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The mode of usage of high temperature geothermal energy in exploited or operating mines

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ABSTRACT

The proposed project offers a number of exciting opportunities and addresses other issues which are currently of major concern. The concept of using 'worked out' or redundant mine working for the location of geothermal generating plants linked to turbo-generators located in the galleries of the redundant mines working will provide a source of clean energy.

It is suggested that the developments, which this project is intended to realise, would provide many European communities with a terrorist resistant energy system.

1. INTRODUCTION

The increasing demand for energy, particularly electrical energy, has been recognised in the western world for several years. However, with the expansion of the Asian economies the global demand is likely to increase at an even faster rate in the next few decades. The effect on the environment of the present energy situation is giving real concern to many of the world's responsible and thinking governments The vast majority of electrical power is still being generated from the combustion of fossil fuels , often in relatively old plants, of low thermal efficiency, using low grade fuel. These aspect all lead to the emission of high levels of pollutants and the deterioration of the atmosphere. These problems have focussed attention on the reduction of emission to the atmosphere. These problems have focussed attention on the reduction of emissions to the atmosphere by the increased use of 'clean' methods of electricity generation with target to replace significant amounts of fossil fuel generated power by renewable sources. This will not be easy as two of the major methods of using the natural sources of 'wind power' and 'solar power' can make useful contributions to the energy balance, but can never meet total demand. The other proven sources such as geothermal energy, fuel cells, wave power and hydro systems are those which are likely to be more reliable and hence more viable for long term planning of future demand. Research to improve Photovoltaic (PV) efficiency and other method s of energy conversion will continue to be most important It is becoming increasingly clear that there is a major problem of transformation and distribution of power at period of peak demand particularly when there is a need for transmission across national boundaries. The major 'blackouts' over the eastern part in the United State s and in Europe, notably in Italy, indicate the fragility of the present systems of electrical energy distribution. A significant amount of thought has been given by many people involved in the energy sector, not only to an increase in the application of renewable energy, but also to the need to develop a system of more localised power generation and distribution.

2.USING GEOTHERMAL ENERGY IN MINE

The project offers a number of exciting opportunities and addresses other issues which are currently of major concern. The concept of using 'worked out' or redundant mine working will provide a source of clean energy. This would have a number of advantages even over the traditional geothermal power stations. With the entire 'buildings' operation underground there will be a reduced visual impact, although there may still be a need for some distribution infrastructure above the surface in some cases. However, it could be possible to design a power station of this type in serve a local area where all geothermal heating plant, transformer equipment and distribution cabling is located underground. If one studies the energy distribution maps for Europe it becomes apparent that there is a potential risk in the world of the 21st century. The world is engaged in a war against terrorism and it has to be recognised that the effect on governments would be much greater if the energy systems, on which western economies are totally dependent, were seriously interrupted. Unfortunately, there are a number of places in Europe where it would be easy relatively to cause a major disruption system of electrical power. It is suggested that the developments, which this project is intended to realise ,would provide many European communities with this project is intended to realise, would provide many European communities with a terrorist resistant energy system. The development of a significant number of similar constructions, to run in parallel, with existing efficient thermal plant and the development of SOFC would provide Europe with viable methods of power generation consistent with the needs to reduce the emissions of gases and other pollutants. The following table 1 shows a renewable sources of energy in Poland (of J .Sokolowski, J .Zimny, R.H. Kozlowski).

Table 1

	Renewable sources of energy	Energy potential (PJ/year)	Share (%)
1	**Geothermal energy**	**625 000**	99,8
2	Biomass	407	0,2
3	Solar energy	280	
4	Wind energy	140	
5	Water energy	43	
Total		625 870	100,0
Annual demand in Poland (2004)		4 200	

The project outcome would be of real application to any area with deep mining of coal and this clearly would apply to many European areas, i.e . in Germany, France, U.K., Czech Republic, etc. Although it is not a part of the project application, a successful would be equally applicable to any form of deep mining of mineral deposits worldwide. Steam extracted from Devonian geological structures is intended to be raised to 850 degrees Celsius in electrical furnaces and used for SOFCs for increased electrical generation or

hydrogen production. ECN in Petten (The Netherlands), Risoe Natonial Laboratory (Denmark) and a few other European institutions are working on a similar process using steam generated by conventional combustion techniques (so–called high temperature solid oxide electrolyser concept) . On the other hand , there is a clear indication in the EU that a hybrid option of energy conversion should be developed i.e. geothermal and fuel cells (example in Iceland).

The use o f geothermal waters and their energy together with the existing operating coal mines, would make it possible to create a geopower engineering system, mostly hidden under the ground surface, advantageous in the time of terrorism, which would secure the production of electrical and thermal energies for domestic and foreign needs.

In future years the production of clean energy, generated from geothermal and geothermic sources, would increase

And the coal resources could be used in chemical plants to produce plastics and oils or in gasification process for modern power plants based on fuel cell modules.

3. RESEARCH TOPIC

The proposed method of generating electricity in exploited or operating mines(A)extracts high-temperature geothermic energy from the strata(D) below the exploited layers(C)and the overburden(B)at the level of excavation.

