Value of interconnector and renewable energy sources in generation adequacy assessment

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Overview

The EU's energy union strategy aims at providing secure, sustainable and competitive energy for all. The energy system in Europe is undergoing a rapid transformation with increasing energy supply coming from fluctuating RES (Renewable Energy Sources) and increased interconnector capacity. An energy system with a large share of renewables can result in reduced profitability of conventional power plants and thereby make them economically infeasible. This, combined with other factors like nuclear phase-out in Germany and ageing power plant fleet can result in generation adequacy (GA) problems. Generation adequacy refers to the presence of sufficient capacity to meet the demand at all times. The first challenge towards ensuring GA is that of measuring it in an interconnected system with large shares of renewables. Not considering the contribution of interconnector and RES in GA assessment can lead to overcapacity and increased cost. While the importance of interconnector and neighbouring capacity is generally recognised in ensuring GA, their contribution while measuring adequacy level is seldom considered. The challenge is further complicated by the presence of varying methodologies to measure generation adequacy by different member states (Blanco, Spisto, & Fulli, 2016). This raises the questions: *How can generation adequacy be measured in an interconnected system with high shares of renewables? What is the impact of considering the cross border contribution and stochasticity in RES has on capacity planning?*

Methods

The analysis is based on cost minimization bottoms up techno-economic electricity market model (ELTRAMOD[1]). The model is calibrated for 2016 (reference year). The model has endogenous investment and disinvestment. The geographic scope of analysis is Germany and neighbours. The optimisation is carried out for a year with an hourly resolution. The model is further constrained by emission reduction targets through the EU ETS (Emission Trading System) mechanism.

To analyse cross broader contribution to generation adequacy assessment the paper presents three different interpretations of GA which represents a different level of assumptions of perfect information and coordination. The interpretations are modelled through capacity requirements for each country. The three interpretations of GA considered are: no contribution (each country meets its capacity needs without considering contribution of neighbouring capacity), dynamic contribution (for each hour the country needs to satisfy the capacity requirement while dynamically considering import and export of capacity counted towards adequacy) and static contribution (a single value of neighbouring capacity is considered in generation adequacy).

The paper also investigates the effects of considering stochasticity of RES in generation adequacy. Large historic CF (Capacity Factor) data (30 years, with hourly resolution) has been used for calculating generation from RES. Using this data, for Germany, probable value of different peak residual load (residual load = load – RES generation) has been calculated. This is then used in model analysis as capacity requirements to calculate the change in system costs to achieve different confidence levels for meeting peak residual load. Furthermore, the recognised capacity requirements are modelled with the three interpretations of GA with respect to cross border contribution.

Results

The analysis is done for multiple years till 2035 with the three adequacy interpretations. Initial results show a reduced installed capacity requirement (~8GW till 2025) when considering the contribution of neighbouring capacity to generation adequacy. Germany, in particular, with increasing shares of renewables, can benefit from considering neighbouring capacity towards generation adequacy. The results also show an overall system cost reduction by using a coordinated approach to measuring adequacy.

The analysis of 30 years weather data shows a significant variation of peak residual load (~10 GW for Germany). The results show that considering the contribution of RES in GA can result in a significant capacity reduction, at the same time achieving high confidence level in GA. Furthermore, the cost of reaching the same confidence level is lowest when also considering the contribution of interconnector to capacity requirement.

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[1] ELTRAMOD (Electricity Transhipment Model) has been developed at the chair of Energy Economics, TU Dresden. https://tu-dresden.de/bu/wirtschaft/ee2/forschung/modelle/eltramod

Conclusions

The paper illustrates the importance of considering the contribution of interconnector and RES to GA. Historically these factors could have been ignored in GA assessment. However, with increasing share of RES and interconnector capacity, it is of vital importance to take into account these factors in GA assessment. If these factors are not taken into account, overestimation of capacity requirement results in increased system cost. The paper quantifies the value of the contribution of interconnector and RES.

References

Blanco, M. P., Spisto, A., & Fulli, G. (2016). Generation Adequacy Methodologies Review. https://doi.org/doi:10.2790/054903