Project: Coordination of Offshore Wind Farms and Virtual Storage Plants for the Provision of Ancillary Services

Key focus: co-located storage system, flexible offshore wind solution, virtual storage plants

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Background

Because of the target of the UK to curtail its greenhouse gas emission by 80% before the end of 2050 through the integration of renewable energy resources, offshore wind has a promising future. Offshore wind accounts for the equivalent power needs of 4.5 million homes annually and is projected to account for 10% of the UK's electricity consumption in 2020. Its deployment is projected to steadily rise in the upcoming decades. Offshore wind provides the lowest cost option for clean power generation compared to other major sources of clean power, including nuclear plants. Similar to most renewable energy sources, the output power of conventional wind farms is intermittent, not dispatchable, and prone to cause instability issues in the grid. To address these challenges, electrical energy storage systems are typically integrated into the power grid to provide balancing, ancillary services, and to stabilise the network. Storage devices can absorb excess energy, augment for energy shortfalls and help with grid frequency and voltage regulation. There exists a broad range of energy storage technologies (e.g., batteries, flywheels, capacitors), with each having its own features and technical/operating specific requirements. Therefore, each storage technology has its relative advantages and disadvantages in terms of energy density, power density, response time, efficiencies, installation cost and so on, which makes it more or less suitable for one or the other service provision (for instance, ultracapacitors or even batteries might be suitable for primary regulation, whilst hydro plants are more suitable for secondary or tertiary reserve provision). A control method to optimally coordinate these different storage technologies, along with offshore wind farms, for the provision of balancing and ancillary services to the grid is an open and relevant challenge this project aims to address.

Project description

The main research challenges, as well as the main novelty aspects, will be the coordination of different storage technologies and the decision-making under the uncertainty coming from wind generation. Hence, this research project aims to design a distributed control method for the integration and coordination of multiple energy storage technologies to create a virtual storage plant (VSP), which maximizes the benefits of storage technologies co-located with offshore wind farms for the provision of balancing and ancillary services. A high-level illustration of a VSP is shown in Fig. 1.

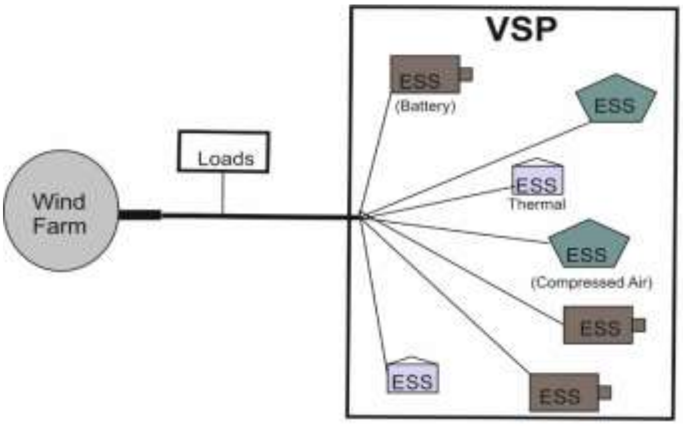

Fig. 1. Illustration of virtual storage plant (VSP) composed of different energy storage system (ESS) technologies. The ESSs are coordinated to provide auxiliary services

Research outcomes/impact

The main outcome of this study will be a distributed, robust, scalable, control system devised for VSPs in co-located wind farms. This control system will be based on a multi-agent framework, where each energy storage device in a VSP is regarded as an agent. The multiple agents are to collaborate to provide the required ancillary services, e.g., stabilization of grid frequency within defined limits. This control framework can be employed by several relevant stakeholders, such as system operators and aggregators.

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