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Feed-in tariff for solar photovoltaic: The rise of Japan

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ABSTRACT

Japan started implementing a national Feed-In Tariff (FiT) mechanism on the 1st July 2012, which included specific payment tariffs for solar photovoltaic (PV) installations. This marks a new era in the renewable energy landscape in Japan. This paper aims at analysing the solar PV prospect in Japan, particularly in both residential and non-residential sectors. The paper presents, first, an overview of energy trends in Japan prior to the Fukushima event. This is followed by a short review of solar PV progress in the country, highlighting the major policies and programmes that have been implemented as well as the installations that have been carried out over the past two decades. Next, the financial impact of the new FiT scheme on consumers is evaluated. The financial analysis investigates the total profit, the average annual return on investment and the payback period. For a comparison purposes, a similar financial analysis is also conducted with selected countries around the world – namely Germany, Italy and the United Kingdom. The results from this analysis indicate that the new Japanese FiT rate generates a good profit, a moderate annual return on investment and an acceptable payback period, suggesting an increasing trend of solar PV uptake over the next years.

1. Introduction

In March 2011, the coastal region of Tohoku in Japan experienced a massive earth quake with a magnitude of 9.0 on the Richter scale. This was followed by a tsunami that caused widespread damage to the region and crippled the 4.7 GW Fukushima-Daichi nuclear power plant. The severity of the radioactive leakage is considered as the second worst nuclear disaster after the one in Chernobyl [1] and has placed the country into a significant power crisis. The aftermath of this event has seen a turning point in energy production, by shifting Japan's energy policy away from nuclear provision [2].

This paper aims to evaluate the potential of solar photovoltaic (PV) in Japan specifically in the residential and non-residential sectors. The recent introduction of feed-in tariff (FiT) scheme in July 2012 is expected to accelerate the penetration of PV in Japan - mainly due to the lucrative incentive given by the Japanese government. To evaluate the FiT scheme, a financial analysis is carried out to calculate the potential total profit, the payback period as well as the annual return on investment that will be obtained by installing a PV system in Japan. Note that, since it is not practical to cover the financial analysis of various installation sizes, this paper only demonstrates two cases of installations: (i) a 4 kW installation for residential sector, and (ii) a 100 kW installation for a non-residential sector.

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Section 2 discusses the energy trend in Japan prior to the Fukushima event. In Section 3, the progress of solar PV installation in Japan is reviewed from 1990s until present time – focussing on the major policies, the incentives as well as on the major programmes implemented by the government. Afterwards, the new FiT scheme is explained in detail in Section 4, while in Section 5, a financial analysis is carried out to evaluate the impact of the FiT scheme on consumers. Finally, the conclusions are presented at the end of the paper.

2. Energy trend prior to Fukushima event

Since the 1950s, the energy consumption in Japan has shown a steady increase [3]. Japan has been relying heavily on fossil fuels to satisfy its energy needs – mainly petroleum, coal and natural gas. When the oil crisis occurred in 1973, Japan introduced a number of measures to reduce its dependency on petroleum [3]. As a result, the energy supplied from petroleum was greatly reduced from 77.4% in the fiscal year[1] of 1973 (FY1973) to 43.7% in FY2010 [3]. The remaining balance of the energy in 2010 was supplied by coal (21.6%), natural gas (17.3%), nuclear power (10.8%), hydro (3.1%) and other renewables (3.5%). The energy is consumed mainly by three sectors: (i) industrial; (ii) transport, and (iii) commercial and residential.

The rising energy consumption trend is also reflected in a rising in the electricity consumption in Japan. It is reported that around 50% of the primary energy supply is converted into electric power [3]. Based on a recent statistic from Japan's Federation of Electric Power Companies, the electricity consumption in Japan has varied between 945 TWh and 1030 TWh for the past 10 years [4]. The percentage breakdown of the data is illustrated in Fig. 1. Nuclear power has been contributing around a third of the electricity until FY2010, while renewables contributed only about 1% to the share [4]. However, the Fukushima incident pushed for a new reform regarding the nuclear energy future in the country.

In September 2011, the government introduced the "Innovative Energy Environment Strategy" [4] which has three main pillars: (i) to have a society independent of nuclear power; (ii) the creation of a Green Energy Revolution, and (iii) to have a secure and stable supply of energy. The strategy aims at phasing out nuclear power by 2030 through the contribution of renewable energy sources.

