# *ANALYSIS OF ELECTRICITY SOURCES IMPACT ON LITHUANIA'S ELECTRICITY MARKET PRICE*

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**Overview**

With new environmental policies and electricity market liberalization taking place, the energy generation mix is rapidly changing in many countries around the world. Stricter environmental regulations significantly increase electricity generation from renewable energy sources such as wind and solar. As a result, marginal electricity prices are fluctuating, while unfavorable market conditions cause conventional power plants to become less competitive. To develop a sustainable and feasible electricity system, it is important to understand different power sources' impact on electricity market prices. Scholars believe that renewable energy generation will continue to dominate the economics of energy markets in the future. This will create a challenge and need for quantifying the price effects of renewables [1]. It is expected that renewable energy will lead to a reduction in electricity market prices, however, scholarly literature is scarce and there is a need for new research [2].

**Method**

The method of this research consists of three parts: data collection, variables selection, and regression analysis. Research is based on Lithuanian electricity system data. The collected dataset contains two-time series groups: electricity market price and electricity supply from different sources. Electricity market price data is gathered from Nord Pool [3], a Northern Europe electricity exchange market operator where Lithuania is one of the 14 most active power ex-change participants. Electricity supply data from different energy sources is gathered from the ENTSO-E transparency platform [4]. ENTSO-E represents a European network for electricity transmission system operators, where Lithuania is one of the member states. Lithuania receives electrical energy from 7 energy sources: natural gas, hydro pumped storage, run of river, photovoltaic solar, waste fuel, and wind power plants, as well as electricity imports from neighboring countries.

The relation between electricity market prices and power sources is identified using Pearson's correlation formula (1).

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}} \quad (1)$$

In the presented formula, the dependent variable is electricity market price, and the independent variables are the above-listed electricity sources.

Variables that meet correlation requirements, a meaningful correlation with electricity market prices, are selected to be included in the regression. The linear regression model is presented in formula (2).

$$y_j = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_j x_i + \varepsilon_i \quad (2)$$

In the linear regression model, the dependent variable is electricity market price, while independent variables are all previously identified electricity sources. Constant intercept identifies the average electricity market price that would be achieved if all selected independent variables were zero. The coefficient value next to the independent variable shows how much the electricity price would change if the average monthly generation of a power source increased by 1 MW. The coefficient plus or minus sign determines if the electricity market price would increase or decrease.

**Results**

Table 1 presents the results of the correlation analysis between electricity market price and 7 electricity sources in Lithuania.

**Table 1.** Correlation values between electricity market price and electricity sources.

| Generation source | Correlation coefficient |
|---|---|
| Natural gas | -0.126 |
| Hydro pumped storage | 0.185 |
| Run of river | **-0.369** |
| Photovoltaic solar | 0.077 |
| Waste fuel | 0.001 |
| Wind power | -0.053 |
| Electricity import | **0.538** |

Bolded values represent correlation values higher than 0.3

Correlation analysis identified that natural gas, run of river, and wind power generation have a negative effect on electricity prices, while pumped storage, solar, waste fuel generation, and electricity imports have a positive one. Only 2 out of 7 electricity sources have a higher than 0.3 correlation coefficient. Run of river generation and electricity imports can be considered as having a meaningful impact on electricity prices.

Table 3 presents linear regression results between run of river generation and electricity imports as independent variables and electricity market price as the dependent variable.

**Table 3.** Regression analysis results and important statistics.

| **Regression statistics** | | | | |
|---|---|---|---|---|
| Multiple R | 0.631 | | | |
| R square | 0.398 | | | |
| Adjusted R square | 0.377 | | | |
| Standard error | 6.164 | | | |
| **Variables** | | | | |
| | Coefficient | Standard error | t stat | p value |
| Intercept | 39.563 | 2.680 | 14.760 | **<2e-16** |
| Run of river | -0.131 | 0.041 | -3.213 | **0.002** |
| Electricity import | 0.017 | 0.003 | 4.981 | **6.2e-06** |

Bolded values represent variables with a higher than 1% significance level in the regression

Regression results refer that selected variables can be used to partly explain electricity market price movements. $R^2$ statistic shows that around 40% of the electricity market price can be explained using intercept, run of river generation, and electricity import. To understand independent variables' magnitude on electricity prices, coefficients are used to build the regression equation (3).

$$Electricity\ market\ price = 39.563 - 0.131\ Run\ of\ river + 0.017\ Electricity\ Import \quad (3)$$

**Conclusions**

Correlation analysis was used to identify electricity sources that meaningfully influence electricity prices in Lithuania. Identified electricity sources were used for linear regression where their influence magnitude on electricity prices was determined. The regression equation showed that without a run of river generation and electricity import electricity market prices in Lithuania would be around 40 €/MWh. Regression coefficients indicated how much electricity prices would increase or decrease if 1 MW of average monthly generation was added to the monthly generation mix. A 1 MW increase in an average monthly run of river generation could decrease electricity prices by 0.131 €, while a 1 MW increase in average monthly electricity import could increase electricity prices by 0.017 €. Other electricity sources, including wind and solar photovoltaics, did not have a meaningful impact on Lithuanian electricity market prices. A possible explanation for that is a relatively small wind and solar power generation amount compared to the whole national electricity demand.

Presented research method and results explore only electricity generation sources' influence on electricity prices. In reality, electricity prices are affected by a number of additional factors such as electricity demand/supply, commodities prices, weather conditions, electricity grid operation costs, government subsidies, and others. Additional variables in the methodology and regression analysis could help to better explain electricity price fluctuations and deliver more robust research results. Further research is planned towards regression analysis expansion by including other electricity price influencing factors. Electricity flow through the links with neighboring countries, foreign power plant generation, commodities market prices are a few of the variables examples that are planned to be included in future analysis to improve the model.

**References**


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