

**NP «MARKET COUNCIL»
EDUCATION CENTRE**

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Benchmarking of electricity distribution companies in ERRA member countries

ERRA VIDEO TRAINING PROGRAM

Presentation contains:

- ✓ **The theoretical approaches for different benchmarking techniques which can be applied for distribution companies**
- ✓ **Practical example**
- ✓ **Overview of comparative results from applying different benchmarking techniques**
- ✓ **Conclusions**

Two prevailing models of regulation - Cost plus and Incentive regulation

- ✓ **Cost plus - price which enables a return on justified operating costs, depreciation as well as a return on assets employed.**

The basic goal of this method is to identify and guarantee a certain profit.

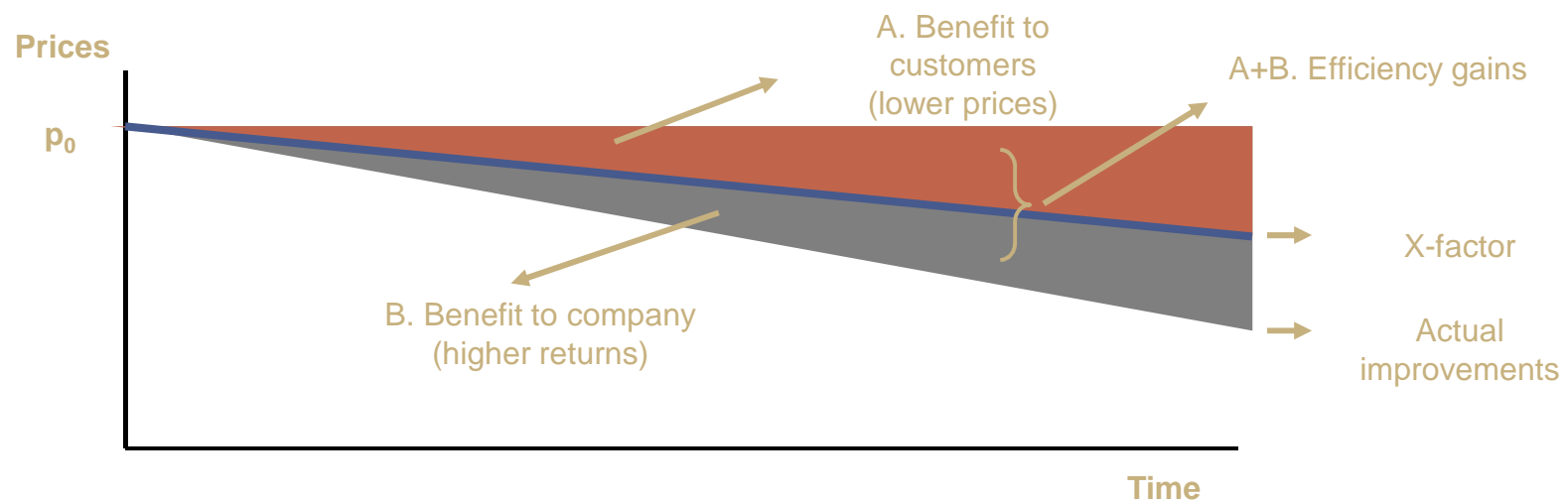
- ✓ **Incentive methods – introduce incentives for operational efficiency improvements in the pricing models.**

These methods are based on the performance of each individual distribution company. Performances are determined by applying benchmarking techniques.

General formula which provide incentives to increase inefficiency would be:

$$P_t = (1 + CPI - X_t) * P_{t-1}$$

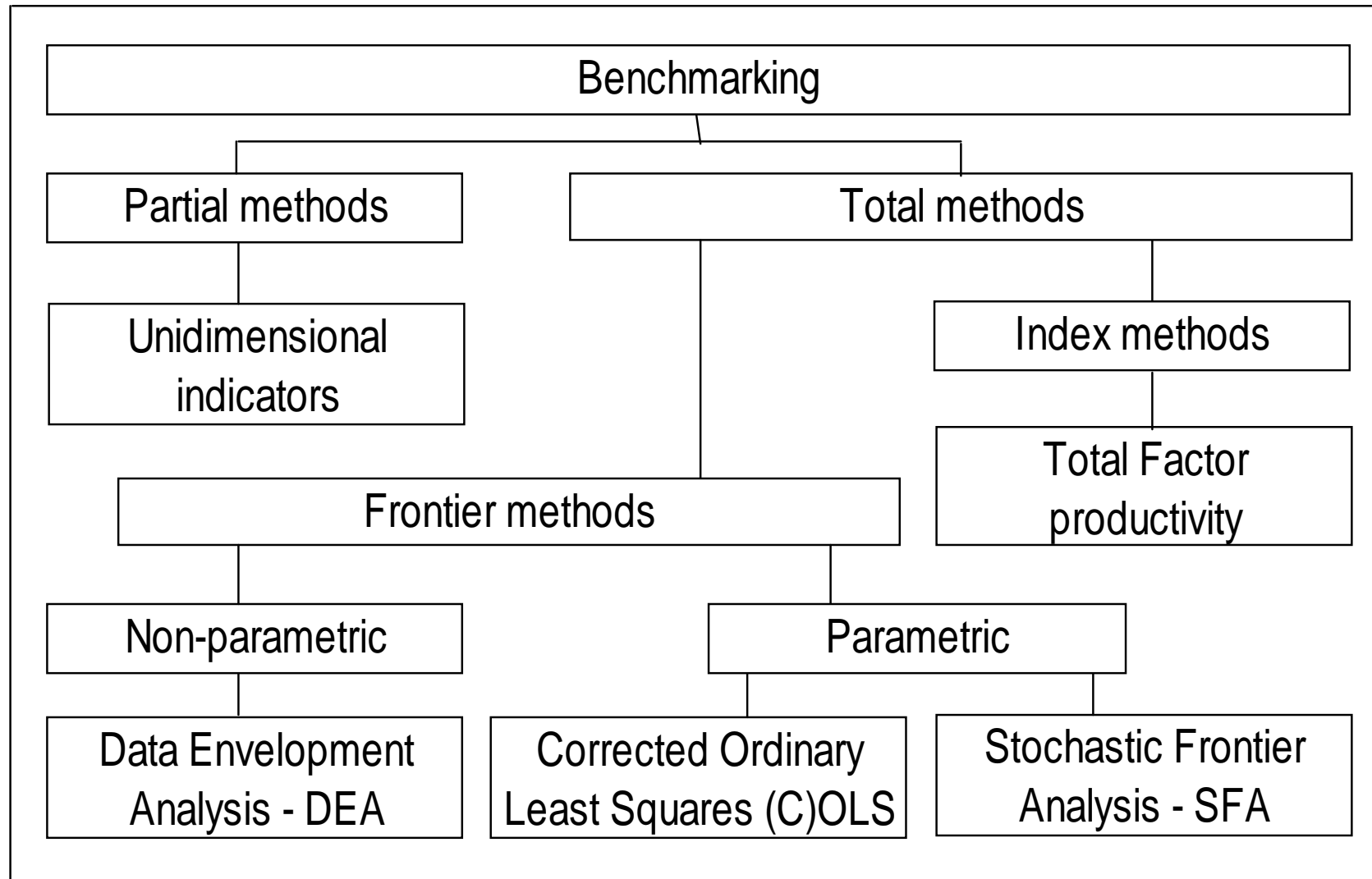
By this formula, approved revenue (or price) for the distribution company in year t (Pt) is equal to the income from the previous year (Pt-1) increased by the planned inflation (CPI) and less the incentive factor (X) which is determined on the basis of results obtained by benchmarking.



