Resources and Energy 4 (1982) 231–263. North-Holland Publishing Company

A SYSTEMMODEL OF COMBINED HEAT AND POWER GENERATION IN DISTRICT HEATING

Aviel VERBRUGGEN*

Universitaire Faculteiten Sint-Ignatius, 2000 Antwerp, Belgium

A model for evaluating the economic performance of cogeneration steam plants in district heating systems is discussed. Emphasis is on a detailed analysis of the production process. Analytical functions are presented for the main determinants of economic performance, i.e., heat load, temperature and mass flow of the water, heat and electric output and fuel consumption of the cogeneration units. Illustrative results, obtained with the model, are given.

1. Introduction

1.1. Low-temperature heat

In this paper low-temperature heat is energy transferred as heat at temperatures above the ambient temperature and below 120°–130°C (248°–266°F). This energy is seldom recognized as a separate product. The demand for low-temperature heat is met by the conversion of high-quality energy (fossil fuels, electricity) taking up 30 to 40% of the total energy flow in some industrialized nations [BMFT (1977)]. Large quantities of low-temperature heat are transmitted as waste to the environment. Markets for low-temperature heat were mostly not organized for simple reasons. Conveyance of low-temperature heat is expensive and the commodity is difficult to store in large amounts for longer periods. These properties require demand and supply to be geographically close and temporally synchronous. Because primary energy was cheap and environmental amenities were abundant, there was little incentive to recuperate low-temperature heat by complex conservation systems.

The 1973 energy price rise stimulated research on the organization of the low-temperature heat market, especially on industrial cogeneration and district heating [e.g. BMFT (1975), BMFT (1977)].

*I wish to thank W. Van Gool, editor of this Journal and two anynomous referees for their extensive comments on a previous draft. Thanks are also due to F. Verhaest, J.L. Roisin and P. Van Speybroeck for their support. P. Coene contributed a lot in improving the text by rewriting parts of it and by stimulating me to clarify some ideas.

0165–0572/82/0000–0000/$02.75