Introduction

In recent years, the contribution that increasing deployment of renewable energy systems in building can make to the UK economy and to national environmental targets has been recognised. A technical issue which has received little attention is the control of such systems. Renewable energy sources are generally of low intensity and temporally inconsistent: these characteristics cause particular control problems which must be solved if the integration of renewable energy into buildings is to be effectively exploited. An optimal supervisory control strategy is developed in this research to address the particular issues.

Renewable energy system

The research has been model-based and structured around an operating building, the Brocks Hill Environment Centre in Oadby, Leicestershire. The building has been designed towards sustainability. The energy systems installed include includes a ventilated photovoltaic array, solar collectors for air and water heating, biomass-fired boiler, a stratified thermal store, and an air-handling unit with heat recovery.

Using dynamic modelling techniques, we studied the following factors of the system:

- The dynamic behaviour of the systems;
- The thermal response of the building;
- Impact of the changes in the boundary variables such as weather and interior loads;
- The energy and performance implications of bringing on-stream an auxiliary energy source.

Optimal supervisory control

The supervisory control problem is, for each source, whether to deploy the received energy directly into the building, store for later use or to reject to the environment. These decisions are currently made by a building energy management system (BEMS) programmed with a complex, arbitrary set of rules and set points. The considerable number of operational states means that such a control system is very difficult to commission. Analysis of the data for the early stages of building operation indicate strongly that it is unlikely that optimal use is being made of the renewable energy sources with this approach. The objective of the research is to investigate the potential effectiveness of replacing the rule-based control scheme with one based on a combination of building/system model with an optimization algorithm.

Results

Periods of exemplar operations were used to compare the existing control with that based on an optimal approach. Results indicate that significant improvements in system operation are possible, but also that significant improvement in execution time will be needed for on-line deployment. The project has served as a proof of concept that, given further development, an optimal or near-optimal control scheme can be found using a combination of a detailed system model and an evolutionary optimization method.

Research Status and Publications

This research project successfully concluded in July 2006.

Acknowledgements and references


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