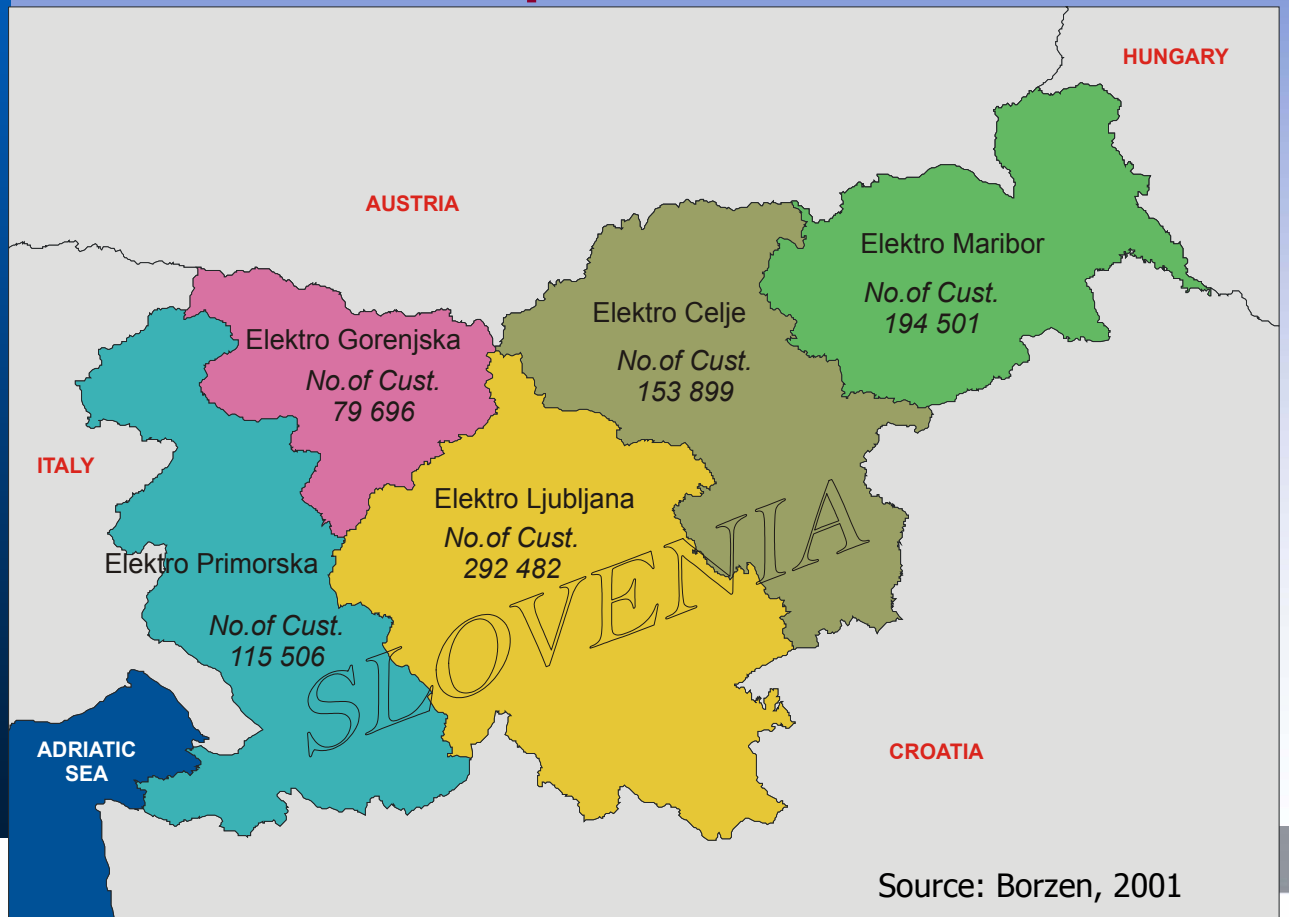
  - DEA (Data Envelopment Analysis) ✓
  - COLS (Corrected OLS)
  - SFA (Stochastic Frontier Analysis)

PRICE REGULATION OF DISTRIBUTION UTILITIES (2)

- Network charge is set to cover:
  - infrastructure network costs (managing, operating maintaining and development of the network)
  - technical losses in the network
- Energy Agency assesses the eligibility of costs and determines required income based on price cap
- Also benchmarking with comparable foreign utilities is used (80% efficiency is required)
- In the first regulatory period: companies have to reduce costs between 4 to 9%