Benchmarking identifies the most efficient companies in the sample and measures the relative performance of less efficient companies against a reference performance.

Benchmarking is a multi-step process for comparison of distribution companies in the following steps:

- ✓ **Selection of a sample of appropriate companies**
- ✓ **Determination of input/output data which will be analysed**
- ✓ **Identification of the most efficient companies in the sector (in the sample)**
- ✓ **Determination of the efficiency frontier (reference value)**
- ✓ **Measurement of the relative inefficiency of other companies against the referent value**
- ✓ **Assignment of individual incentive factor X on MAR (Maximum Allowed Revenue) to the companies**



Uni-dimensional indicators:

- ✓ **Distributed energy / employee**
- ✓ **Distributed energy / number of customers**
- ✓ **OPEX / employee**
- ✓ **OPEX / length of lines**

They appear in annual reports of companies.

They are easy to calculate and interpret.

A firm that performs well on one measure may do badly on another, while one firm may do reasonably well on all measures, but not be the most efficient on any.

There are no unique approach for:

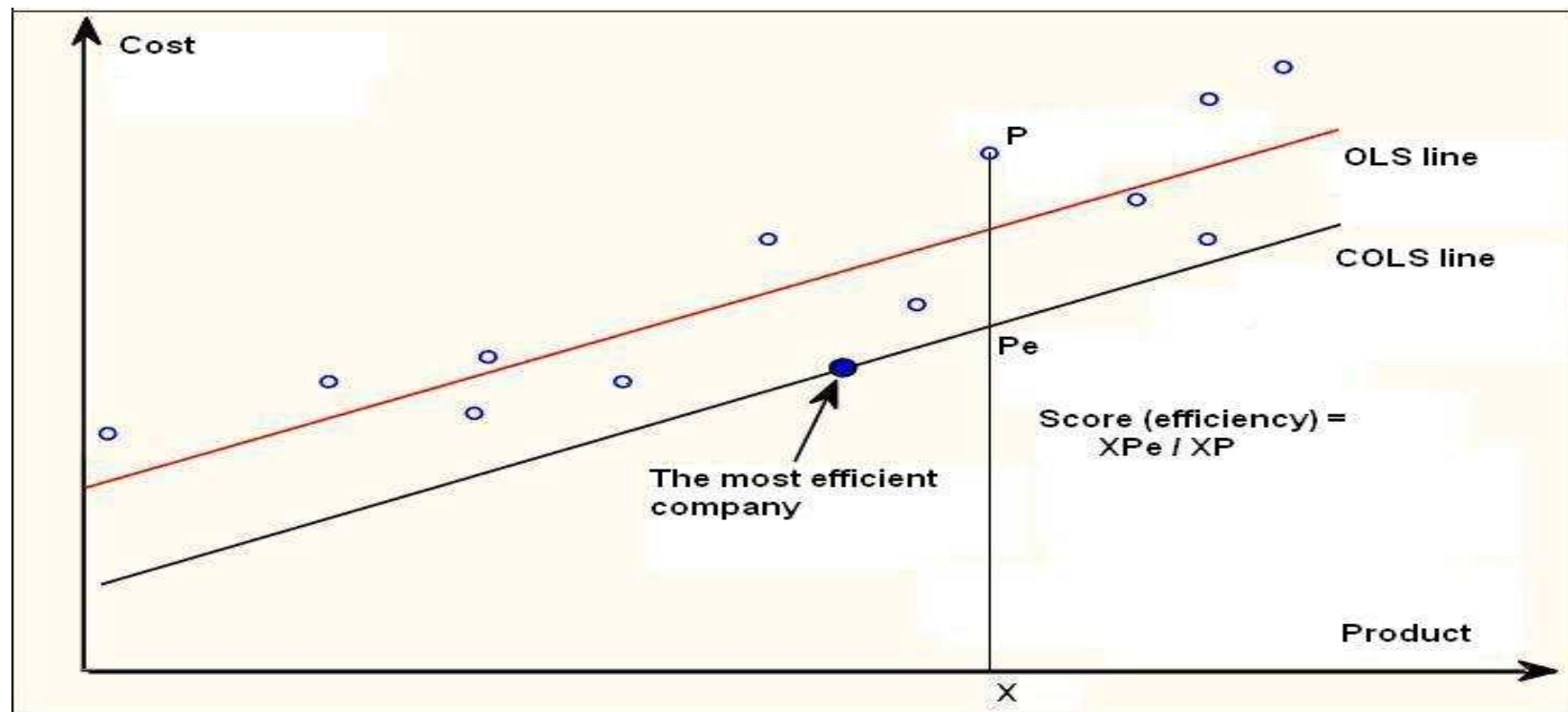
- ✓ selecting the observed indicators and
- ✓ determining weighting factors for each observed indicator

| Company | A | B |
|---|-------|---------------------|
| Uni-dimensional indicators | | |
| Employees / Users of the system (in 000) | 10 | 6 |
| Costs / Distributed energy (mil.din/kWh) | 3 | 8 |
| Weights | | Combined indicators |
| case 1: | 25/75 | 4.75 |
| case 2: | 50/50 | 6.50 |
| case 3: | 75/25 | 8.25 |

Statistical method of regression analysis

Reference line shows the average cost for each input unit of product

Corrected reference line is determined for the company that has the best ratio of costs per unit of electricity distributed



DEA is a non parametric method based on linear programming technique

Maximization of operational efficiency of company

- ✓ **Technical efficiency reflects the ability of a company to achieve maximum production output from a given combination of inputs (labor, capital) and**
- ✓ **Allocative efficiency reflects the ability of company to use inputs (labor, capital) in optimal proportions taking into account their relative prices.**

This method provides the possibility of using a large number of input / output data

