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A smart grid based on a three port energy transfer component

Visagie, Deon-Louis

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ABSTRACT

As the demand for electricity increases worldwide on mostly constrained networks, Smart grids pose an alternative solution to conventional generation. Previous work on Smart grids is discussed in this dissertation and it is highlighted that future Smart grids should not only address peak demand, but also stimulate the use of distributed renewable energy sources and promote interaction between customers and the utility.

A solution to the above three requirements in the form of a novel 'T'-Smart grid comprising of a fundamental Control-component and 'T'-components is presented. It can seamlessly and intelligently integrate a large number of distributed energy sources and energy storage devices. The 'T'-Smart grid can also ensure complete protection between all the Grid-components (sources, loads and energy storage elements) by the use of a novel Fault Current Limiter (FCL). The FCL not only limits fault current amplitudes and negates fault current propagation throughout the grid, it also transforms the grid into discrete states which allows the 'T'-Smart grid to assess, manage and control any network condition in an optimal way as this system makes information about the available energy and load requests known upfront.

Several financial incentives and hardware solutions to reduce peak demand or ensure a flatter energy consumption profile are also proposed and discussed.

The financial solutions consist of charging customers for exact shared network usage, for events where external grids are required to assist with energy or where other loads had to be shed to meet the demand, as well as a network demand charge.

Possible hardware solutions include the 'T'-Smart grid's unique ability to intelligently manage energy storage elements in three different modes of operation.

The proposed 'T'-Smart grid is developed and tested within a simulation environment and it is then shown and concluded that the three requirements mentioned earlier are met. It is also concluded that the 'T'-Smart grid, its components, properties, grid management rules, models and test simulation results make it a possible future Smart grid solution.