4. BENCHMARKING OF SLOVENIAN DISTRIBUTION COMPANIES

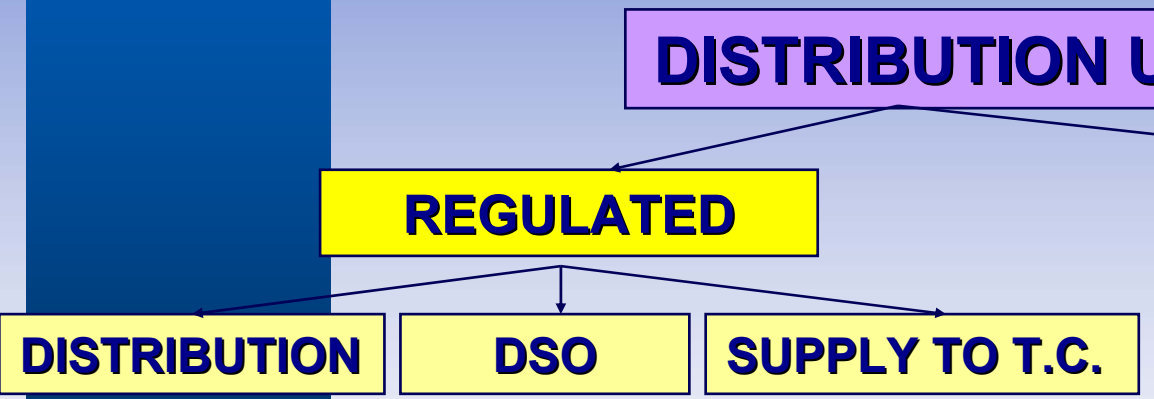
- **5 distribution companies**



Source: Borzen, 2001

SLOVENIAN ELECTRICITY DISTRIBUTION COMPANIES

- Reorganisation of distribution utilities to comply with the EU legislation



- supply to eligible customers
- telecommunications
- engineering
- other non-regulated energy activities

- Distribution companies finished year 2002 with a loss (due to low tariff prices)

Table 1: Selected measures for Slovenian distribution utilities in 2000

Utility	1	2	3	4	5
Labour productivity (MWh/employee)	2,698	1,701	2,215	2,018	1,883
Capital productivity (MWh/MVA)[1]	2,491	1,152	1,069	1,163	1,166
Average cost (€/MWh)	24.7	32.2	27.1	28.1	28.8
Customer density 1 (customer/km)	17.5	13.0	17.5	14.2	10.5
Customer density 2 (customer/km^2)	55.9	48.7	38.1	26.6	33.3
Load factor	0.67	0.60	0.65	0.65	0.64
Share of household customers (%)	89.9	89.7	89.0	86.8	89.0
Share of sales to households (%)	30.1	37.4	32.2	27.8	30.0

Stochastic Frontier Analysis (1)

- Frontier cost function: identifies the minimum costs at a given output level, input prices and existing production technology
- Stochastic cost frontier:

$$C_i \geq c(y_i, w_i; \beta)\, e^{v_i}$$

- Cost inefficiency: deviation from the optimal point on the cost frontier

$$EFF_i = \frac{C_i}{c(y_i, w_i; \beta)\, e^{v_i}} \geq 1$$

$$\rightarrow \quad C_i = c(y_i, w_i; \beta)\, e^{v_i} EFF_i$$

SFA (2)

- Stochastic frontier cost function (single output Cobb-Douglas form for panel data):

$$\ln C_{it} = \beta_0 + \beta_y \ln Y_{it} + \sum_n \beta_n \ln w_{nit} + v_{it} + u_{it} \qquad u_{it} \geq 0$$

u_i – time-invariant cost inefficiency

$\sum_n \beta_n = 1$ (homogeneity of degree 1 in input prices)

- Maximum likelihood estimation

Distribution assumptions:

(i) $v_{it} \sim N(0, \sigma_v^2)$

(ii) $u_i \sim N^+(0, \sigma_u^2)$

(iii) u_i and v_{it} are distributed independently of each other and of the regressors

COST FRONTIER FUNCTION OF ELECTRICITY DISTRIBUTION (1)

- Costs of operating a distribution system:

  costs of building and maintaining the system of service lines, mains and transformers, and costs of measuring and billing electricity

- Factors affecting distribution costs:
  - electricity sold (output)
  - input prices
  - length of distribution line
  - total number of customers served
  - size of the distribution area
  - customer density
  - maximum demand
  - security of supply

COST FRONTIER FUNCTION OF ELECTRICITY DISTRIBUTION (2)

- Data: Panel data set for 5 Slovenian electricity distribution utilities over the 1991-2000 period

- Cost function specification:

$$\ln\left(\frac{C}{P_K}\right) = \alpha_0 + \alpha_y \ln Y + \alpha_{PL} \ln \frac{P_L}{P_K} + \alpha_{CD} \ln CD + \alpha_{LF} \ln LF$$

C – total costs (expenditures for electricity purchased excluded)
P_L – price of labour (average monthly wage)
P_K – price of capital (residual costs divided by transformer capacity)
CD – customer density (customers per km of lines)
LF – load factor (ratio between average and maximum demand)

