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Photovoltaic remuneration policies in the European Union

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HIGHLIGHTS

- ▶ This work shows the EU positioning on development of photovoltaic (PV) systems.
- ▶ The installed power and the internal rate of return have been used as reference.
- ▶ The existing programs in relation to pay and incentives have been reviewed.

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ABSTRACT

The purpose of this paper is to study the development of photovoltaic (PV) systems in some countries of the European Union (EU). We establish the stage of development of each country, their short- and long-term degree of compliance and the trends of international investors favouring one market or another. EU countries employ four major types of programs to encourage PV use: (1) feed in tariffs (FIT), (2) green certificates with a quota system, (3) investment and tax incentives, and (4) bids on the quota system. The FIT is the most widely used program to create incentives for the use of PV systems. During the past two years, PV tariffs have been reduced in many European countries. Investments in PV are still attractive, in some cases even overly generous with respect to the financial landscape in the world.

This paper shows, for each country, the type of incentive and the trends in and forecast for installed capacity and calculates the internal rate of return (IRR) for investment in grid-connected PV systems.

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1. Introduction

Photovoltaic (PV) installation has seen remarkable growth since 2005, especially in the European Union (EU). The general philosophy is to encourage the installation of PV solar energy by promoting private, profitable investment in a particular PV plant. This remuneration policy is the key to the development and future of the PV industry, for both the private investors and governments involved. Despite having lower solar radiation than other countries in Europe, Germany has led the market since 2004 and positioned itself as a leader in the industry.

The program most often used to encourage PV installations is FIT, a fixed-price contract for a specified period of time with procedural operating conditions. Recent experience indicates that FIT is the most effective reward system to increase the development of various power generation systems (Couture and Gagnon, 2010). FIT can be combined with a premium on the price of energy in the spot market. The amount of the premium is related to the cost or value of the energy generated.

This remuneration system may count the total kWh produced, including consumption (gross FIT), or the net kWh (net metering). Gross FIT implies that all the energy produced by the PV system is remunerated and that the energy consumed by the system (for example, the energy used by the house in a home PV system) is bought to the electrical grid at the price of the electricity. Net metering, on the other hand, grants remuneration for only the net energy injected to the electrical grid (the energy produced by PV minus the energy consumed by the system). Tariff rates may vary depending on plant size, technology, and other factors, and their value may decrease over time.

Another program used by some countries is the green certificates with quota system. Under it, the government requires producers, distributors or consumers to maintain a certain quota of renewable energy in their overall energy consumption. The price of energy is set by the actors involved in the program. The quota system is generally known as a quota obligation or Renewable Portfolio Standard (RPS) in the United States. Green certificates are the primary mechanism used to implement this system.

Government tax incentives and support for investment are also used to encourage the use of PV systems. A set of measures eases access to credit and reduces the tax burden for the installation of PV systems. The cost of capital is seen as the main

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barrier to the development of the PV industry. Different measures act as investment support, such as grants and loans, or tax incentives, such as tax credits, reduced taxes, and accelerated depreciation. Incentive programs usually use a combination of these methods.

The fourth program employed in some countries is the bid to quota system, in which the government holds public auctions for certain projects to produce electricity. Each producer has a project, and the winning bidder is then paid for it.

The following sections of this article show the current development of and forecast for several European countries that have opted to promote PV energy. The forecast was produced through comprehensive, extensive data collection and market research based on a highly representative sample of the PV industry, national associations, and energy agencies. Through the cross-checking of data and the consolidation of complementary market projection methods, two scenarios for the future development of the PV industry are proposed: the government sales policy-driven and the moderate scenarios. The government sales policy-driven scenario refers to the potential for installing PV created by each regulatory framework. This potential depends solely on the power ceiling in each country. Without a power ceiling, it is estimated that the maximum value of the power will be installed. The moderate scenario refers to the power expected to be installed annually in each country, depending on the sector's capacity, the number of companies, and other factors. The differences between the moderate scenarios and governmental forecast scenarios arise from the market response to the different incentives offered by countries.

