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Geothermal energy: sustainability and the environment

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Abstract

Geothermal resources can be considered renewable on the time-scales of technological/societal systems and do not require the geological times of fossil fuel reserves such as coal, oil, and gas. The recovery of high-enthalpy reservoirs is accomplished at the same site from which the fluid or heat is extracted. Moreover, truly sustainable production can be achieved in doublet and heat pump systems. Generally the environmental impacts of geothermal power generation and direct use are minor, controllable, or negligible. There must be full compliance with environmental regulations, which may vary from country to country. In any case the effects must be monitored and documented (often over long periods), rated and, if necessary, reduced.

Keywords: Resource recovery; Sustainability; Environmental effects; Legislation

1. Introduction

Geothermal energy is usually referred to as a renewable source of energy and as such is listed with solar, wind and biomass as alternative energy options in governmental R & D programs, in materials promoting geothermal energy, etc. It is also termed as environmentally friendly, by virtue of the particularly low emissions of greenhouse gases into the atmosphere. Both attributes are indeed applicable, but within certain limits, which must be addressed in a fully objective manner. Any attempts at disguising or even concealing production decline or a possible impact on

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the environment could bring discredit upon an entire industry, spreading mistrust amongst the authorities as well as the general public (as in the case of nuclear energy).

2. Sustainability

The original definition of sustainability dates back to the Bruntland Commission (1987; reinforced at the Rio 1991 and Kyoto 1997 Summits): *"Meeting the needs of the present generation without compromising the needs of future generations"*. In relation to geothermal resources and, especially, to their utilisation for energy purposes, sustainability means the ability of the production system to sustain production levels over long periods. Often the resources are put into production (with the reservoir fluid as heat carrier) with the main objective of meeting economic goals, in other words, a quick payback of the investment costs of exploration and equipment, with the result that the reservoir is swiftly depleted (Fig. 1). There are numerous examples of this approach worldwide, the most prominent being the vapour-dominated field of The Geysers, USA. In contrast, sustainable production of geothermal energy secures the longevity of the resource, at a lower production level.

Geothermal resources are customarily exploited by withdrawing the fluid and extracting its heat content. There are many important examples of how this can be accomplished in a totally renewable way: thermal springs in many parts of the world

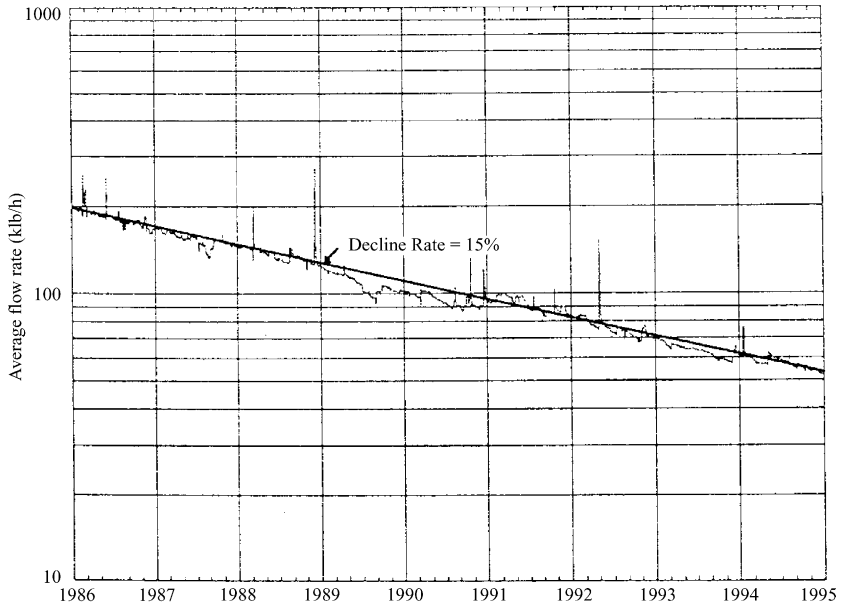

Fig. 1. Example of 150% production decrease over 10 years in the steam reservoir at Calistoga, USA (average daily flow rate versus time; from Sanyal et al., 2000).