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Effectiveness and weaknesses of supporting policies for solar thermal systems—A case-study

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ABSTRACT

It is well known that the European Union has pledged to achieve by 2020 a 20% share of renewable sources in final energy consumption and the same share as reduction of final uses. To achieve these goals, the solar thermal sector could provide an important contribution, since the demand for heating and domestic hot water production accounts for 37% of the total energy demand in Europe. In recent years, several supporting policies were actuated in the EU countries and, among these, the Italian Ministry of Environment, in collaboration with Regions, developed several measures for local renewable energies integration in the regional territory, also with the purpose to spread solar thermal water heating (SWH) systems in the built environment. This paper's goal is to evaluate the effectiveness of the supporting strategies to SWH through a comprehensive assessment on the Lombardy Region case-study; to that end, representative indicators were calculated and analyzed. In particular, a so-called *Renewables Incentive Paradoxical-Effect* (RIPE) was experienced, according to which the greater is the specific amount of subsidy over the years, the higher is the recorded turnkey cost of the specific technology. The results obtained are described in this paper, in order to orient future choices and identify the most promising strategies for improving SWH.

1. Introduction

The world market for solar thermal systems has been growing continuously since the beginning of the 1990s. According to a recent study of IEA (2013) on solar thermal market conducted for 56 countries all over the world, an installed capacity of 234.6 GW_{th} corresponding to a total of 335.1 million m^2 of collector area was in operation by the end of 2011. The installed capacity in these countries represents more than 95% of the solar thermal market worldwide. The vast majority of the total capacity in operation was installed in China (152.2 GW_{th}) and Europe (39.3 GW_{th}), which together accounted for 81.6% of the total installed.

The European Union pledged to achieve by 2020 a 20% share of renewable sources in final energy consumption and the same share as reduction of final uses. To achieve these goals, the solar thermal sector should provide an important contribution, since the demand for heating and cooling accounts for 49% of the total energy demand in Europe. Within the heating and cooling sector, solar thermal energy will play a vital role. To date, it has only covered a minor share of the heating demand in Europe, although it has the greatest potential of all renewable energies for heating and cooling.

At the European level, in spite of the decrease recorded over the last four years, the annual market size for solar thermal systems has doubled over the past decade at an average annual growth rate of 10% (ESTIF, 2013). The outlook remains uncertain, but it is expected that the main markets could be negatively affected by the lack of government incentives programs and stagnation in the construction industry resulting from the global financial crisis. Positive and opposite effects should be generated by the RES Directive (2009/28/EC), that should contrast the stagnation by introducing incentives for heat production from renewable sources (NREAP, 2009).

The development of the solar thermal market over the last decade shows its strong dependency on external factors, e.g. fossil fuel energy prices, new evolving heating technologies, supporting programs etc. This translated into great uncertainties in the market forecasts and reinforces the need for a strong political support to accelerate the market uptake of solar thermal (ST). One of the barriers for the diffusion of ST technology could be attributed to the high cost of ST systems. Solar thermal heat is often not yet competitive, but the potential of cost reduction, which can be achieved through R&D support, is still vast and the market develops well. As evidenced, since 1995 solar thermal collector production costs

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have been cut by nearly 50%, which corresponds to a learning factor of 23% achieved over the past 15 years (ESTIF, 2012).

In the past, several European countries adopted the policy to support ST technology by providing different financial incentives to stimulate the market (Beerepoot, 2007; ESTIF, 2006; Roulleau & Lloyd, 2008; Valentini & Pistochini, 2011). The overview on these energy policies is discussed in the following section. Currently, financial incentives for solar thermal energy, together with other systems for generating heat from renewable sources, are planned or under study at national level (D.M. 28/12/2012; DECC, 2001).

As an effective example of such energy policy in recent years, the Italian Ministry of the Environment, in collaboration with Lombardy Region (northern Italy), has developed several measures for energy efficiency and local renewable integration in the regional territory, within the so-called Framework Program Agreement on Energy and Environment. Public support has consisted in the provision of grants to finance companies and private entities, on the basis of a public selection. Among various measures, one is related to the diffusion of solar thermal (ST) systems in the built environment. The incentives were provided within different calls: most of the systems funded are SWH, and a few belong to advanced technologies related to space heating and cooling applications.

This paper aims to evaluate the effectiveness of supporting strategies for SWH through a comprehensive assessment on the Lombardy Region case-study; to that end, representative energetic, environmental and economic indicators were calculated and analyzed.

2. Financial incentive schemes for solar thermal technologies in the European countries

Solar thermal technology has been promoted by different kinds of financial incentives (FI) in a number of European countries, regions and local communities. Financial incentives include any public policy providing a financial advantage for solar thermal systems. In Europe, in the past, two kind of main mechanisms for FI have been used: Direct grants/subsidies and Tax credits/reductions.

