Combined heat and power generation for residential applications
Burrows, J.

Publisher’s version / Version de l'éditeur:

i-Homes & Buildings, Summer, p. 12, 2005-06-01

Combined heat and power generation for residential applications

Burrows, J.

IRC-VISI-422

A version of this document is published in / Une version de ce document se trouve dans :
I Homes & Buildings, Summer 2005, p. 12

Combined Heat And Power Generation for Residential Applications

Published in i-Homes and Buildings (CABA)

By John Burrows

This article summarizes the results of tests carried out to assess the performance of a residential-sized combined heat and power (CHP) system. The tests were conducted at the Canadian Centre for Housing Technology.

Several combined heat and power technologies are under development for residential applications in search of economy, energy efficiency and security against utility power failures. The National Research Council of Canada's Institute for Research in Construction (IRC) was part of a consortium, led by Natural Resources Canada, of Canadian electric and gas utilities and other stakeholders formed to assess the performance of a residential-sized combined heat and power (CHP) system.

The CHP system was installed and assessed in one of the test houses of the Canadian Centre for Housing Technology CCHT).* The test house simulates the heat, power and water usage and schedules of a house with a family of four people. The house was modified to integrate the prototype CHP to heat the house and hot water, provide electricity for the house, and supply surplus electricity back to the grid.

The CHP unit was fuelled by natural gas and had an electrical generating capacity of 750 W and a thermal output of 6.5 kW. It was designed to be controlled by the heat demand of the residence, and to provide electricity generation as a by-product. The unit was installed as a grid-connected device and local electrical inspections were performed. The engine was connected in parallel to the grid and the residual heat from the engine was collected, stored and used to meet space and water heating loads. As well, the house's electrical wiring was reconfigured to permit the CHP generator to provide electricity to both the house, and to the electrical power grid, on occasions where the house loads were less than the CHP unit's electrical output.

The CHP unit was installed in the basement of the test house and connected to thermal and electrical systems. The house thermostat on the main floor wall, and the programmed demand for hot water controlled the CHP by calling for heat from the system. The CHP generated electricity simultaneously whenever there was a demand for heat. Meters tracked how much electricity was being generated and where it was going, whether to the house, to the grid, or both.

Testing took place from March to June and therefore covered the wide range of climatic conditions occurring from late winter to summer for the City of Ottawa. The performance of both the house and the CHP unit were monitored extensively. This allowed the unit's performance to be assessed under a range of space heating loads and the simulated demand for hot water.

Findings

The CHP unit supplied all of the space and water heating loads in most circumstances. In addition, it provided a considerable percentage of the house's electrical requirement, 43% in one example, and even exported 6% of its electricity generation back to the grid in that same period.

The overall performance of the CHP system was shown to compare favourably with the efficiency of domestic combination space and water heaters fired by natural gas, e.g., about 82% total efficiency of the CHP unit, with an average of 76% of the outputs going to heating and 6% going to electricity generation. The heat storage and distribution system designed for this test averaged about 57% efficiency, resulting in a total CHP system efficiency of about 50%. All efficiencies were noted to be higher in colder weather, when the heat was better utilized, and resulted in lower standby losses. Efficiency could be further enhanced through improvements to heat capture and storage.

It is estimated that the cost of incorporating a CHP unit into new residential construction (wiring, metering and controls) is about US $1,600 to $2,400. The value of the unit tested was US$ 12,000. Current models cost approximately US$ 7,500. The study touched on reliability, durability, and the value of the electricity generated, but a detailed calculation of 'return on investment' was not made.

The results show that small, residential-sized combined heat and power systems can be viable alternatives to utility power sources. However, before the mass introduction of residential combined heat and power systems can occur, the following issues must be addressed:

- Utilities need to examine purchasing surplus CHP electricity that could be added to the grid. (This was not a problem for the test house, located as it was on the NRC campus, which already has a co-generation plant in operation.)
- Further investigation is needed regarding the operation of a heat-driven CHP unit in the summer when the thermal load is small.
- Further study is needed to examine whether a backup water heater burner would be required to meet all space and water heating loads of the house.

Combined heat and power (CHP) systems can meet residential power and heating needs in an environmentally efficient way owing to high efficiency and low greenhouse gas emissions. While the testing period in this study was short, the performance of the CHP unit suggests that the system has promise and merits follow-up work to address the identified issues.

The full research report can be viewed at:
http://irc.nrc-cnrc.gc.ca/fulltext/b6010/b6010.pdf

*CCHT is a partnership involving IRC, Natural Resources Canada and Canada Mortgage and Housing Corporation. It began operation in 1999 and is used to accelerate the development of new technologies and their acceptance in the marketplace.

For more information, contact Mike Swinton, Research Manager, Canadian Centre for Housing Technology. Mike.swinton@nrc-cnrc.gc.ca

John Burrows is an Ottawa-based consultant and technical writer.