Flexibility-enabling Contracts in Electricity Markets

As the share of intermittent renewable energy increases in the generation mix, power systems are exposed to greater levels of uncertainty and risk, which requires planners, policy and business decision makers to incentivise flexibility, that is: their adaptability to unforeseen variations in generation and demand. The greater need for flexibility, along with the fact that its provision is costly, highlights the importance of efficient procurement. As a commodity, flexibility has multiple attributes such as capacity, ramp rate, duration and lead time among which there are complementarities. Additionally, along with traditional sources, which already enable flexibility, a number of business models, such as thermostat-based demand response, aggregators and small storage providers, are emerging in electricity markets and expected to constitute important sources of flexibility in future decentralised power systems. However, due to presence of high transaction costs, relative to the size of resource, the emerging small resources cannot directly participate in an organised electricity market and/or compete. This paper asks the fundamental question of how should the provision of flexibility, as a multi-dimensional commodity, be incentivised in this context? We model the procurement of flexibility services from emerging small resources through bilateral contracts in a multidimensional adverse selection setting. We take a normative perspective and show how efficient contracts for flexibility services can be designed given its peculiarity as an economic commodity. Through a simulation analysis we elucidate the applicability of the proposed model and demonstrate the way it can be utilised in, for example, a thermostat based demand response programme.