Table 2: Descriptive statistics

Variable	Description	1. Quartile	Median	3. Quartile
C	Total cost * (in € thousand)	31,579	44,441	65,470
Y	Output (GWh)	963.5	1,374.9	1,576.1
P_L	Price of labour * (€/employee)	742.4	808.1	890.6
P_K	Price of capital (€/kVA)	15.01	17.05	20.65
CD	Customer density (customer/km)	12.93	13.74	17.50
LF	Load factor	0.6075	0.6226	0.6434

* Constant 2000 prices

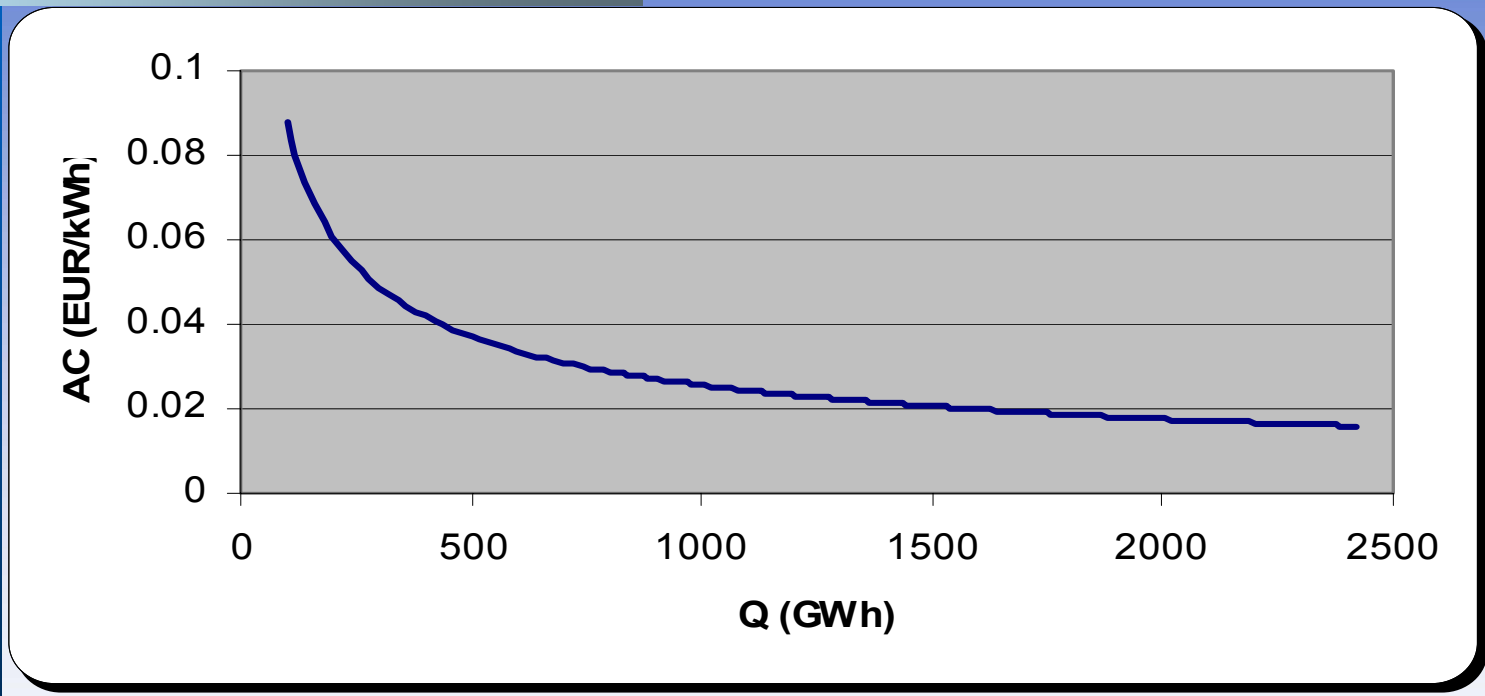
RESULTS

Table 3: Parameter estimates

	Coefficient (a)	t-Value
Constant	3.650***	3.232
Ln Q	0.462***	9.300
Ln PL	0.625***	10.987
Ln CD	-0.562***	3.163
Ln LF	-0.352	-0.428
σ^2 (v)	0.022	
σ^2 (u)	0.158	
Log-likelihood function	18.623	

(a)***: significant at 0.1%

Figure 1: Scale expansion path of AC



- Presence of increasing returns to scale
- Most of the distribution utilities do not reach the minimum efficient scale

