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An evaluation of a local reactive power market: the case of Power Potential

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The transition to a low-carbon energy system brings challenges due to decarbonisation targets that encourage the addition of more intermittent generation (i.e. wind power) in the energy system and changes in the electricity demand profile. These require more and enhanced interventions by both electricity system operators and distribution utilities to keep the system stable. Reactive power is one type of ancillary service which is usually required by system operators to keep the system voltage within appropriate limits. There is a need to explore and evaluate further options to procure reactive power, which is the motivation for this paper.

The aim of this study is to produce a social cost-benefit analysis (SCBA) to quantify the benefits of introducing reactive power markets that promote the participation of distributed energy resources (DER) in a coordinated way, between the electricity system operator and electricity distribution utilities. The SCBA involves three different scenarios: Business-As-Usual (BAU) - scenario (S1) - which consists in matching the gap between reactive power system requirements and existing reactive power capability by acquiring network assets for reactive power, specifically static synchronous compensators (STATCOMs). The other two scenarios, scenario 2 (S2) and scenario 3 (S3), involve a more competitive approach with the provision of reactive power support from DER within the distribution network.

The analysis is done in the context of the Power Potential (PP) innovation project. PP seeks to procure reactive power from DER located in the distribution network operated by UK Power Networks (UKPN) in day-ahead market with a pay as bid pricing mechanism. PP considers the contribution DER could make (by displacing conventional network assets) in supplying reactive power support to a specific area in the South of England in combination with the current approach. This area involves four Grid Supply Points (GSPs) where transmission network capacity is limited by voltage stability and the available thermal capacity. Price information from the PP live trial conducted between January and March 2021 is used to evaluate the robustness of the SCBA and to estimate benefits using actual prices.

Results from the SCBA suggest that savings from competitive procurement could be of the order of £14.3m in 2018 money (out to 2050, assuming 100% of DER participation). These savings represent around 8% of the BAU costs and are driven by the deferment of the purchasing of reactive assets which can occur if

DER can provide reactive power. The potential value of increased reactive power capability from optimisation by the DNO of their assets is also analysed. This produces a large additional benefit of the order of £23m in 2018 money (average figure) out to 2050, disregarding the potential costs entailed by such DNO optimisation. This is equivalent to a further increase of c.13% of BAU costs. Results from the live trial suggest that the estimated weighted average prices submitted by DER (availability and utilisation) are within the range of prices proposed in the prior SCBA. Higher discounted savings are calculated when observed prices are incorporated in the analysis.

We discuss how competitive procurement might give rise to even larger benefits.

First, if competitive provision also freed up additional thermal capacity for export from the four GSPs that would further enhance the value of lessening the voltage constraints. It would do this by reduced distributed generation (DG) curtailment encouraging even more connection on the distribution system behind the four GSPs.

Second, more flexible use of DER to provide reactive power can also reduce system losses. To the extent that more reactive power capability in the distribution system leads to better constraint management and that additional thermal transfer capacity reduces the need to thermally stress network assets, this might be an additional benefit from DER participation in reactive power markets.

Third, we might envisage that a long run benefit of competitive procurement from DER is increased innovation in reactive assets that would face direct competition from flexible DER. We have assumed that STATCOMs remain at the same real price and of a fixed size. If competitive procurement from DER drove innovation in reactive assets, reducing their unit size and unit cost this would be a further benefit of PP.

Fourth, we do only consider leading (not lagging) reactive power. If we were to model competitive procurement of lagging reactive power, there would be some smaller additional benefits arising from situations where the procurement of lagging reactive power from DER was cheaper than other sources.

Finally, if competitive procurement were extended to transmission connected generators (not just DER) who could provide reactive power, this might significantly reduce the delivered cost of reactive power procurement via the mandatory reactive power market in Great Britain, if the prices were below the current mandatory price level.

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