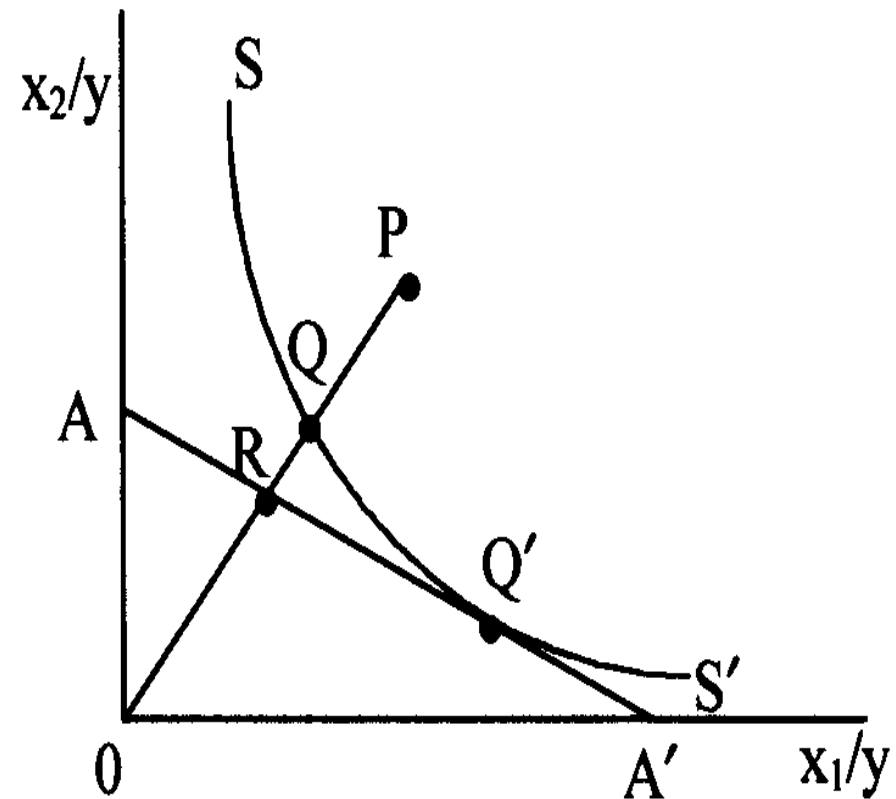
Input orientated model uses two inputs to produce a single output

Output orientated model uses two outputs and one input

$$TE_i = OQ/OP$$

$$AE_i = OR/OQ$$

$$OE_i = TE_i * AE_i = OR/OP$$



When applying benchmarking, it is necessary to take into account:

Size and structure of the observed sample

The sample should be as large as possible

It is desirable that the sample consists of companies that operate in the same region, which are approximately the same size, operate in a similar legal and economic environment

Which type of data is used for comparison

Operating costs and technical data

Quality of data

Published data from official financial reports

Choice of methods

To apply at least two different approaches

Three benchmarking methods have been applied:

- ✓ **Partial indicators** - combined indicator was calculated by applying the weighted average (weights of 50%) to uni-dimensional indicators: distributed energy / operating costs and the number of users / operating costs.
- ✓ **COLS** - value of operating costs was used as the dependent variable, and the weighted average data on the distributed energy and number of users as the independent variable, with selected weighted factors of 50%.
- ✓ **DEA** - operating costs were used as input data, and data on the distributed energy and number of users were used as output data.

