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Country Update for the United Kingdom

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ABSTRACT

The exploitation of geothermal resources in the UK continues to be minimal. There are no high temperature resources and very limited development of low and medium enthalpy resources. Research into Hot Dry Rock technology has ceased in terms of fieldwork in the UK. An exploratory 1000m borehole is currently being drilled at Eastgate, Weardale in northeast England to exploit potential warm water resources.

There is an increasing awareness of the use of groundwater for heating and cooling of domestic, commercial and public buildings and a number of high profile projects have been undertaken.

The use of flooded mine workings as a source of fluid for major projects is also under consideration.

1. INTRODUCTION

In a worldwide context, the exploitation of geothermal energy in the UK remains minimal. The geological and tectonic setting precludes the evolution of high enthalpy resources at economic depths and only low to moderate temperature fluids are accessible. Fluids of moderate temperature have been identified in sedimentary basins in the south and Northeast of England, and elevated temperature gradients have been measured in some 'dry' granitic intrusions, particularly in Southwest England. These granites were previously the site of the UK's Hot Dry Rock programme, but this programme has now ceased.

The UK Government is committed to achieving a target of 10% of its electricity generation from renewables by the year 2010 but there is no direct support for geothermal. There are, however, grants available for individuals and communities who wish to utilise ground source heat pump systems.

2. GEOTHERMAL UTILISATION

There is no electric power generation from geothermal resources in the UK (See Table 1).

The City of Southampton Energy Scheme remains the only exploitation of low enthalpy geothermal energy in the UK. The scheme was started in the early 1980s when an aquifer containing 76°C fluid was identified at approximately 1800 metres in the Wessex Basin. Construction of a district-heating scheme commenced in 1987 and this has since evolved and expanded to become a combined heat and power scheme for 3,000 homes, 10 schools and numerous commercial buildings.

The famous hot springs at Bath have long been a tourist attraction among the Roman architecture of the ancient city. Now the baths, together with four adjacent listed buildings, are undergoing a major refurbishment, which began in 2000 under a Millennium Commission grant. Unfortunately the refurbishment has been beset with technical difficulties and is not yet complete, but work continues.

Greater use is being made of groundwater for a number of heating and cooling projects in London. Traditionally used for hospitals, swimming pools and factories, more novel applications are now being considered. The new Greater London Authority building in central London is one of the greenest buildings in the city, with both passive and active energy design elements. Among them is the use of water from the aquifer beneath London, which provides air conditioning and is then recycled for use in toilets and irrigation. Open loop geothermal systems have been used to heat and cool several other prestigious projects in the UK recently; the Queen's Gallery, Portcullis House and the Mayor of London's offices all use this type of system. These systems in London use water from the naturally porous chalks and sandstones under the city.

3. EXPLOITATION OF FLOODED MINES

A large number of mine workings have been abandoned in recent years in the UK and most of them have now flooded, or are flooding. In many areas these represent a renewable energy resource that can be exploited now with current technology. Any project with a heating, hot water or cooling load in the vicinity of mine workings is a potential candidate to use the resource.

The mines reached depths in excess of 1000m with rock temperatures of over 50°C. It is estimated that more than 25% of the mined volume still forms permeable and open pathways in the rock despite the collapse of the old workings. This mine water energy resource is one form of an open loop, low temperature geothermal resource that is in common use throughout the world. However, the underground voids created by mining allow the ground water to accumulate in otherwise low permeability formations where it can be pumped out for use.

Several projects using mine water as the energy source are already in operation; two are in Glasgow, heating blocks of apartments. A major project has been planned for a regeneration development in Midlothian, Scotland. Work has just commenced on the detailed design for a new town on the site of the former Monktonhall Colliery. The Monktonhall project to support the Shawfair new town is of a similar size to another potential project; the Camborne Redruth Urban Regeneration programme in Cornwall. There is potential to support over 4000 homes, schools, hospitals, leisure centres and commercial premises with a thermal load of over 50 MWt. A recent unpublished review of the potential resource from old coal mines in Scotland suggests that a conservative estimate of 300 MWt of heat could be produced indefinitely in areas with matching heat loads. The underground conditions in Cornwall are generally more favourable and the interconnection between mine workings

are probably more extensive than in the Scottish project. However, there are fewer mine sites in Cornwall located in areas of intensive housing or developments with high heat load densities than in Scotland. Notwithstanding this possible limitation, Camborne-Pool-Redruth is an ideal area to consider such projects with the extensive mining activity coinciding with plans for intensive urban renewal.

Technically, an individual project can be of any size but, typically, it would make sense to consider 100-300 home modules, (1 MWt-3MWt). Water would be pumped from a mine, through the heat exchangers where it is cooled and returned to the mine workings or discharged. The heat is extracted by heat pumps that could be driven by carbon dioxide free electricity or a biofuel powered combined heat and power unit. In this way, 3-5 times more heat can be delivered than simply burning the fuel in the first instance and with zero or carbon neutral carbon dioxide emissions.

