EVALUATING THE BUSINESS CASE FOR FLEXIBILITIES AS RISK MANAGEMENT IN DIRECT MARKETING OF RENEWABLE ENERGIES

Nicolas Thie, RWTH Aachen University, +49 (241) 80 97340, thie@ifht.rwth-aachen.de
Maria Vasconcelos, RWTH Aachen University, +49 (241) 80 930 39, vasconcelos@ifht.rwth-aachen.de

Overview

To increase the economic efficiency of the distributed energy resources's (DER) targeted deployment, the political demand for stronger market integration has intensified in the European market areas. Recent recommendations and directives drafts of the EU commission include a stepwise reduction of subsidies to incite the transition to purely market based operation.

In contrast to subsidy based operation, there are two challenges associated with the direct marketing of DER. First, current market requirements (e.g. minimum lot size of products) pose a significant entry barrier for individual, small to medium-sized DER. Consequently, established DER marketing concepts envisage a specific level of aggregation. Second, the direct marketing of DER is subject to market risks. These risks are caused by uncertainties related to the forecasting of intermittent generation (volume risk) and spot market prices (price risk). Both risks have an impact on the profitability of direct marketing. While price risks directly influence market revenues, volume risks cause schedule deviations, which have to be compensated by expensive balancing energy. Therefore, to increase economic efficiency of direct marketing and support a purely market based renumeration of DER, risk management plays a significant role.

Against this background, aggregating DER to a Virtual Power Plant (VPP) has proven to be an efficient approach for the direct marketing of DER. It enables both overcoming market entry barriers and the efficient use of flexibilities for managing the risks of intermittent generation. Flexibile assets such as battery storage systems (BSS) and combined heat and power (CHP) plants are used to react to forecasting errors and compensate schedule deviations. The technical feasibility of this concept as well as the existence of a general business case for exemplary flexibilities have been shown in previous papers, e. g. [TEN17]. However, detailed evaluations of the business case for flexibilities as a tool for risk management in the direct marketing of a VPP as well as a comparison between different flexibility technologies are missing. As a risk management tool, flexibilities can both increase revenues and minimize risks by moving sales to times with higher prices (compensating price risks) or by compensating schedule deviations (reducing balancing energy costs). On the other side, operational and investment costs of integrating flexibilities into the VPP have to be considered.

Therefore, this paper evaluates the economic efficiency of various flexibility technologies for both increasing revenues and reducing market risks of DER in a Virtual Power Plant.

Methods

The evaluation is done by using the stochastic market scheduling approach presented in [THI18], which is based on mixed integer linear programming (MILP). Aside from the market schedule, both expected revenues and market risks are determined in a multi-criterial optimization. Therefore, the economic improvements achieved by integrating fleixbilities can be compared with the respective costs. To consider risk within the optimization, the risk measure Conditional-Value-at-Risk (CVaR) is integrated into the objective function. The CVaR indicates the expected profit margin of all scenarios within a confidence interval of 95%. Within the optimization it quantifies risk exposure and allows for risk averse planning. The MILP approach further allows for the implementation of a wide range of technical restrictions of DER and flexibilities as well as the market specifications of different energy markets (day-ahead, intraday, reserve energy). Uncertainties are integrated via discrete scenarios of the stochastic optimization including day-ahead and intraday forecasts for generation and market prices.

Results

The method is applied to an exemplary VPP portfolio consisting of wind power and PV plants with an installed power of 30 MW in total. Within a first investigation, the influence of integrating a battery storage system of

different sizes into this portfolio is investigated. Investment costs are derived based on [IRE17] and [AGO14]. A detailed specification of assumed costs and technical parameters will be included in the full paper.
Figure 1 (left) shows the effect on overall expected profits and the risk measure CVaR (including investment costs of storages) by integrating storages with an installed capacity of 1 to 4 MW/MWh. Both values are normalized compared to the benchmark without any storage. It can be seen that both expected profit and CVaR can be increased by about 10% - 15% compared to the benchmark without storage for all regarded BSS configurations. Integrating the first 1 MW/MWh storage has the highest impact due to mitigating volume risks and reducing balancing energy costs, especially in times with high balancing energy costs. Additional storage capacity further reduces balancing energy demand. Within this additional compensation the marginal cost reduction decreases due to lower balancing energy prices and less efficient use of the storage capacity. Therefore, the decrease of balancing energy costs slows down with increasing storage size and is mainly compensated by the increase of investment costs (s. Figure 1 (right)). The preliminary results suggest that integrating flexibility into a VPP portfolio bears economic potential for risk management. A more detailed analysis will be provided in the full paper.