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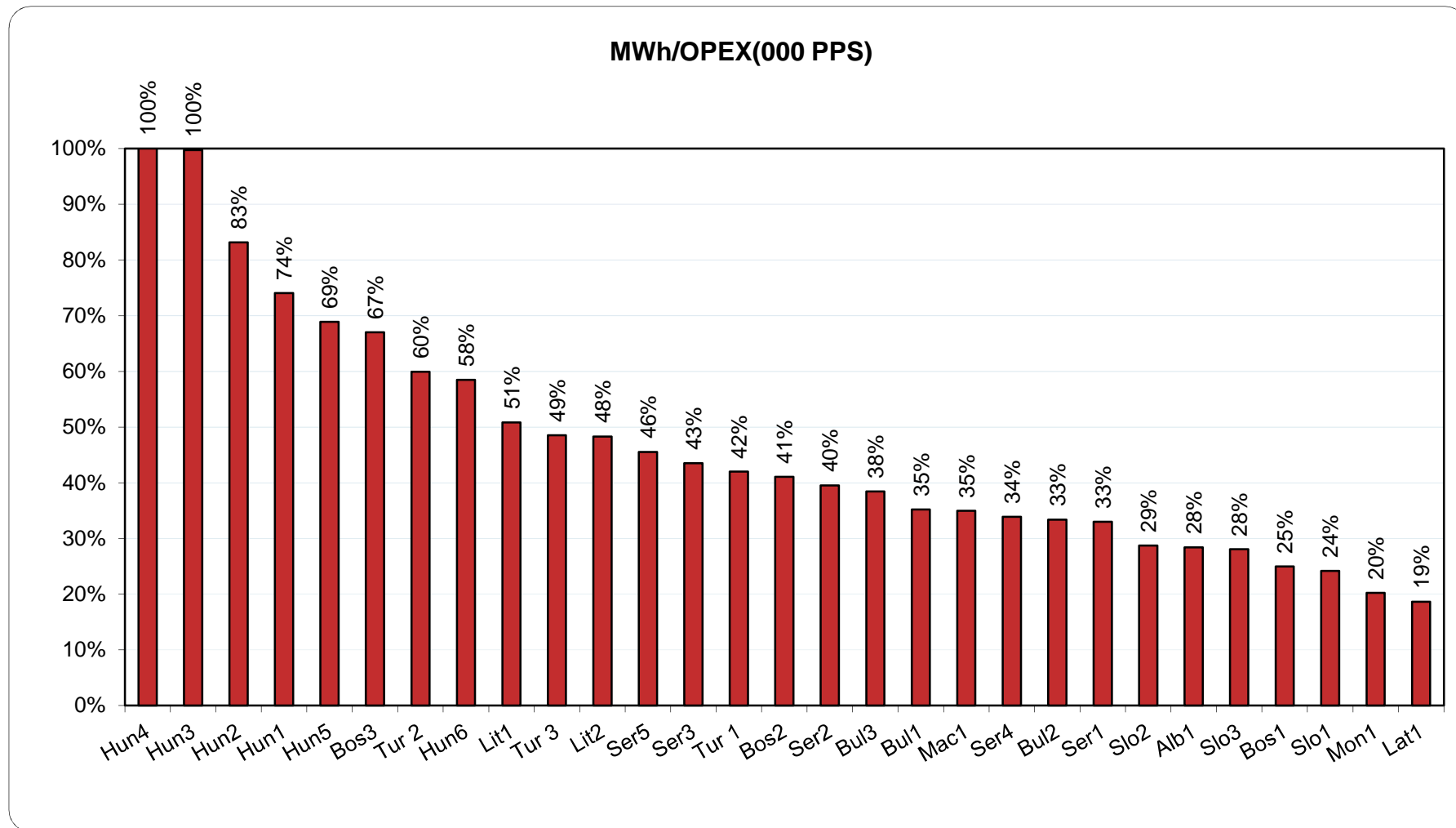
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