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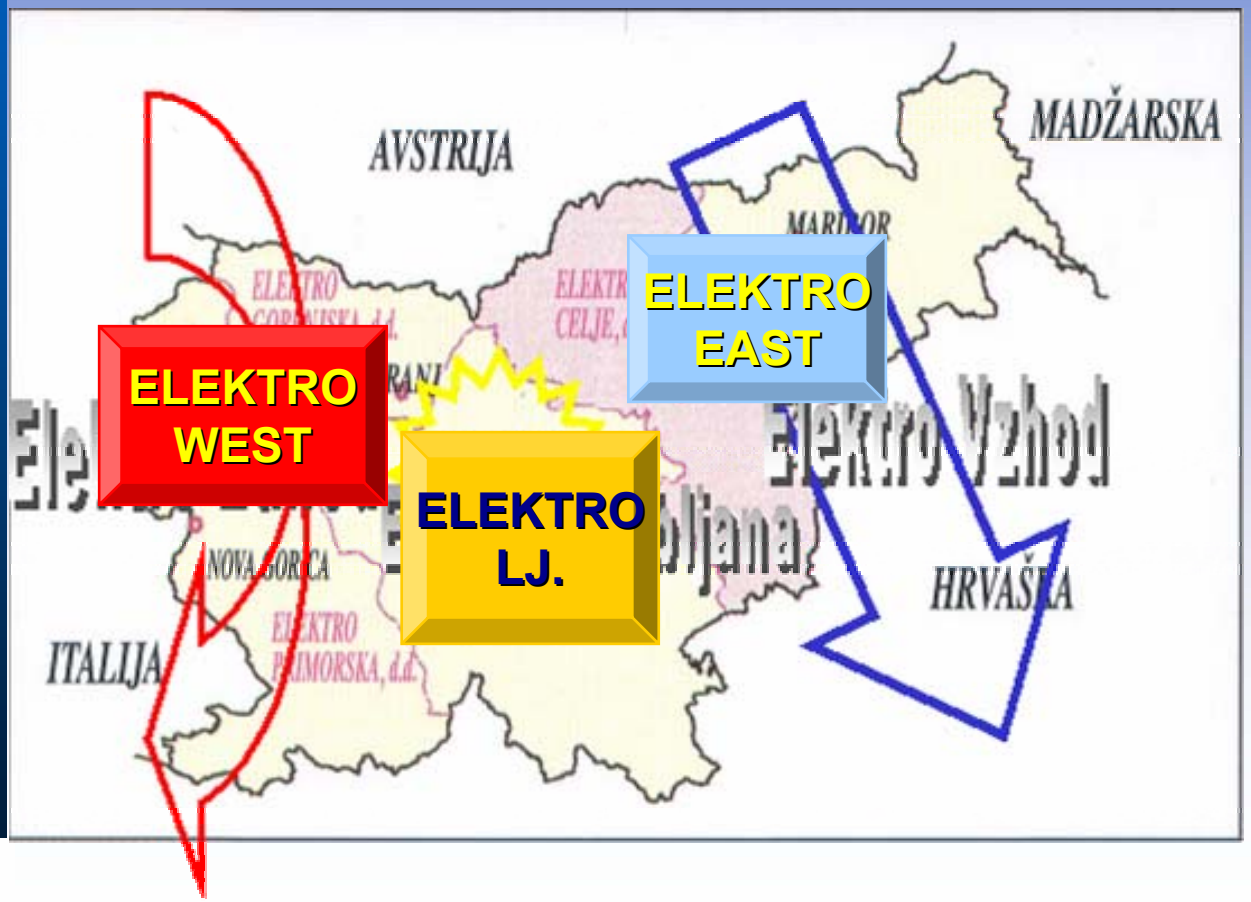
REORGANISATION OF ELECTRICITY DISTRIBUTION COMPANIES

- 3 companies (Study by Tajnikar et al. 2002)



5. INEFFICIENCY ESTIMATES

- Cost inefficiency: the ratio of actual costs to the efficient level of costs

$$EFF_i = e^{u_i} \geq 1$$

- Alternatively, cost efficiency: $EF_i = e^{-u_i} \leq 1$

Table 4: Inefficiency scores (EFF)

	Min	Average	Max
EFF	1.04	1.35	2.25

LIMITATIONS OF THE STUDY

- Small sample size (due to the small number of utilities operating in the sector):
  - limitations wrt number of variables included in the model
  - limitations wrt functional form chosen
- Possible extensions and improvements:
  - Applying non-parametric benchmarking techniques (DEA)
  - International benchmarking

CONCLUSIONS

- Benchmarking analysis can be used to estimate inefficiency of utilities and thus establish a larger informational basis for more effective price-cap regulation.
- Mean cost inefficiency of Slovenian electricity distribution utilities is estimated to be 35%.
- Results should be used with caution and not in a mechanical way since they can be influenced by the model specification, functional form and econometric approach.
- Presence of economies of scale also indicates potential for cost savings by merging smaller utilities.