

Statistical Evaluation of Variable Renewable Energy Source's Contribution to the Variability of Swiss Electricity Prices 2015-2020

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2024-08-03

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Introduction

Governments and scientists around the world largely agree on the need for a low-carbon electricity grid. A step in this direction is the construction, installation and connection of Renewable Energy Sources (RES) such as Hydropower, Wind and Solar to the electricity grid. These produce no direct emissions while supplying electricity and have life cycle carbon costs far lower than fossil fuels. A substrate of RES are so called Variable-RES (VRES), which are electricity sources whose production cannot be increased or decreased by the operator. Wind and Solar both rely on meteorological conditions, if these are not right, nothing is produced. This is contrary to most other sources whose production can be increased or decreased according to market needs. Although the time it takes to ramp production up or down can present a challenge, it is far more manageable than VRES.

The lack of control over production with VRES presents a huge challenge to the adoption of such sources, since there is no large scale energy storage available. Battery Storage, Pumped Hydro and Heat Pumps do store energy, but currently these forms of power would not be able to power a country for even a couple of hours.

Worst yet for all energy producer, the addition of electricity from VRES has the possibility to:

1. Drastically lower electricity prices.
2. Increase volatility.

The reason for the first claim is that VRES has practically no marginal costs. No fuel rods, pumping, gas or other notable inputs are required to produce solar and wind energy. This means producers of VRES will bid their energy at almost any price. If they cannot profit - maximize, they will loss - minimize.

The second claim is the case because meteorological events tend to be fairly consistent across an area. When one wind / solar farm is producing, so are the ones around it. This means there is huge downward pressure on prices during periods of favorable VRES production and none at all during unfavorable conditions.

Relevance

Policymakers would be interested in these results, particularly those countries considering feed-in-tariffs (FIT).

FIT - paying a fixed price for renewable energy, if the price is volatile, government's expenditure will also be.

Consumers of energy (so most people), will also want to know how prices could fluctuate in the future.

Providers of energy storage, who require volatility in prices to make.

more will be added here

Literature Review

Although generally speaking the academic literature identifies increases V-RES sources as being correlated with volatile prices, it is unclear whether these effects are generalizable to the Swiss grid without further research. A number of studies find an increase in variability as V-RES penetration increases. Amongst them: Pereira da Silva and Horta (2019) who use EGARCH time series and regression while studying the Iberian power market; Frauendorfer, Paraschiv, and Schürle (2018) who find that the Swiss are "importing" lower German power prices during peak solar production, as Germany has much more solar energy sources than the Swiss. Finally, the authors Dong et al. (2019) find that the Swedish have more stable prices due to the relatively high proportion of non variable fossil and hydropower than the Danes, who are more reliant on V-RES in the form of wind and solar.

Other studies are more conflicted, such as Rintamäki, S. Siddiqui, and Salo (2017) who compare Germany and Danish prices and find that the effect of increasing wind production on day ahead prices is not constant. They caution that interconnectivity with other grids is important in determining the direction of effect. As such, this is further motivation to study each nation's grid independently, as there may be a large number

of variables influencing the price. Although the previously mentioned Frauendorfer, Paraschiv, and Schürle (2018) paper studies the Swiss grid, it does so in the context of transnational energy trade, and not increases in domestic capacities. This is the gap we are evaluating.

Sources

Electricity Prices

Swissgrid provides data on 15-minute electricity prices, divided into secondary and tertiary.

Link: <https://www.swissgrid.ch/en/home/operation/grid-data/generation.html>

Generation Share Wind and Solar

https://data.open-power-system-data.org/time_series

*more will be added here

Exploratory Data Analysis (EDA)

Histograms

Time Series Plots

Models

Suggest 2-3 models, done well. This means verifying the assumptions and making necessary transformation. I suggest doing the results in a separate section

Results

Model 1:

for each model cover the important and interesting statistical models and how they relate the research question. Also, discuss model specific limitations in this context.

Model 2:

for each model cover the important and interesting statistical models and how they relate the research question. Also, discuss model specific limitations in this context.

Limitations

-cover general limitations

Conclusion

What did we learn, what did we not learn, how does this relate to policymakers.

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