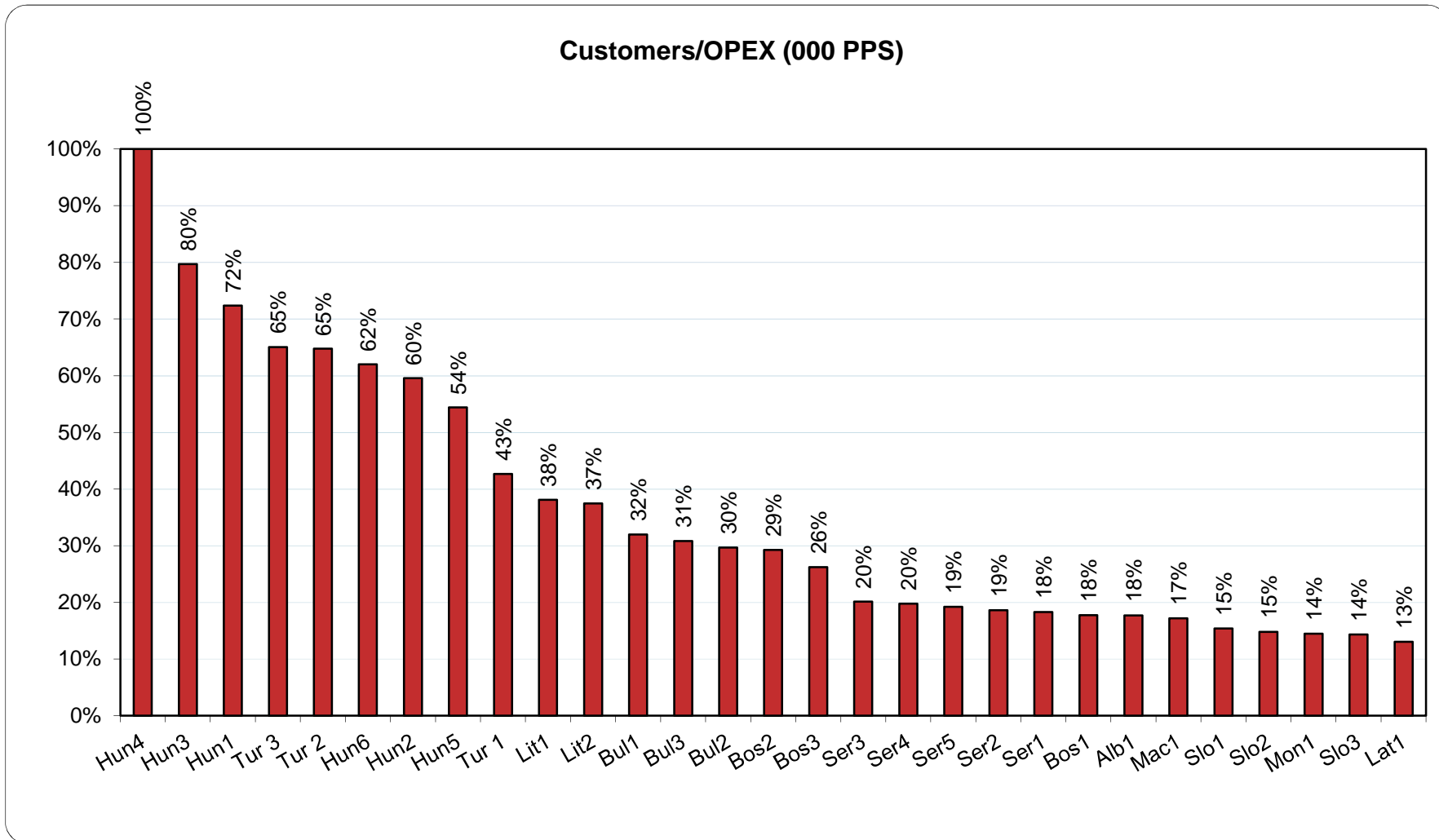
Example - Data

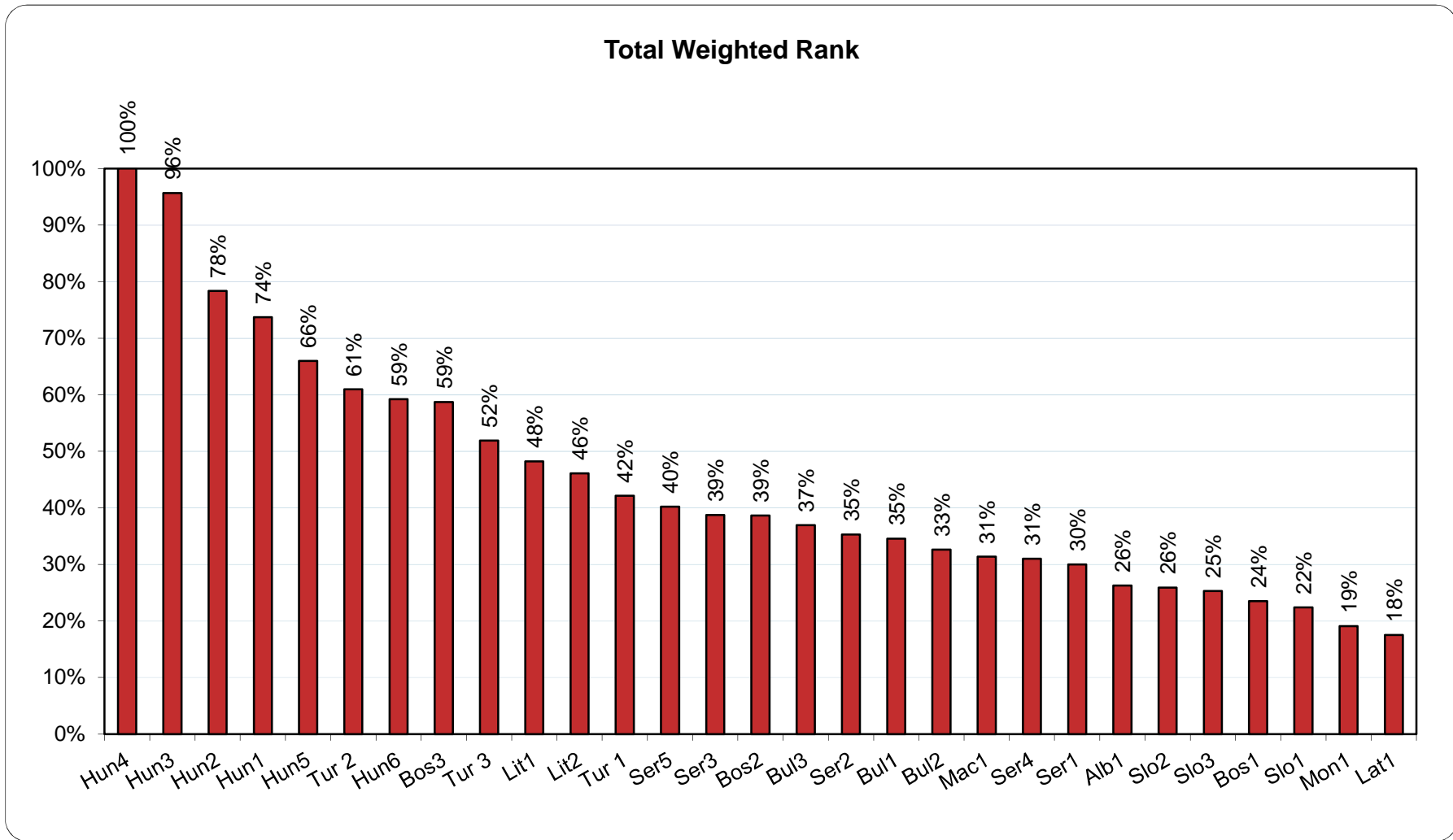
DATA VALIDATION - ADJUSTED DATA (Data for 2009)

