New method to encourage virtual power plants for efficient renewable energy production

Researchers from the University of Southampton have devised a novel method for forming virtual power plants to provide renewable energy production in the UK.

In the last decade, small and distributed energy resources (DERs), like wind farms and solar panels, have begun to appear in greater numbers in the electricity supply network (Grid).

To ensure that energy demand is met without interruptions, the Grid requires power suppliers to provide an estimate of their production and the confidence in meeting that estimate. Depending on the confidence placed on the estimates, the Grid is able to choose the appropriate number of conventional generators needed to produce and supply energy whenever it is needed - the more accurate the provided estimates, and the higher the confidence placed in those estimates, the better for the Grid scheduling activities.

Although the deployment of DERs could reduce reliance on conventional power plants, their integration into the Grid is problematic since the DERs, given their small size, are largely 'invisible' to the Grid. Even if visible, the uncertainty and uncontrollability of renewable energy sources prevents individual DERs from profitably dealing with the Grid directly, or participating in the wholesale electricity market because they are often unable to meet the set generation targets.

Virtual Power Plants (VPPs) are fast emerging as a suitable means of integrating DERs into the Grid. They are formed via the aggregation of a large number of such DERs, enabling them to reach similar size and supply reliability as conventional power plants.

In a new study, University of Southampton researchers promote the formation of such 'cooperative' VPPs (CVPPs) using intelligent and multi-agent software systems. In particular, they designed a payment mechanism that encourages DERs to join CVPPs with large overall production.

Dr Valentin Robu, from the University's Agents, Interaction and Complexity Research Group, who worked on the study says: "There is considerable talk about how to integrate a large number of small, renewable sources into the grid in a more efficient and cost effective way, as current feed in tariffs, that simply reward production are expensive and ineffective.

"CVPPs that together have a higher total production and, crucially, can average out prediction errors is a promising solution, which does not require expensive additional infrastructure, just intelligent incentives."

By using a mathematical technique called proper scoring rules (a scoring rule, is a measure of the performance of an entity, be it person or machine, which repeatedly makes decisions under uncertainty), intelligent software agents, representing the individual DERs, are incentivised to report accurate estimates of their electricity production.

The researchers devised a scoring rules-based payment mechanism that incentivises the provision of accurate predictions from the CVPPs - and in turn, the member DERs - which aids in the planning of the supply schedule at the Grid. The mechanism guarantees that DERs are rewarded for providing estimates that are both accurate and have a high confidence, ensuring that software agents are given credit for high probability estimates that are close to the realised ones.

Valentin adds: "Scoring rules with specific incentive properties have long been used to design payment mechanisms that incentivise agents to report private probabilistic predictions truthfully and to the best of their forecasting abilities. "We show that our mechanism incentivises real DERs to form CVPPs, and outperforms the current state of the art payment mechanism developed for this problem."

The researchers collected half-hourly wind-speed data for a 10-week period from 16 commercial wind farms in the UK in order to validate their approach. They will be presenting their paper at the AAAI conference (22-26 July), in Toronto, Canada this week

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The Southampton researchers have been exploring these ideas for some time through the iDEaS project, an industrially-funded project, which aims to explore the issues associated with the decentralised control, operation and management of future generation electricity networks. The other members of the research team are Dr Ramachandra Kota and Dr Georgios Chalkiadakis. The project is led by Dr Alex Rogers and Professor Nick Jennings from Electronics and Computer Science at the University of Southampton. http://www.ideasproject.info/ [1]

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