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P20

SODO
SISTEMSKI OPERATER DISTRIBUCIJSKEGA OMREŽJA Z ELEKTRIČNO ENERGIJO

Monte Carlo method for pricing forecasting errors

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IMBALANCE EXPENSES VERSUS ACCURACY COST

Sign of the imbalance volume W_o	Net financial value to the company	Interpretation of balancing transaction (Z)	Interpretation of accuracy costs (S)
Negative: long position	**Formulae**	$W_o < 0: \ Z = C_- \cdot W_o$	$W_o < 0: \ S = (C_- - C_0) \cdot W_o$
	Positive: revenue or profit?	The excessively contracted energy was sold on the market. The money received is the revenue from selling overstocked goods.	The long position of the company was different from the position of the market and contributed to the balance. The amount constitutes profit from selling at a price higher than purchasing price.
	Negative: expenses or loss?	Someone was paid to consume excessively contracted energy. The money paid is the payment for purchasing the demand on the market.	The excessively contracted energy was sold on the market at a price lower than the purchase price (possibly negative, i.e. the demand being purchased). The positive value is the loss generated in the process.
Positive: short position	**Formulae**	$W_o > 0: \ Z = C_+ \cdot W_o$	$W_o > 0: \ S = (C_+ - C_0) \cdot W_o$
	Positive: revenue or profit?	The insufficiently contracted energy generated demand that was bought on the market. The money received is the revenue from selling demand missing on the market.	The insufficiently contracted energy was purchased at a price lower than the original purchasing price. The amount presents opportunity profit for purchasing the energy at a lower price compared to the original purchase.
	Negative: expenses or loss?	The insufficiently contracted energy was purchased on the market. The money paid is the payment for purchasing this energy.	The insufficiently contracted energy was purchased later at a greater cost. The amount presents net loss for purchasing the energy at a greater price compared to the original purchase.

INPUT TIME SERIES

W_g – actual consumption [MWh]

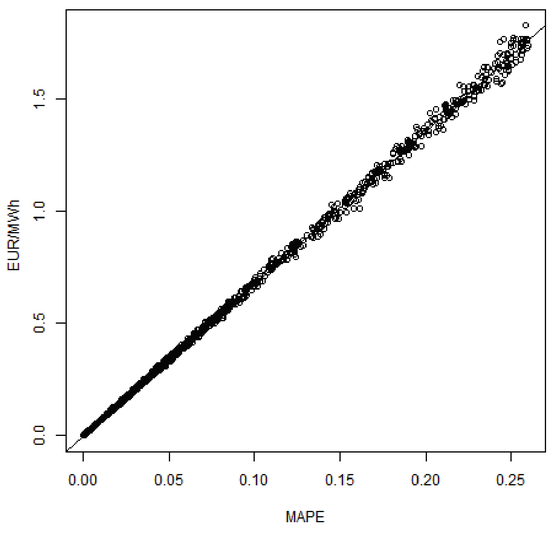
W_f – predicted consumption [MWh]

C_0 – price of purchased energy [€/MWh]

C_+ – price for positive imbalances [€/MWh]

C_- – price for negative imbalances [€/MWh]

COMPUTATION

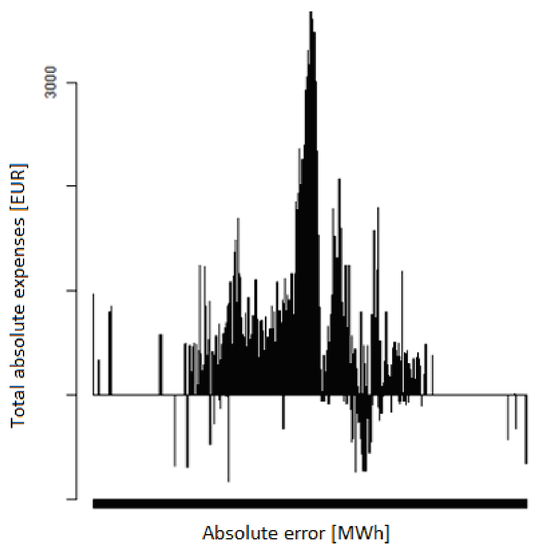


Dependence of the accuracy costs on MAPE for a particular energy usage time series: relative costs in EUR/MWh (right).

ACCURACY COSTS

Absolute coefficient [€/year]		Relative coefficient [c€/MWh]	
Coefficient	**39.054**	**Coefficient**	**6,76**
Std. error	47,65	**Std. error**	0,00828

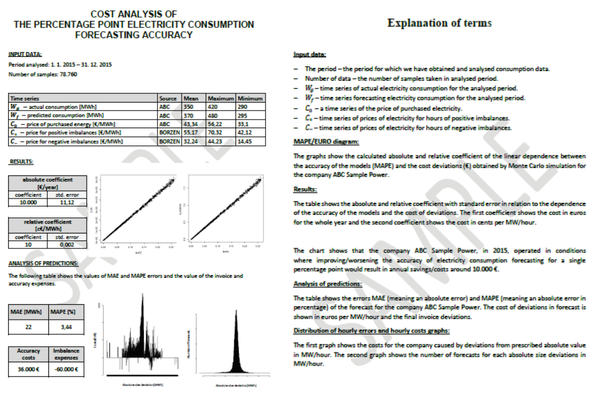
ERROR DISTRIBUTIONS



Distribution of total absolute expenses [EUR] realized at specific absolute error [MWh] of forecasts.

