Available online at www.sciencedirect.com
ScienceDirect
Renewable and Sustainable Energy Reviews
12 (2008) 344–371

RENEWABLE & SUSTAINABLE ENERGY REVIEWS

www.elsevier.com/locate/rser

Ground-source heat pumps systems and applications

Abdeen Mustafa Omer*

17 Juniper Court, Forest Road West, Nottingham NG7 4EU, UK

Received 28 July 2006; accepted 13 October 2006

Abstract

Ground-source or geothermal heat pumps are a highly efficient, renewable energy technology for space heating and cooling. This technology relies on the fact that, at depth, the Earth has a relatively constant temperature, warmer than the air in winter and cooler than the air in summer. A geothermal heat pump can transfer heat stored in the Earth into a building during the winter, and transfer heat out of the building during the summer. Special geologic conditions, such as hot springs, are not needed for successful application of geothermal heat pumps. Ground-source heat pumps (GSHPs) are receiving increasing interest because of their potential to reduce primary energy consumption and thus reduce emissions of greenhouse gases. The technology is well established in North America and parts of Europe, but is at the demonstration stage in the UK. This article provides a detailed literature-based review of ground-source heat pump technology, concentrating on loops, ground systems, and looks more briefly at applications and costs and benefits. It concludes with the prospects for GSHP in the UK. It is concluded that, despite potential environmental problems, geothermal heat pumps pose little if any serious environmental risk when best management practices are applied during the installation, operation, and decommissioning of these systems.

Keywords: Ground-source; Heat pumps; Loops; Applications

Contents

*Tel.: +44 115 978717.
E-mail address: abdeenomer2@yahoo.co.uk

1364-0321/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.rser.2006.10.003

1. Introduction

Climate change is a real threat to our future, and a major cause is the use of fossil fuels to power homes and businesses. Renewable energy, combined with energy efficiency, offers a viable and potent solution to countering the effects of global warming. By installing any one of the renewable energy technologies, one will be making a major personal contribution to the well being of future generations and could also benefit from lower fuel bills.

Our natural sense of heat is based rather more on instinct than on science. Humans are warm-blooded and judge "heat" by comparing it to touch. Since our body temperatures need to be maintained within a few degrees centigrade, our natural senses have evolved to make extremes of temperature uncomfortable. To us, a hot summer's day feels many times "hotter" than the freezing mid-winter. But in reality the Earth's surface does not vary in "heat energy" as much as we might imagine. Scientifically speaking, there is only 11% less energy in cold river water at 5 °C (40 °F) compared to hot bath water at 40 °C (105 °F) [1].

Ground-source heat pumps (GSHPs) provide a new and clean way of heating buildings in the world. They make use of renewable energy stored in the ground, providing one of the most energy-efficient ways of heating buildings. They are suitable for a wide variety of building types and are particularly appropriate for low environmental impact projects. They do not require hot rocks (geothermal energy) and can be installed in most of the