Dynamic optimal control of thermal energy systems

DYNAMIC OPTIMAL CONTROL OF THERMAL ENERGY SYSTEMS

A.G.E.P. van Delft

Dept. of Physics, T.U. Eindhoven (NL)

ABSTRACT

This paper describes a method of finding the dynamic optimal control strategy for thermal energy systems for residential heating.
The system under study consists of a heat pump, combined with solar collectors and ground storage. Control variables are: the fluid flows between the components and the rotation speed of the heat pump compressor. The performance of the system is expressed in total energy consumption of heat pump and auxiliary heater over a fixed period.
In this paper we will discuss some characteristics of the system, and their influence on the choice of the optimisation method. To calculate the optimal control, the iterative form of dynamic programming is used, with a modified conjugate gradient method.

Thus far, dynamic optimisation has been applied to three configurations. Reductions in energy consumption of about 20% are achieved (as compared to conventional control strategies) owing to a better exploitation of the components in the system, as well as a better anticipating on daily or seasonal changes in heat demand patterns. An example of this will be dealt with in the paper.

It can be concluded that dynamic optimal control establishes a significantly better system performance. Furthermore, this approach leads to a better system design, on the one hand because bottle-necks are revealed and system dimensions can be optimised in the same procedure, on the other hand because the results suggest more cost-effective layouts and configurations.

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