APPLICATIONS

Cost-benefit analysis of forecasting accuracy models and technologies (sample) for your electricity consumption time series


COST ANALYSIS OF
THE PERCENTAGE POINT ELECTRICITY CONSUMPTION
FORECASTING ACCURACY

INPUT DATA:

Period analysed: 1. 1. 2015 – 31. 12. 2015
Number of samples: 78.760

Time series	Source	Mean	Maximum	Minimum
W_g – actual consumption [MWh]	ABC	350	420	290
W_f – predicted consumption [MWh]	ABC	370	480	295
C_0 – price of purchased energy [€/MWh]	ABC	83.34	56.22	33.1
C_+ – price for positive imbalances [€/MWh]	BORZEN	55.27	70.32	42.12
C_- – price for negative imbalances [€/MWh]	BORZEN	32.24	44.23	14.45

RESULTS:

absolute coefficient [€/year]	
coefficient	std. error
10.000	11,12

relative coefficient [€/MWh]	
coefficient	std. error
10	0,002

ANALYSIS OF PREDICTIONS:

The following table shows the values of MAE and MAPE errors and the value of the invoice and accuracy expenses.

MAE [MWh]	MAPE [%]
22	3,44

Accuracy costs	Imbalance expenses
36.000 €	-60.000 €

Explanation of terms

Input data:

- The period – the period for which we have obtained and analysed consumption data.
- Number of data – the number of samples taken in analysed period.
- W_g – time series of actual electricity consumption for the analysed period.
- W_f – time series forecasting electricity consumption for the analysed period.
- C_0 – a time series of the price of purchased electricity.
- C_+ – time series of prices of electricity for hours of positive imbalances.
- C_- – time series of prices of electricity for hours of negative imbalances.

MAPE/EURO diagram:

The graphs show the calculated absolute and relative coefficient of the linear dependence between the accuracy of the models (MAPE) and the cost deviations (€) obtained by Monte Carlo simulation for the company ABC Sample Power.

Results:

The table shows the absolute and relative coefficient with standard error in relation to the dependence of the accuracy of the models and the cost of deviations. The first coefficient shows the cost in euros for the whole year and the second coefficient shows the cost in cents per MW/hour.

The chart shows that the company ABC Sample Power, in 2015, operated in conditions where improving/worsening the accuracy of electricity consumption forecasting for a single percentage point would result in annual savings/costs around 10.000 €.

Analysis of predictions:

The table shows the errors MAE (meaning an absolute error) and MAPE (meaning an absolute error in percentage) of the forecast for the company ABC Sample Power. The cost of deviations in forecast is shown in euros per MW/hour and the final invoice deviations.

Distribution of hourly errors and hourly costs graphs:

The first graph shows the costs for the company caused by deviations from prescribed absolute value in MW/hour. The second graph shows the number of forecasts for each absolute size deviations in MW/hour.

Market size assessment for forecasting accuracy improving technologies, including smart grid solutions (rough estimates, see further research)

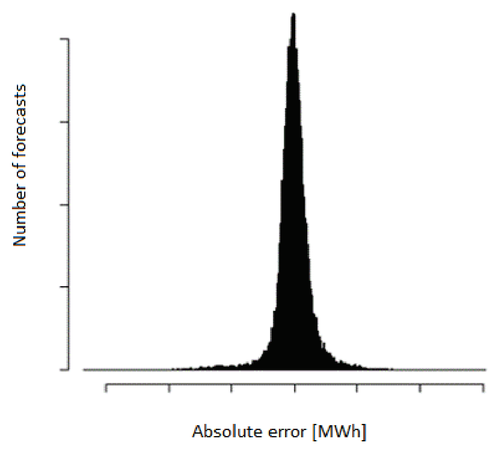
FURTHER RESEARCH

Comparison of imbalance settlement mechanisms according to resulting strength of incentives for accuracy.

Development of market's strength of accuracy incentives indicators and comparison of European electricity markets.

Utility-side cost-benefit analysis of balancing technologies (demand side management, demand response management, etc.)

Assessment of system-wide OVE introduction costs due to higher imbalances .



Distribution of number of forecasts realizing specific absolute error [MWh] of forecasts.

Country	Total consum. [GWh]	Accuracy cost per perc. pt.	Market size per perc. pt. [000 EUR]
Slovenia	14.700	0,07	1.029
Croatia	18.870	0,07	1.321
Hungary	42.570	0,07	2.980
Austria	65.670	0,07	4.597
Italy	307.200	0,07	21.504
Germany	582.500	0,07	40.775