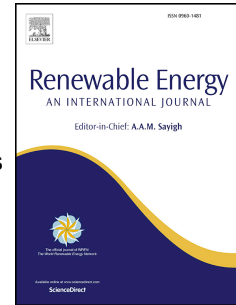


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Environmental Impact by Hydrogeothermal Energy Generation in Low-Enthalpy Regions

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Abstract:

In view of the climate crisis, the development and the path of growth and expansion of renewable energy systems is an urgent task, but must be carried out with great care on environmental compatibility and protection. Renewable energy supply systems that are suitable for grid-bound heat supply, particularly in urban areas in Europe, are geothermal binary plants that provide power as well as power and heat. This paper will present studies whose objective was the assessment of hydrogeothermal power and heat generation in low-enthalpy regions from the environmental standpoint. The German Environment Agency published results of a network of studies conducted between 2008 and 2016 on the analysis of detailed and comprehensive environmental impacts of the geothermal energy generation in Germany and has continuously evaluated these findings. In this article, the results of the Life Cycle Assessment are discussed, taking into account all effects and material flows within the entire life cycle. Based on these balances, differing geothermal systems are compared to each other and to other renewable and fossil energy generation systems in order to assess the ecological advantages and disadvantages of these systems. Taking into account local environmental impacts as well as a comprehensive ecologic evaluation of potential environmental and human health impacts becomes possible. The paper presents the results of a) the mass and energy fluxes of the process chain along the life cycle, and b) the local environmental impacts along the life cycle with regard to the environmental indicators of these cases. The focus is on the impact of site and plant parameters. Concluding, it can be summarised that geothermal power and heat generation is a very low-carbon technology and can contribute to a sustainable energy supply. Hydrogeothermal plants show a significantly low surface consumption, and environmental impacts are only locally relevant and technically controllable. Through the development of optimised overall concepts, geothermal based power and heat generation can achieve minimal environmental impacts in all areas. The combined heat and power generation from geothermal resources is by far the most environmentally and climate-friendly energy supply compared to all other regenerative and fossil systems.

Keywords:

Climate protection, energy policy, renewable energy, heating sector, geothermal energy, environmental impact, Life Cycle Analysis (LCA), local environmental impact

1. Introduction

In December 2015, at the climate summit in Paris the global community adopted a new international climate agreement. Besides its legal obligations, the treaty sets the political direction towards a global decarbonisation of the economy. The Paris Agreement may be called a historical breakthrough for climate protection, but environment scientists also alert that the necessary level of ambition has not yet been achieved. The European Union and Germany have to adapt their climate policies to the more ambitious global goal to hold temperature increase well below 2°C, or even 1.5°C. A key sector to reduce greenhouse gas emissions is the energy sector.

In order to accelerate the research, development and marketability of renewable energy and energy efficiency systems, Germany has enacted legislations such as the Renewable Energy Act (EEG), the Energy Conservation Act (EnEV), and the Renewable Heat Act (EnWG), and thereby promoted the expansion of renewable energies and significantly reduced the greenhouse gas emissions in the energy sector. One of the remaining challenges for Germany is, and it is an urgent need for the whole of Central and Eastern Europe, that climate change mitigation is reliant on the market entry of low-emission energy technologies especially in the heating sector. To cover the demand for heat from low-carbon technologies and renewable energy sources geothermal energy provides a significant potential on a world wide scale [16]. Sufficient geothermal potential exists even in low-

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