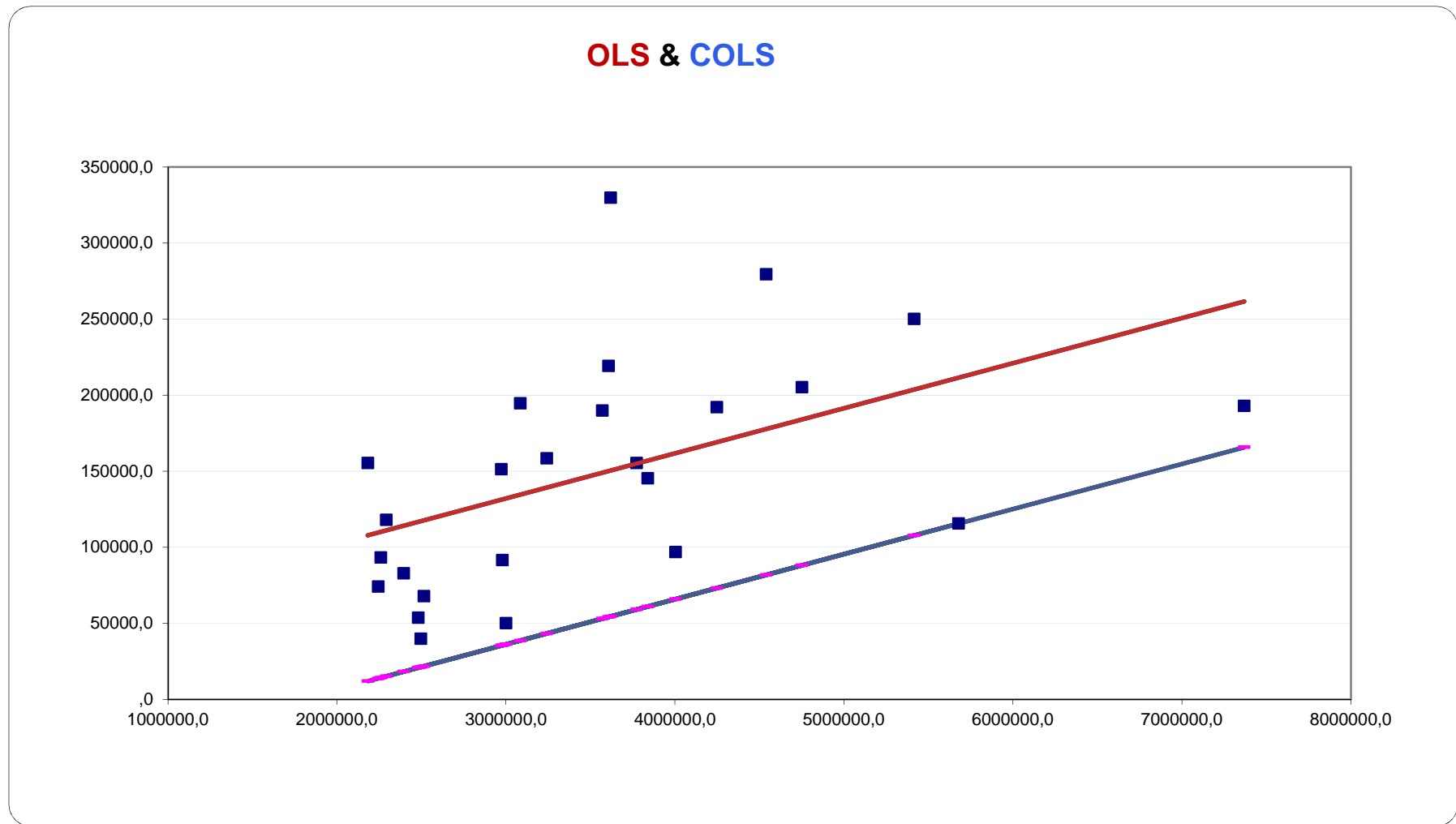
| Ordinal number | Country | Country Codes | Ownership Status x) | Method of Regulation y) | Served Area (sq. km) | Total length of Lines (km) | Total Electricity Distributed (MWh) | Total number of consumers connected | Employees | O&M Costs (000 US\$) | O&M Costs (000 PPS) |
|----------------|-------------|---------------|---------------------|-------------------------|----------------------|----------------------------|-------------------------------------|-------------------------------------|-----------|----------------------|---------------------|
| 1 | Albania | Alb1 | 1 | 0 | 28.000 | 42.768 | 6.223.000 | 990.831 | 6.700 | 179.132 | 219.244 |
| 2 | Serbia 1 | Ser1 | 1 | 0 | 25.211 | 58.737 | 6.255.954 | 885.438 | 2.653 | 127.063 | 189.866 |
| 3 | Serbia 2 | Ser2 | 1 | 0 | 21.500 | 25.261 | 7.583.166 | 911.633 | 2.191 | 128.507 | 192.023 |
| 4 | Serbia 3 | Ser3 | 1 | 0 | 2.838 | 16.138 | 6.747.211 | 797.658 | 1.522 | 103.950 | 155.329 |
| 5 | Serbia 4 | Ser4 | 1 | 0 | 22.029 | 33.059 | 3.989.499 | 595.376 | 1.680 | 78.918 | 117.924 |
| 6 | Serbia 5 | Ser5 | 1 | 0 | 6.120 | 14.647 | 2.582.647 | 278.288 | 686 | 37.994 | 56.772 |
| 5 | Lithuania 1 | Lit1 | 0&1 | 1 | 30.378 | 57.326 | 3.766.010 | 721.504 | 1.353 | 74.284 | 74.200 |
| 6 | Lithuania 2 | Lit2 | 0 | 1 | 34.700 | 63.510 | 3.998.162 | 792.518 | 1.772 | 82.945 | 82.851 |
| 7 | Latvia | Lat1 | 1 | 0 | 63.943 | 103.850 | 6.142.599 | 1.096.585 | 2.656 | 351.869 | 329.777 |
| 8 | Macedonia | Mac1 | 0 | 1 | 25.000 | 23.226 | 5.282.084 | 664.390 | 3.059 | 101.637 | 151.291 |
| 9 | Bulgaria 1 | Bul1 | 0&1 | 1 | 40.000 | 54.758 | 8.789.369 | 2.040.635 | 2.693 | 211.829 | 250.098 |
| 10 | Bulgaria 2 | Bul2 | 0&1 | 1 | 29.617 | 41.804 | 5.281.446 | 1.200.700 | 1.496 | 134.259 | 158.514 |
| 11 | Bulgaria 3 | Bul3 | 0&1 | 1 | 42.745 | 55.375 | 7.886.138 | 1.616.220 | 2.975 | 173.461 | 205.279 |
| 12 | Hungary 1 | Hun1 | 0 | 1 | 18.235 | 31.749 | 3.971.291 | 992.202 | 128 | 61.813 | 53.696 |
| 13 | Hungary 2 | Hun2 | 0 | 1 | 4.134 | 23.124 | 9.597.655 | 1.757.733 | 226 | 133.048 | 115.578 |
| 14 | Hungary 3 | Hun3 | 0 | 1 | 15.509 | 22.237 | 4.982.282 | 1.018.282 | 125 | 57.602 | 50.039 |
| 15 | Hungary 4 | Hun4 | 0 | 1 | 18.472 | 25.376 | 3.976.189 | 1.016.685 | 453 | 45.837 | 39.818 |
| 16 | Hungary 5 | Hun5 | 0 | 1 | 18.223 | 30.741 | 6.661.164 | 1.344.486 | 506 | 111.420 | 96.789 |
| 17 | Hungary 6 | Hun6 | 0 | 1 | 18.728 | 25.555 | 3.957.522 | 1.072.244 | 390 | 77.991 | 67.750 |
| 18 | Slovakia 1 | Slo1 | 0&1 | 1 | 15.746 | 20.611 | 3.755.307 | 609.554 | 88 | 230.521 | 155.436 |
| 19 | Slovakia 2 | Slo2 | 0 | 1 | 14.928 | 35.986 | 8.022.142 | 1.055.934 | 83 | 414.388 | 279.414 |
| 20 | Slovakia 3 | Slo3 | 0 | 1 | 17.978 | 32.701 | 5.458.205 | 711.749 | 176 | 288.669 | 194.644 |
| 21 | Turkey 1 | Tur 1 | 0 | 1 | 77.393 | 62.114 | 6.094.727 | 1.582.666 | 2.601 | 162.978 | 145.317 |
| 22 | Turkey 2 | Tur 2 | 0 | 1 | 60.382 | 95.271 | 11.547.028 | 3.190.095 | 4.195 | 216.304 | 192.864 |
| 23 | Turkey 3 | Tur 3 | 0 | 1 | 39.782 | 75.437 | 4.437.161 | 1.521.183 | 2.129 | 102.698 | 91.570 |
| 24 | Bosnia 1 | Bos1 | 0&1 | 0 | 3.697 | 10.553 | 562.152 | 102.107 | 557 | 20.596 | 22.541 |
| 25 | Bosnia 2 | Bos2 | 0&1 | 0 | 16.754 | 33.435 | 3.822.559 | 695.833 | 2.414 | 85.166 | 93.211 |
| 26 | Bosnia 3 | Bos3 | 0&1 | 0 | 9.356 | 11.618 | 1.852.489 | 185.196 | 1.130 | 25.284 | 27.673 |
| 27 | Montenegro | Mon1 | 1 | 0 | 13.812 | 18.964 | 1.924.600 | 351.719 | 1.559 | 85.616 | 95.139 |

