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Is Renewable Heat Incentive the future?

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ABSTRACT

This paper focuses on the renewable heat incentive (RHI) scheme in the United Kingdom (UK); and in particular, on its implications in relation to solar thermal systems (STSs). First, a short review on the UK's energy demand is provided. Then, an overview of the past and present activities related to STS installations is discussed, covering regulation, policies and programmes, research and development expenditures and implementations. A financial analysis is presented afterwards, analysing the RHI scheme, in terms of total profit, payback period and average annual return on investment. This is based on installations of different sizes and at various levels of solar insolation. The analysis also presents the reduction of carbon dioxide emissions that could be achieved by installing an STS. From the financial analysis it is found that the RHI scheme could generate a good total profit, a high average annual return on the investment and an 'acceptable' payback period, depending on locations. As a result, it could increase the penetration of solar thermal systems in the UK. Significant reductions of carbon dioxide emission can also be achieved by installing an STS on a building.

Contents

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1. Introduction

Renewable energy has grown significantly in the past few years. A report by the Renewable Energy Policy Network for the 21st Century (REN21) [1] indicates that presently, about 16.7% of the world's energy consumption is from renewable sources and the rest from fossil fuels and nuclear. Solar energy is one of the forms of renewable energy that has great potential. In 2010, Abbot [2] estimated that solar energy could produce 85,000 TW per year, enough to satisfy the world's energy requirement of 15 TW. The two main applications of solar energy are for electricity generation (via solar photovoltaic (PV) systems and concentrating solar thermal power (CSP)) and for solar heating and cooling (SHC) applications [3].

One of the technologies for SHC applications is the solar thermal system (STS).[1] An STS utilises the heat from the sun to increase the temperature of water. A typical STS consists of four main components (see Fig. 1) [4]: (i) a solar collector which is used to collect solar energy; (ii) a storage tank for storing the solar-heated water; (iii) a supporting stand to mount the solar collector, and (iv) connecting pipes and devices such as the boiler, drain valve, pump and sensors. When the demand cannot be met by a solar collector, the system is usually in need of an auxiliary means of heating the water, i.e. it needs to use a boiler. The three most common collectors for STS are unglazed, flat plate and evacuated tube [5].

The International Energy Agency (IEA) has reported that in early 2011, the solar thermal market has reached 245 GW_{th} of installed capacity and generated 204 TWh [6]. In terms of total capacity and energy production, solar thermal is placed second only to wind amongst the renewables [6], as illustrated in Fig. 2. In terms of annual growth rate in 2011, solar thermal system was placed third (27%) behind solar PV (74%) and CSP (35%) [1]. The vast majority of the capacity was installed in China (117.6 GW_{th}) and Europe (36.0 GW_{th}), corresponds to 78.5% of the total installation worldwide [6].

The United Kingdom (UK) is one of the countries that have been focusing in developing and installing STS. The country is located in the Western Europe and consists of four states—England, Wales, Scotland and Northern Ireland covering a total area of 243,610 km^2 [7]. It has a total population of 63 million people [7], living in approximately 26.4 million households [8].

From 1970 until 2011, the total energy consumption in the UK varies between 1579 and 1871 TWh per year mainly from petroleum, gas, electricity and solid fuel [9]. Although the energy consumption does not differ much, significant changes can be seen in terms of total expenditure on energy, as illustrated in Fig. 3. The UK spent about £5 billion in 1970, but the amount increased by 27 fold in 2011, totalling £134 billion [9] mainly due to the increase in the fossil fuel price. In 2011, the UK consumed 1610 TWh of energy, primarily in four major sectors; transport (30%), domestic (30%), industry (23%) and services (17%) [9]. A detailed breakdown of the energy usage for each sector (excluding the transport sector) indicated that heat is the major contributor to the energy usage, about 81%, 54% and 65% for the domestic, service and industry sectors respectively [9]. Table 1 shows the breakdown of energy consumption by end users (excluding the transport sector) in 1990, 2000, 2010 and 2011.

It is projected that by 2030, the total population will increase to 69.9 million people and the total number of households will increase by 21% totalling to about 32.1 million [10]. The increase in population could result in an increase in the energy requirement in the country. This, plus other factors such as fossil fuel dependency, energy security and energy cost prompted the UK Government to introduce a number of measures to elevate the usage of renewable energy in the country. STS is one of the possible solutions in providing heat to buildings.

The government has expressed its commitment to increase the renewable energy penetration in the country, which includes solar energy. The UK receives a moderate amount of sunlight, with an insolation of between 800 and 1300 kWh/m^2 per year [11] depending on location, with an average of around 1000 kWh/m^2 [12]. Fig. 4 shows the average yearly solar insolation in the UK.

Section 2 presents an overview of past and current regulations, policies and programmes related to STSs. Section 3 discusses the research and developments spending while national implementation of STS is evaluated in Section 4. Section 5 presents a financial analysis in relation to the Renewable Heat Incentive and its impact on domestic and non-domestic consumers in the UK. In Section 6, the reduction in carbon dioxide emissions by installing STSs is deduced. Conclusions are presented at the end of the paper.

2. National regulations, policies and programmes

Despite the moderate levels of insolation at northern latitudes, the UK government recognises the potential of solar energy. To ensure a sufficient penetration amongst its citizens, the government has introduced a number of policies. The impact of these policies has been discussed in a number of research papers [14–16]. To date, there are about 67 different energy policies which arise both from the European Union (EU) directive and from the country's national initiatives [17]. These policies are designed to address the energy and climate change agenda as a whole. All the information on energy policies is reported to the European Commission (EC) and the qualitative database of measures for each EU country can be accessed in MURE (Mesures d'Utilization Rationelle de l'Energie), an online database created from an EC-funded project [17]. As this paper focuses on the STS, only the major policies which relate to STS installation are discussed.

[1] For this paper, a solar thermal system is defined as solar hot water and heating system.