Direct subsidy is the most common type of policy to promote renewable energies. Solar water heaters have been subsidized in many regions and countries such as Austria, Germany, Sweden, Netherlands, Italy, Greece, however, the way the subsidy is granted can lead to different results. In most cases, the subsidy is related either to the collector area, or to the system performance.

In addition to direct subsidies, some governments, including France, Greece and Italy, used and currently use tax credits/deduction as a financial incentive. In the tax credit scheme, a fraction of the capital cost of the SWH system is deducted from the amount of tax that the consumer had to pay. As for tax credits, tax deductions are related to the customer's income tax. By off-setting investment costs against taxable income, the customer could reduce investments costs. In Greece, such a policy tool has been used in the past and is currently effective in Italy.

Some examples of such financial incentives in European countries are described below.

Germany has provided grants to solar water heating systems since 1995, first by a '100-million-program' followed in 1999 by Market Stimulation Program (MSP), which remained effective until 2009. The German MSP was extremely successful just up to 2001, because the volatile promotion rate due to the interruptions and regular corrections in the program led to strong fluctuation in market adoption. Despite the obvious lack of stability, the MSP was successful in terms of overall market development.

Austria sponsored solar thermal systems for almost 30 years. High-level grants and the confidence in efficient solar water heaters, enforced by long-duration policy, have enabled the success of solar thermal energy in Austria.

In Sweden (Roulleau & Lloyd, 2008), a subsidy scheme was launched in 1992, but then abandoned in 1997 and a new subsidy was introduced in 2000. The Swedish program led to an increase in the solar collector area installed during the years 2001–2005, however also led to an increased price of the solar energy systems installed. This could be explained by the fact that during the financial incentive regime the demand for solar thermal systems increased rapidly, but the supply did not in the same way, and therefore the system costs increased, experiencing a so-called Renewables Incentive Paradoxical-Effect (RIPE). The results of the solar subsidy policy in Sweden, however, appeared to be disappointing in terms of penetration, but this should be viewed in light of Sweden having a very strong market for heat pumps and the availability of solar radiation being one of the lowest in Europe.

In the Netherlands, the government has been implementing subsidy schemes since 1988. As an effect, between 1994 and 2001 the solar collectors area installed annually in the Netherlands increased steadily. By 2003 and the end of the subsidy scheme, however, the annual additional installed solar collector area started to decrease, suggesting that the installation rate was tied to the subsidies. In fact the installation of SWH in existing buildings nearly stopped, but the new-built sector has, however, remained active because of the increasingly tight energy efficiency requirements for new buildings. In fact, another study (Beerepoot, 2007) concluded that the incentive from energy performance standards in the Netherlands appeared to be too low to promote the use of solar thermal systems, and that energy performance standards need to be more severe in order to stimulate such use.

The first French incentive policy "plan soleil" was launched in 1999 and remained effective for 9 years, until 2008. The policy evolved considerably during the first 7 years. Initially, the user of a solar water heater benefited from a subsidy as well as a reduction in VAT, then replaced by a progressively increasing tax credit. Buyers, however, benefited from the tax credit after 1 year of the purchase of the system, which may have had an adverse impact on the effectiveness of the scheme. By 2006, France had the most subsidized solar hot water market in Europe; as a consequence, France thus had the fastest growth of SWH sales in Europe. However, while deployment grew, the costs of the SWH increased between 2000 and 2006. A RIPE effect, as in the case of Sweden, could partly explain this increase in cost, but the perverse effect of a tax credit scheme may also be the answer.

In 1970, Greece started an incentive program of high amount of tax deduction on solar thermal systems, which led to reaching the market for SWH in 2002 at a critical size and being capable of self-supporting. The tax deduction program in Greece was judged to be very successful, at least during the first years. However, the policy had an important equity issue; people who paid the highest amount of taxes (the richest part of the population) obtained the maximum cost reduction.

In Italy, in the past, solar thermal technologies were supported through subsidy incentive schemes at regional levels across the Country (ESTIF, 2006). The current scheme, 55% tax deductions, in force since 2007, represents the most generous system of incentives ever established by the Government to promote energy efficiency and thus solar thermal systems in the Italian real estate context (Valentini & Pistochini, 2011). The effect of this incentive scheme is evident: during these years the Italian market for solar thermal systems is growing continuously and has consolidated its second position in Europe, after Germany (ESTIF, 2013).

As described above, in many cases the financial incentives for supporting solar thermal technology worked well and produced a significant effect on market development. In other cases, financial incentives were not as effective, and, in the worst cases,