There are no technical barriers to putting the old mine workings back to work in sustainable developments to provide heating, hot water and cooling. However, the issues of surface and subsurface ownership, licences for abstraction and discharge, the control of pollution and the potential claims of mineral owners are issues that will need resolution for any particular project. Assuming these legal and commercial issues do not become obstacles then several thousand properties and developments could use existing technology to exploit a resource of general benefit to the UK.

4. GROUND SOURCE HEAT PUMP SYSTEMS

The difference in this update of UK geothermal activity is that over the reporting period, ground source heat pumps (GSHPs) have at last been recognized as having a role to play in the delivery of heating and/or cooling and domestic hot water. In particular it is now understood that ground source heat pumps connected to the UK electricity grid offer very substantial reductions in overall carbon emissions compared to conventional fossil fuelled systems. This has led to the inclusion of ground source heat pumps along with other renewable or alternative energy technologies into several official energy programmes. The industry is still embryonic in the UK compared to other northern European and North American countries, but a wide range of projects are now being tackled. New build and retrofit social housing schemes through to large commercial and institutional projects and a wide range of domestic installations are now operating at locations throughout the UK. The Clear-Skies programme which has been set up to promote a handful of renewable technologies has increased awareness of GSHP systems dramatically, and has led to accreditation standards for both installers and heat pumps. October 2004 saw the launch of a UK Ground Source Heat Pump Club at the National Energy Foundation. This should be the precursor to the establishment of a trade association. It is anticipated that due to changes in fuel tariffs and pressure to reduce carbon emissions, there will now be a rapid acceleration in the installation of GSHPs in the UK, albeit from a very low baseline.

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TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY (Installed capacity)

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Renewables (Specify)		Total	
	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. Gwh/yr	Capacity MWe	Gross Prod. GWh/yr
In Operation in December 2004			60,796	291,757	4,256	5,962	12,098	88,686	1,394	6,708	78,544	393,113
Under Construction in December 2004												
Funds committed, but not yet under construction in December 2004												
Total project use by 2010												

TABLE 2. UTILISATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT AS OF 31 DECEMBER 2004 (other than heat pumps)

Locality	Type	Maximum Utilisation					Capacity (MWt)	Annual Utilisation			
		Flow Rate (kg/s)	Temperature C		Enthalpy kJ/kg						
			Inlet	Outlet	Inlet	Outlet		Ave Flow (kg/s)	Energy (Tj/yr)	Capacity Factor	
Southampton (Western Esplanade)	D	15	72	28			2.761	12.5	72.545	0.83	
Penryn (Gabbons Nursery)	G	5	22	10			0.251	5	7.914	1.0	
Bath Spa (Avon)	B	13	46.5								

TABLE 3. GEOTHERMAL (GROUND SOURCE) HEAT PUMPS AS OF 31 DECEMBER 2004

Locality	Ground or Water Temp C	Typical Heat Pump rating (kW)	Number of Units	Type	COP	Heating equivalent Full Load Hr/Year	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
~300 domestic sites throughout UK	9 -12	Avg 8 (3.5 to 16 kW)	~ 500	V And H	3 to 4	1800	17.7	
~ 50 commercial & institutional sites throughout UK	9 – 12	Avg 125 (30 – 400 kW)	~ 50	Mainly V	3 to 3.5	1800	27.9	11.6
Total							45.6	11.6

TABLE 6. WELLS DRILLED FOR ELECTRICAL, DIRECT AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 2000 TO DECEMBER 31, 2004 (excluding heat pump wells)

[1] Include thermal gradient wells, but not ones less than 100 m deep

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (specify)	
Exploration[1]	(all)		1			1000
Production	>150° C					
	150-100° C					
	<100° C					
Injection	(all)					
Total			1			1000

TABLE 7. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with University degrees)

1) Government
2) Public Utilities
3) Universities
4) Paid Foreign Consultants
5) Contributed Through Foreign Aid Programs
6) Private Industry

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2000	0.1		0.5	-	-	3
2001	0.1		0.5	-	-	4
2002	0.1	0.1	0.5	-	-	5
2003	0.2	0.1	1.0	-	-	6
2004	0.2	0.2	1.0	-	-	7
Total	0.7	0.4	3.5	-	-	25

TABLE 8. TOTAL INVESTMENTS IN GEOTHERMAL IN (2004) US$

Period	Research & Development Incl. Surface Explor. & Exploration Drilling Million US$	Field Development Including Production Drilling & Surface Equipment Million US$	Utilization		Funding Type	
			Direct US$	Electrical US$	Private %	Public %
1990 - 1994	~0.5					100
1995 - 1999	-					
2000 - 2004	~0.5		~7.0		40	60