The system consist of a supply well (shaft or borehole); a turbine with or without a heat exchanger; an electrical power generator, and a discharge well. In the automatic, closed cycle part of the system, water or high-temperature geothermal steam performs the function of a carrier, and the whole system can be completed with successive heat exchangers attached to heat pumps. The proposed system enables the geothermal energy contained in water or steam to pass from a supply well (1) through a heat exchanger (W) to a turbine (T) drives an electricity generator (G).

The remaining thermal energy of water or superheated steam can be used in the associated system consisting of heat exchangers and heat pumps (PC) installed either at the level of electricity generating system or on the ground surface Implementation of this concept can help to produce clean and inexpensive electrical and thermal energies from renewable geothermal sources. In the summer thermal energy can be used for refrigeration and air conditioning. The invention, in its mode of operation, is illustrated in Fig.1, which shows a diagram of the system situated at the bottom of deep mines receiving high – temperature geothermal energy from an well exploitation with dual heat exchangers to turbine– energy generator and a heat pump. Fig. 2 illustrates the receiving of thermal energy by a turbine from the system: exploitation well – absorbing well through a heat exchanger. Fig. 3 shows a similar situation but without a heat exchanger. The proposed project covers the following aspects: designing a minimum of two geoenergy station for transforming energy from geothermal steam to electricity and heat. Designing a geoenergy plant for transforming energy from exploited or operating mines to the production of electricity and the adapting and utilising a GPS system to determine the drill tower location over mines tunnels.

4. POTENTIAL FOR INOVATION

There are two categories of current usage of geothermal sources at ground level both of which can be considered analogous to fossil fuel systems. One of them is heat generation for :space heating, swimming pools, balneology, heat pumps and greenhouses. The other is electrical power generation. There are also installations, which simultaneously provide both thermal and electrical energy. These are similar to conventional heat and power plants. The essential element distinguishing geothermal power engineering from conventional power engineering in that the former is employing renewable sources – it is ecological and does not harm the environment. However, not all of the numerous geothermic and geothermal sources, which can be found in Poland or elsewhere, are adequate for producing electrical energy. The temperature and pressure of geothermal water or superheated geothermal steam which can be obtained at the outlet of a supply borehole have to be taken into account. Undoubtedly, much better conditions for a turbine driving an electrical generator can be found if high pressure and high temperature superheated steam is available. The exciting prospect of this proposal is that it recognises that such resources can be tapped by utilising the energy sources deep underground at the depths at which many mine workings are located. The extensive networks of galleries associated with mining operations will make it possible for multiple generating units to be installed in one mine complex to give the same electrical output a s a large conventional station. It is worth re-emphasising that another attraction is the additional security of supply of electrical power that such underground installations provide un the face of potential terrorist attacks, which the world is currently confronting.

5. UPPER SILESIAN COAL BASIN.

The relevance of such a project for Poland is the existence, under the south- central part of Poland’s Upper Silesian Coal Basin, a geographical region covering an area of 2700 km sq., of a 1000 metre thick stratum of Devonian limestone filled with geothermal waters at temperatures between 100 and 165 °C. Similar geostructural conditions are found and exploited in the areas of hard coal occurrences throughout the world. Higher temperatures are found at the level of hot geothermic rocks. The use of such waters and their thermal energy together with the existing operating coal mines, would make it possible to create a geopower engineering system, mostly hidden underground which would secure production of electrical and thermal energies for home and export need. As the production of clean energy generated from geothermal and geothermic sources would increase, the existing coal resources could be more usefully employed in chemical plants to produce plastic and oil, or in a gasification process for modern power plants based on fuel cell modules.

The coal resources should be used economically and reserved for the future generations, in accordance with the needs of sustainable economic growth.

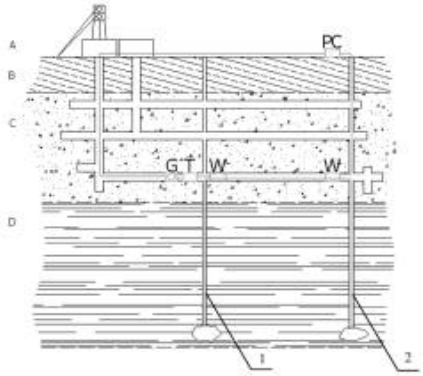

Fig. 1 System with dual heat exchangers

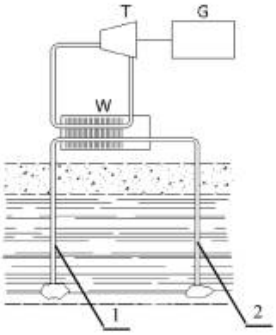

Fig. 2 System with a single heat exchanger

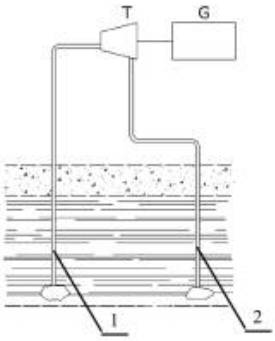

Fig. 3 System without a heat exchanger