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ELECTRICITY STORAGE PROBABILITY IN WESTERN BALKAN COUNTRIES

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Overview

Current integration of renewable energy sources in the electricity grids, especially wind and solar, is making significant influence on operational strategies. With intermittent nature of renewables, dispatching and controlling daily demand-supply is challenging. Energy storage technologies provide among other application, flexibility in form of arbitrage. Arbitraging electricity prices means buying electricity at the time of low price, storing it and selling it at the time of high price. Price spreads that occur in electricity markets make arbitrage successful and profitable. Pumped-hydro storage (PHS), as economicaly viable technology, is leading storage technology with the most installed capacity, while among electrochemical storage, lithium- ion (Li-ion) batteries are currently emerging because of their long cycle life[1]. Research regarding energy storage profitability in terms of arbitrage [2] is conducted for three European markets. Considering region of Western Balkan countries (Albania, Bosnia and Herzegovina, Republic of Kosovo, Montenegro, North Macedonia and Serbia) as study case, this paper investigates opportunities of arbitraging pumped hydro and Li-ion energy storage. This region is highly fossil based dependent and in some countries National Climate Plans aren't in action, hence countires are behind set targets for reaching zero emission by 2050. Paper investigates energy storage implementation in reaching higher shares of renewables and eventually in abondoning generation from fossil power plants.

Method

Considering calculation of costs, price spreads from the electricity market, and generation portfolios in the 2011.-2019. time period from ENTSO-e, profits are maximized in the optimization algorithm with the price-taker approach. Electricity market prices are in the hourly resolution from HUPX exchange as relevant parameter for Western Balkan region. Next equation describes the optimization model:

$$\max \prod_t = \sum_{t=1}^{8760} (P_{Ht} \cdot p_t^d \cdot \eta - P_{Lt} \cdot p_t^c) \cdot \Delta t - \frac{(IC_o \cdot CRF + C_{OM_t} + Cr)}{1000 \cdot FLH} \cdot \sum_t p_t^d \quad (1),$$

Where:

P_{Ht} is selling (high) price of electricity in the market at hour *t* in €/MWh,

p_t^d- discharging power capacity at time *t* in MW

η is storage efficiency,

P_{Lt} is buying (low) price of electricity in the market in €/MWh,

p_t^c- charging power capacity at time *t* in MW

Δt- time difference in hours

IC_o is investment cost of storage at t=0 in €/kW,

CRF is capital recovery factor (1/year),

C_{OM_t} are operation and maintenance costs in €/kW per year (considering assumed full load hours of discharged storage energy),

Cr are replacement costs in €/kW,

FLH are full load hours, i.e operating hours / discharge hours of storage

Results

Generation from renewable energy sources in Western Balkan region has had modest increase over the years. Hydro generation has been dominant and it is still the main source of flexibility, accounting for almost half demand. Investments on wind power plants have been rising since 2017. giving seldom increase in wind generation, while solar installations are scarce and in some countries even inconsistent. Figure 1 presents cummulative renewable generation in Western Balkans over the 9- year period.

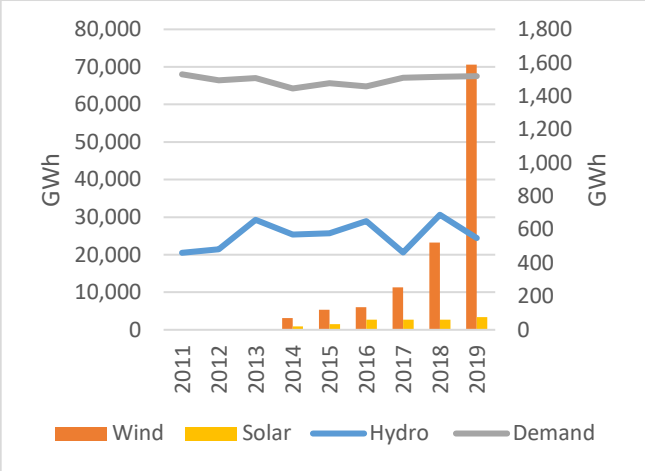

Figure 1 Generation of renewables in GWh in Western Balkan countries (wind and solar seconday axis)

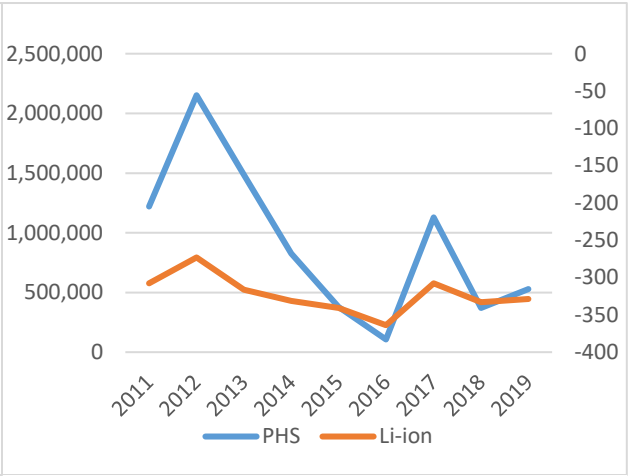

Figure 2 Profits in € from arbitraging PHS and Li-ion storage in HUPX electricity market (Li-ion secondary axis)

Abritrage of 2000 full load hours of pumped-hydro storage with maximum capacity of 100 MW and Li-ion storage with maximum capacity of 100 kW with hourly distribution of electricity market prices for 9-year period from HUPX exchange is used for the maximization of profits. Results prove energy storage arbitrage with Li-ion to be unprofitable which is mainly because of the high costs of the technology. Pumped-hydro storage is proven profitable for price-arbitrage, with profits being influenced the most at the times of high price spreads as in 2012. and 2017..

Conclusions

Conducted analysis provided the next conclusions:

- Western Balkans have high potential for pumped-hydro storage investment due to the geographical region, and high hydro generation.
- Profits from the simulated price arbitrage are higher with higher price-spreads that happen in the electricity exchange, which is influenced with different generation portfolios, especially high thermal generation in the Western Balkan region.
- Li-ion energy storage is still unprofitable, it will remain until technology prices decrease.
- Given the fossil based power plants in the region, price spreads are to be expected.
- There isn't flexibility options available in the region, only two pumped- hydro power plants.
- For reaching set targets for renewable investments in the upcoming years, additional felxibility is expected, with PHS being the cost-effective and promising candidate.
- In the Western Balkan region, governments and energy policymakers are expected to drive Energy Transition, as so far situation is not at the satisfactory level.

References

[1] Zejneba Topalović, Reinhard Haas, Amela Ajanović, Marlene Sayer, “Prospects of electricity storage,” Renew.Energy Environ.Sustain. 8, 2 (2023)

[2] P. Spodniak, V. Bertsch, and M. Devine, “The profitability of energy storage in european electricity markets,” Energy J., vol. 41, no. 1, pp. 221–247, 2020, doi: 10.5547/01956574.41.SI1.LGIR.