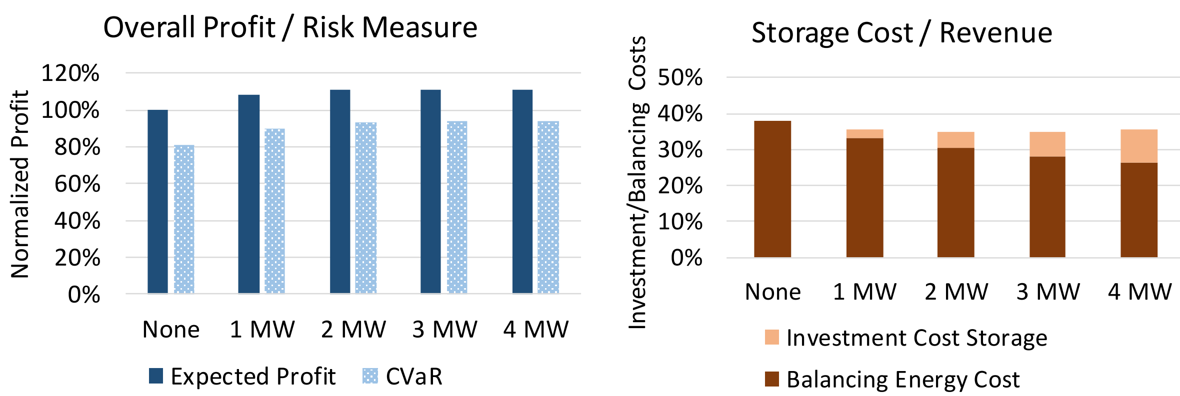

Figure 1: Influence of integrating a battery storage system on overall profit and risk (left hand side) and on balancing energy and storage investment costs (right hand side)

Conclusions

In the context of a politically driven enhancement of the market integration of DER, handling market risks becomes more and more important for an efficient market participation. Integrating flexibilities together with DER into a Virtual Power Plant is a technical feasible and potentially economically efficient concept to reduce both volume and price risks. However, there is still an open question regarding the detailed business case of using different flexibility technologies for risk management in a VPP. Therefore, the goal of this paper will be to assess and compare the economic efficiency of integrating various flexibility technologies into a Virtual Power Plant. The assessment is done with a stochastic market scheduling approach based on mixed integer linear programming. First results regarding the integration of battery storage systems suggest a positive business case by reducing balancing energy costs but also show high influence of cost assumptions and sizing of flexibilities. The full paper will extend these results by considering those sensitivities of costs and technical parameters as well as by including different flexibility technologies.

References

[AGO14] Agora Energiewende, „Stromspeicher in der Energiewende: Untersuchung zum Bedarf an neuen Stromspeichern in Deutschland für den Erzeugungsausgleich, Systemdienstleistungen und im Verteilnetz“, Studie, Berlin, 2014 (only available in german)

[IRE17] IRENA – International Renewable Energy Agency, „Electricity Storage and Renewables: Costs and Markets to 2030”, Study, Abu Dhabi, 2017

[TEN17] F. Teng, et al. „Business Case for Distributed Energy Storage“, CIRED2017, Glasgow, UK, 2017

[THI18] N. Thie, M. Vasconcelos, A. Schnettler, L. Kloibhofer, „Influence of European Market Frameworks on Market Participation and Risk Management of Virtual Power Plants”, 15th International Conference on the European Energy Market (EEM), 27-29 June, 2018, Lodz