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A predictive optimal dispatch and optimal sizing method for a grid-connected PV-diesel-storage system

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2015-05-07
http://hdl.handle.net/10539/17665

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Abstract

Hybrid energy systems are becoming a popular means of exploiting natural sources of energy and increasing electrical efficiency in urban settlements. However, effective implementation of these systems relies on a means of optimally sizing and operating the system to ensure the lifetime costs of the system are minimised.

This dissertation addresses the problem of minimising the lifetime costs of a grid-connected hybrid system with diesel generation, photovoltaic array (PV) and an energy storage component.

To minimise the operational costs a predictive generator-storage scheduling strategy is proposed. The dispatch strategy seeks to minimise the operational costs by scheduling the generator and storage unit to: 1) Minimise the total energy requested from the grid; 2) Minimise the peak energy requested from the grid; 3) Minimise the fuel used by the generator. The dispatch strategy is developed in two papers. In the first paper a demand prediction algorithm is developed which is required by the proposed predictive dispatch strategy. In the second paper, the actual dispatch strategy for the generator and storage unit is formulated. The dispatch strategy takes the form of an integrated convex optimisation model which, when solved, provides the dispatch strategy for the generator and storage.

An optimal sizing method is then developed to take into account the capital costs of the components. The purpose of the optimal sizing method is to balance the trade-off between the increased capital costs incurred by larger PV and storage units and the corresponding decrease in operational costs.

The optimal dispatch strategy and sizing method are then tested on an example case study which investigates the possibility of operating a hybrid on the campus of the University of the Witwatersrand.