Docket #: S16-384

Intelligent control for coordinating distributed energy storage

Stanford researchers have developed an architecture and control scheme for the coordination of distributed energy resources (DER), such as solar and storage, to minimize operation cost, enhance network reliability, and provide DER aggregation. The availability of electric load and generation data in electric grids varies both spatially and temporally due to: the random nature of loads and renewable generation; distributed locations of the loads and DER; and communication delays. Stanford researchers have found that control schemes that utilize local information (within the firmware of the storage unit, or in a home automation appliance) and delayed information to a global controller (e.g., collected from smart meter readings) perform almost as well as a perfect forecast global controller, which has all the load data (hence is not implementable).

Stanford's network architecture and control scheme simultaneously optimizes energy arbitrage and reduces energy cost by distributing control between a global controller (GC) and local controllers (LCs), shifting more responsibility for control decisions to the local controllers. This provides a win-win relationship between the utility companies, who may provide the global coordination, and the DER providers who may provide the local control.

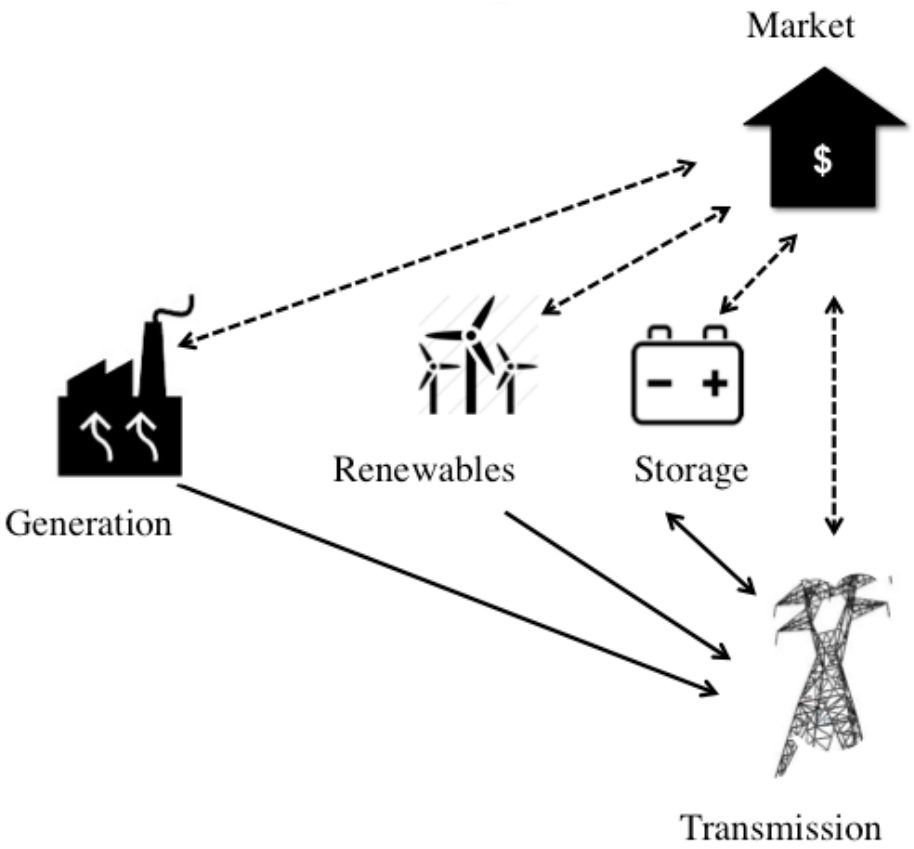

Figure 1 - Smart grid with new technologies in the power transmission system

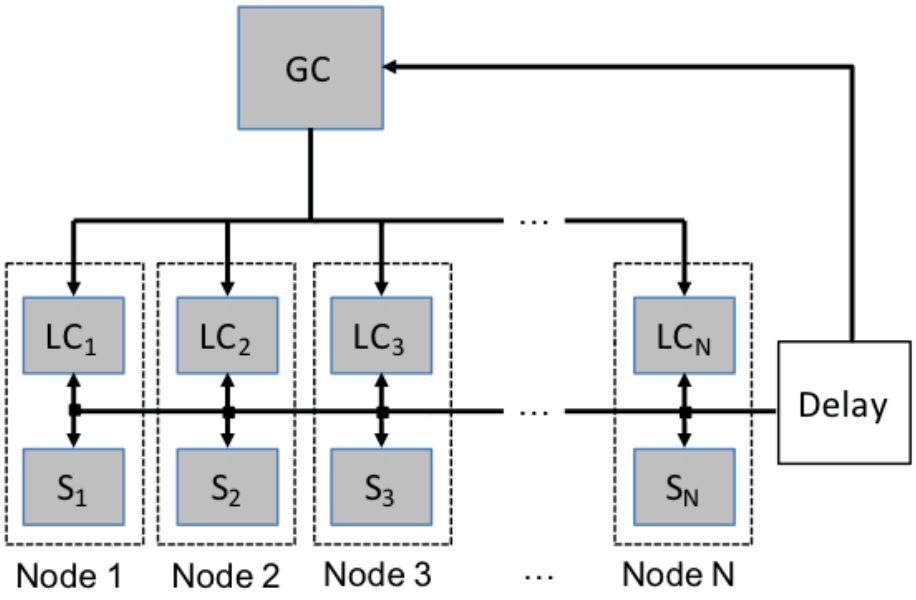

Figure 2 - Data flow in a distribution system. N customers with net loads S and local controllers LC. The local controllers communicate their data to a global controller GC, subject to a delay. The GC sends back control signals to the LCs based on the delayed information and its knowledge of the distribution network.

Applications

- Electric grid – planning and operation

Advantages

- Increased efficiency and balanced load decreases outages, and increases profits.
- Faster and more robust – high delay tolerance makes the system less vulnerable to communication network failures, and reduces the need to upgrade the smart meter infrastructure to provide faster data propagation.
- Increased collaboration between the utility companies and the DER providers instead of the current state of competition and distrust.

Publications

- Anderson, Kyle. "Scalable Software Tools and Methods for Smart Grid Modeling and Optimization." PhD diss., Stanford University, 2015.
- Anderson, Kyle, Ram Rajagopal, and Abbas El Gamal. "Coordination of Distributed Energy Storage Under Spatial and Temporal Data Asymmetry." IEEE Transactions on Smart Grid(2017).

Patents

- Published Application: 20180358812
- Issued: 11,804,717 (USA)

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