Notes: x) 0 - Private, 1 - State owned; y) 0 - Cost based, 1 - Incentive
Weighted factor: 50% MWh/Opex(000 PPS) and 50% Customers/Opex(000 PPS)

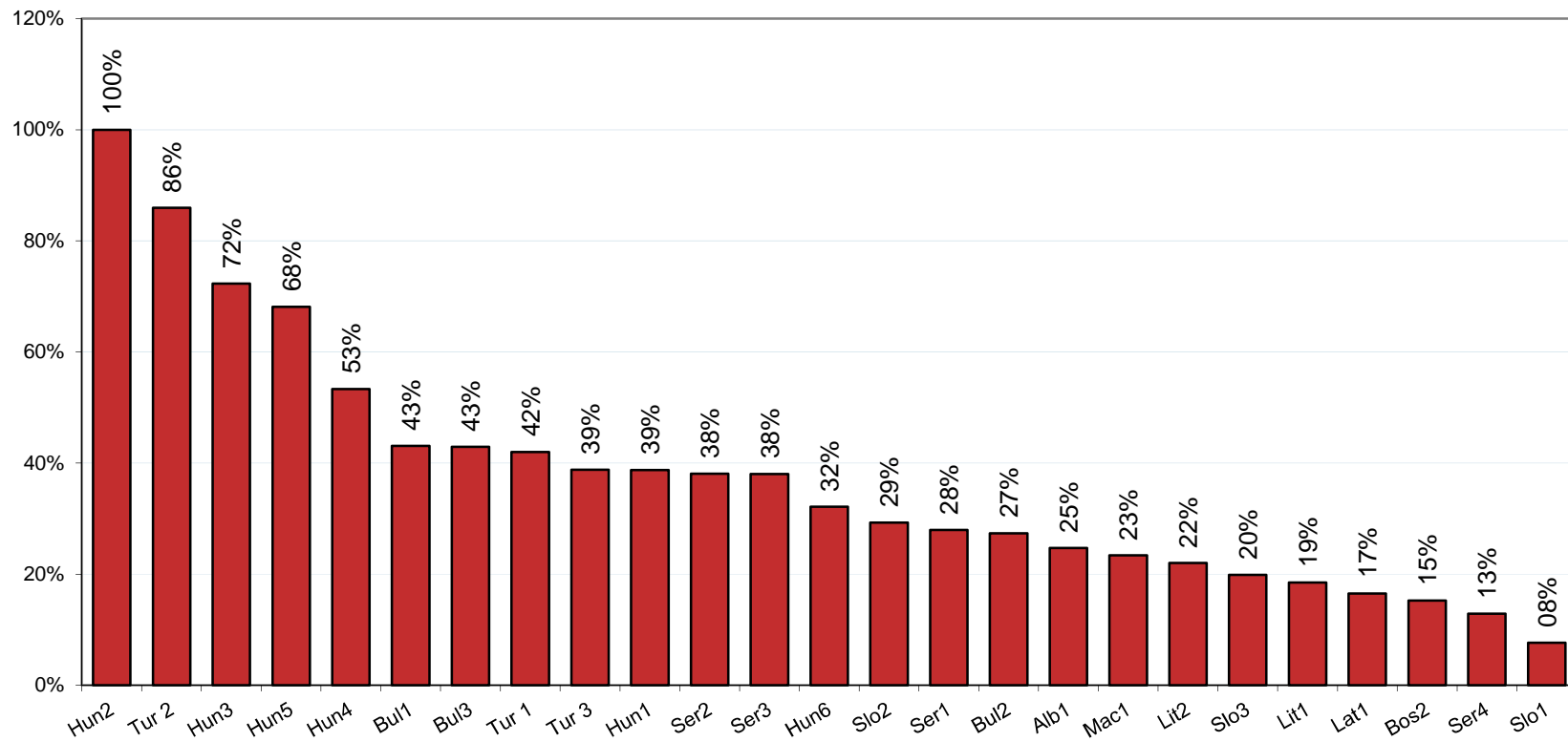




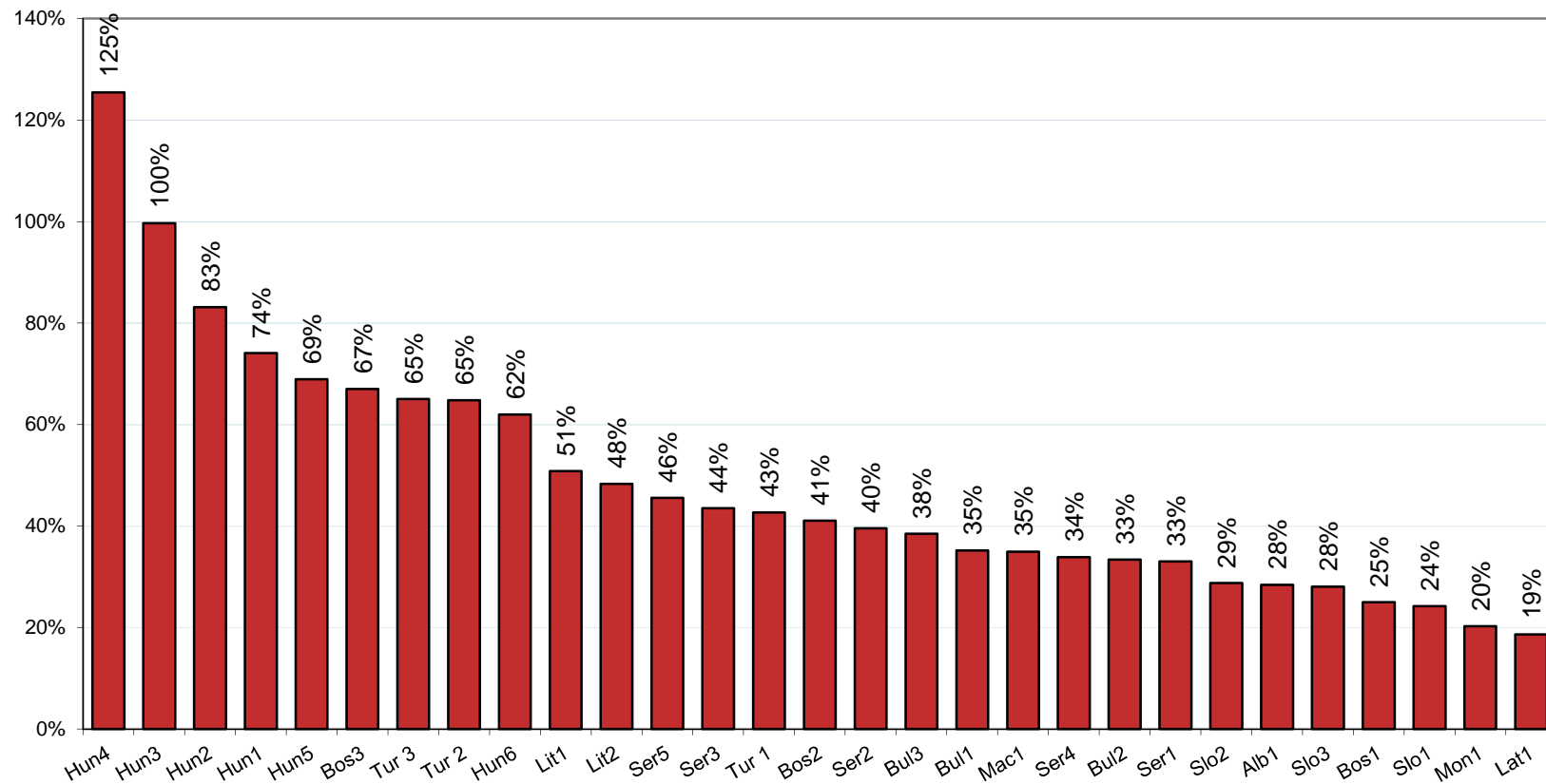




Ranking using COLS



Ranking using DEA



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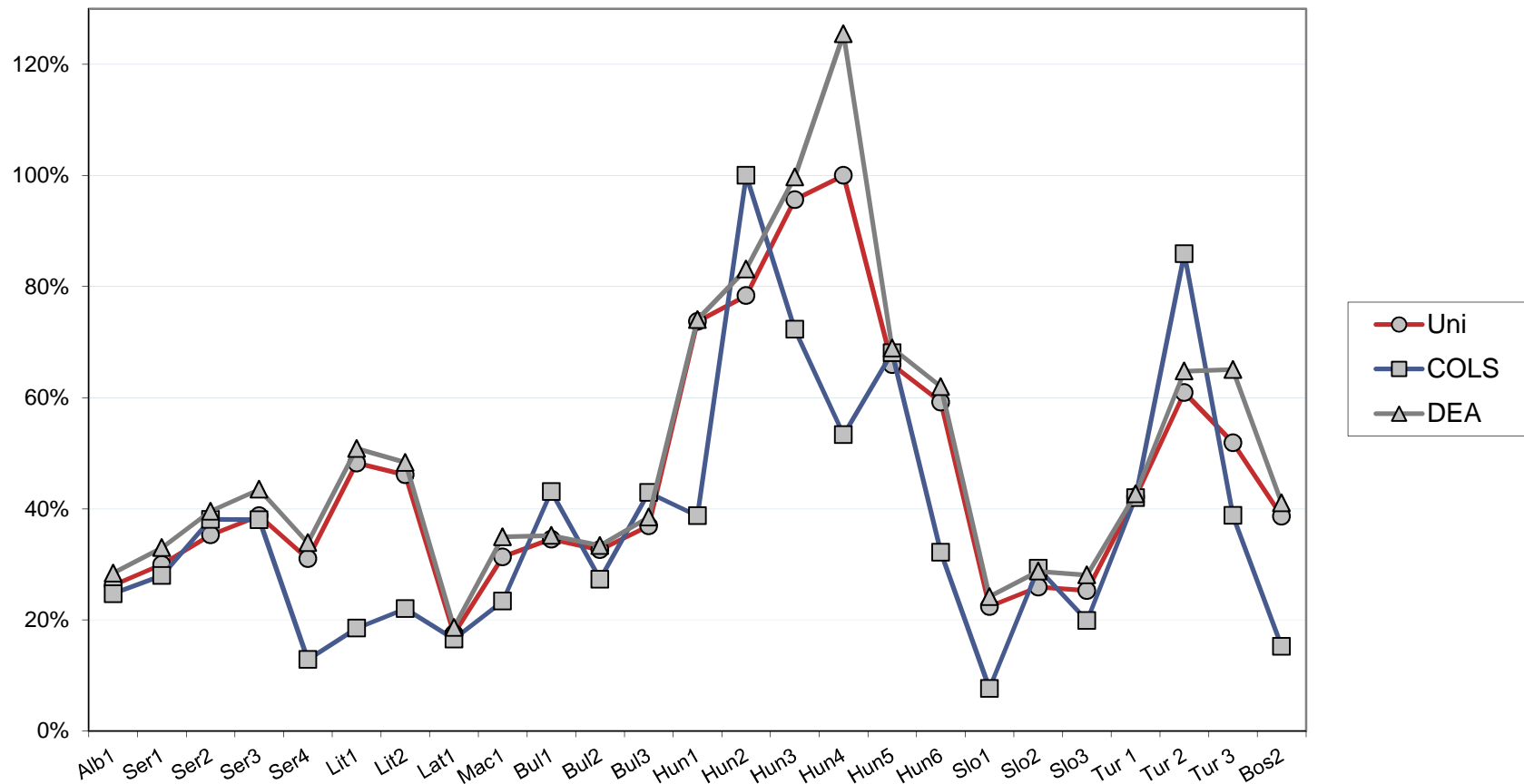
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Example – Ranking using all methods

| Uni-dimensional _{x)} | | COLS | | DEA | |
|-------------------------------|---------|-------|---------|-------|---------|
| Rank | Score | Rank | Score | Rank | Score |
| Hun4 | 100,00% | Hun2 | 100,00% | Hun4 | 125,47% |
| Hun3 | 95,63% | Tur 2 | 85,93% | Hun3 | 99,71% |
| Hun2 | 78,35% | Hun3 | 72,29% | Hun2 | 83,16% |
| Hun1 | 73,72% | Hun5 | 68,09% | Hun1 | 74,06% |
| Hun5 | 65,96% | Hun4 | 53,32% | Hun5 | 68,92% |
| Tur 2 | 60,94% | Bul1 | 43,10% | Bos3 | 67,04% |
| Hun6 | 59,21% | Bul3 | 42,92% | Tur 3 | 65,06% |
| Bos3 | 58,72% | Tur 1 | 42,00% | Tur 2 | 64,78% |
| Tur 3 | 51,89% | Tur 3 | 38,82% | Hun6 | 61,98% |
| Lit1 | 48,23% | Hun1 | 38,73% | Lit1 | 50,83% |
| Lit2 | 46,11% | Ser2 | 38,10% | Lit2 | 48,33% |
| Tur 1 | 42,13% | Ser3 | 38,03% | Ser5 | 45,56% |
| Ser5 | 40,19% | Hun6 | 32,15% | Ser3 | 43,50% |
| Ser3 | 38,74% | Slo2 | 29,28% | Tur 1 | 42,65% |
| Bos2 | 38,66% | Ser1 | 27,96% | Bos2 | 41,07% |