The mechanisms of financial support given to different sources of power generation in different countries (Badcock and Lenzen, 2010) have strongly encouraged the development of solar energy in particular. Consequently, the past economic boom and government guarantees have increased some financial groups' interest in investing in PV generation (Szabó et al., 2010) when the profitability ratios, financial conditions, and quantification of risk are clearly defined. Investors have become a fundamental part of the energy policy framework in all countries (Bürer and Wüstenhagen, 2009), especially in the current situation in which access to financing is limited.

This article explores how the different methods of FIT implemented in different EU countries balance the market and PV industry.

Table 1 shows the internal rate of revenue (IRR) and other relevant data for different EU countries. The data displayed in Table 1 are discussed and analysed in the following sections.

Table 1
IRR and other relevant data in some EU countries.

Country	Specific Annual Yield ^a kW h/kWp	FIT €/kW h	Corporation Tax ^b %	VAT %	Lifetime years	Electricity Price (Europe's Energy Portal, 2012) €/kW h	IRR Loan Model %	IRR W/O Loan %
Germany	1250	0.1601	29.51	19.00	20	0.2282	10.84	8.39
Spain	1575	0.21	30.00	18.00	25	0.172	34.60	15.16
France	1275	0.2137	33.33	19.60	20	0.1215	21.00	12.49
Italy	1500	0.233	31.40	20.00	20	0.1946	37.50	16.02
Greece (Continent)	1500	0.292	25.00	19.00	20	0.1061	20.00	21.46
Greece (Islands)	1500	0.292	25.00	19.00	20	0.1061	20.00	21.46
Portugal	1500	0.32	25.00	22.00	15	0.1668	80.00	23.20
United Kingdom	975	0.19	28.00	15.00	25	0.1347	9.38	7.74
Belgium	900	Various	34.00	21.00	Various	0.1896	Various	Various
Bulgaria	1275	0.367	10.00	20.00	25	0.0865	81.66	25.41
Czech Republic	880	0.423	19.00	19.00	20	0.1455	46.52	18.34
Switzerland	1100	0.41	25.45	7.60	25	0.1897	108.59	23.03

^a PVGIS (2012), best conditions of the country.

^b Taxation and Customs Union (2012) taking into account the energy produced by the 100 kW PV system.

The IRR is calculated using Eq. (1),

$$NPV = \sum_{t=1}^n \frac{F_t}{(1+IRR)^t} - I = 0 \quad (1)$$

where, F_t is the cash flow during the year t , n is the number of years of the investment, and I is the initial investment (€).

The annual (per period) cash flow is the income less the maintenance cost after taxes (considered a standard tax in a limited society that does not have another kind of business). Numerical analysis was used to obtain IRRs that fit Eq. (1). The IRR results assume a typical installation of 120 kWp (peak power) rooftop PV and 100 kW of nominal power which costs 2.0 €/Wp and is executed in one month, an average inflation of 2.5%, and maintenance costs of 7% of income before taxes. The lifetime of the investment is the duration of the FIT for each country. All the electricity produced by the PV system is sold to the electrical grid at FIT.

As Table 1 illustrates, the difference between IRR without loans (ninth column) and with loans (eighth column) is substantial. Loans are the most common investments in the PV industry. The interest ratio demanded by banks makes the loan payments and the fee more or less equivalent. Therefore, the project's cash flow is around zero during the loan period, but as its end approaches, all income is profit.

The results in Table 1 are based on a financing scheme for 80% of the construction costs of the PV installation and the investor bearing 20% of the installation cost. The interest rate is estimated at 6%. The time for repaying the loan is 12 years (11 years plus a 1-year grace period), and payment is calculated monthly. Thus, the calculated IRR is based on a project financing scheme typical of the PV industry.

2. Germany

Germany led the world in installed PV capacity during the first decade of the 2000s. Germany had 81% of installed capacity worldwide in 2006, 64% in 2007, 35% in 2008 and 67% in 2009 (EPIA, 2012).

The growth of the installed power in German has been driven by discounts that are not retroactive. Germany is a world leader in both the PV market and PV installed power (Frondel et al., 2010), and as a result, the German PV industry has participated in several research and development (R&D) programs.

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