Intelligent Balancing Authorities (iBAs) for Reliable and Secure Smart Grids

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We propose a generalization of today's balancing authorities (BAs) into iBAs. These utilize physics-based system models and data-driven algorithms for both operating system reliably and for detection and protection against cyber-attacks. iBAs become basic components of cyber secure electric energy systems, and also an effective way of reducing complexity of large scale systems. We define iBAs as aggregate components grouped in a way that specific performance criteria of interest are met. The criteria can be static or dynamic. Depending on the purpose and operating problem of interest, different model granularity is used for defining iBAs. As an example, we show using real world microgrid, an illustration of static aggregation method and its dependence on changing grid topology. Dynamic aggregation for deriving iBAs is ongoing research in our group. Dynamic grouping is performed as clustering-based aggregation of dynamical components, so that a new higher layer of communication is formed. On the other hand, the lower layer is composed of physical (electrical) connections that are fixed. Modeling a large-scale power system in this manner presents new capabilities in the context of reliable operation, including detection and protection against cyber-attacks.