| Bul3 | 36,92% | Bul2 | 27,33% | Ser2 | 39,55% |
| Ser2 | 35,28% | Alb1 | 24,71% | Bul3 | 38,47% |
| Bul1 | 34,53% | Mac1 | 23,38% | Bul1 | 35,19% |
| Bul2 | 32,61% | Lit2 | 22,01% | Mac1 | 34,96% |
| Mac1 | 31,35% | Slo3 | 19,88% | Ser4 | 33,88% |
| Ser4 | 31,01% | Lit1 | 18,52% | Bul2 | 33,37% |
| Ser1 | 30,00% | Lat1 | 16,54% | Ser1 | 33,00% |
| Alb1 | 26,24% | Bos2 | 15,23% | Slo2 | 28,75% |
| Slo2 | 25,91% | Ser4 | 12,87% | Alb1 | 28,42% |
| Slo3 | 25,28% | Slo1 | 7,67% | Slo3 | 28,08% |
| Bos1 | 23,50% | | | Bos1 | 24,97% |
| Slo1 | 22,39% | | | Slo1 | 24,19% |
| Mon1 | 19,08% | | | Mon1 | 20,26% |
| Lat1 | 17,51% | | | Lat1 | 18,65% |

Note: x) Weighted factor: 50% MWh/Opex and 50% Customers/Opex

Ranking using all methods



- ✓ **The results obtained from distribution companies' efficiency benchmarking can be of great importance for both the Regulator and the distribution companies.**
- ✓ **Basis for assignation of individual incentive X - factors to the distribution companies in ERRA member countries**
- ✓ **Indicators to point out companies' performance inefficiencies.**
- ✓ **Implementation of incentive regulation methods enhance the operational efficiency of companies, resulting in lower prices for distribution service users, as well as in more opportunities for the companies to earn profit by efficiency improvements.**
- ✓ **All 3 methods used - results have shown a relatively high degree of correlation.**