3. Solar photovoltaic in Japan: main policies, programme and installations (1974–2011)

Solar PV is one of the renewable energy technologies that have significant potential in supplying the world's energy needs. According to a statistic from BP Global [5], the total installed capacity of solar PV around the globe in 2012 reached 100 GW. Around 71% of the installations were carried out in Europe and Eurasia, 15.8% in Asia Pacific with the remaining balance in other parts of the world [5]. The rising trend of solar PV installation in many countries has been catalysed mainly by the implementation of a financial incentive known as the feed-in tariff (FiT) scheme, which is currently enacted in more than 80 countries [6].

Solar PV is not new in Japan; however, prior to the Fukushima incident, it only played a minor role in supplying the energy demand [2]. The main reason was the lack of a regulatory structure that emphasised on renewable energy [2]. The energy sector is under the responsibility of the Ministry of Economy, Trade and Industry (METI) which has been traditionally, 'in league' with

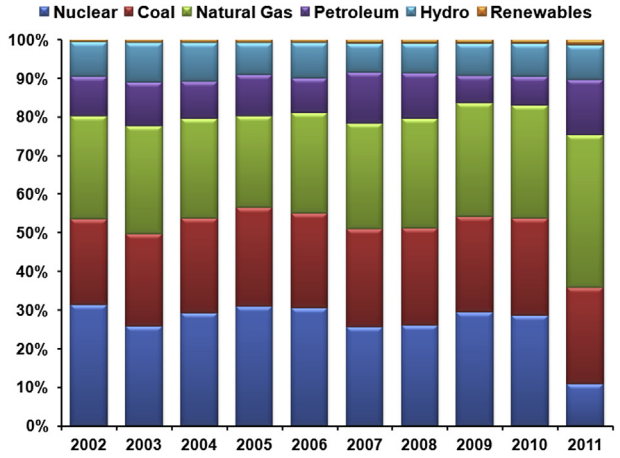

Fig. 1. Breakdown of the total electricity supply by energy source for FY2002 – 2011. Adapted from Ref. [4].

organisations that monopolise the utilities and industry, and are also pro-nuclear [2,7]. This close relationship diminished all attempts towards stringent renewable energy policies [8].

In spite of that, the country did carry out some programmes which helped to increase the uptake of solar PV. In terms of research and development (R&D) activities, in 1974, the Ministry of International Trade and Industry (MITI) funded the Sunshine Project, with a goal of providing a substantial amount of energy from non-fossil sources by 2000 [8]. With the oil crisis in 1979 and the failure of the solar thermal project in 1981, the Sunshine Project enjoyed a generous budget from the government, with an increase of more than 200% when compared with the initial funding [8]. This programme also catalysed the solar PV manufacturing industry to prosper. Some of the companies that benefited from this include SHARP, SANYO and KYOCERA [8].

As for the utility companies and the consumers, the first programme related to solar PV was the net billing programme, which started in 1992 [9]. This voluntary programme was carried out by 10 utility companies whereby each company purchased surplus electricity generated from PV installations with the purchase rate equalled to the retail electricity price (approximately ¥23 per kWh) [9]. In the following year, a specific guideline related to grid connection for solar PV was implemented by the government.

Subsequently, the government introduced a national subsidy programme for residential installation of solar PV in 1994 [9,10]. The subsidy covered 50% of the installation cost with a maximum ceiling price of ¥900,000 per kW [10]. The installed capacity per household varied from less than 1 kW to 5 kW [11]. The subsidy was reviewed regularly and ceased in 2005. At the end of the programme, the subsidy value had been reduced to ¥20,000 per kW [10]. The programme was a significant success, and it funded over 250,000 installations with a capacity of over 930 MW [10]. It also managed to bring down the average installation cost of the system from ¥1,920,000 per kW in 1994 to ¥661,000 per kW by 2005 [12].

Parallel to the subsidy programme, the government also introduced another renewable energy policy known as the Renewable Portfolio Standard (RPS) in 2003 [2,13]. This policy obliged the utility companies to generate a specific percentage of the electricity from renewable sources (1.35% by 2010) – including solar PV. However, due to little incentive from the government as well as the termination of the national subsidy for solar PV installations, the utility companies were less interested in expanding into renewables [13]. Unlike Europe, where FiT is the main driver for renewable energy, Japan opted for RPS instead of FiT mainly due to the influence of utility companies [8]. This caused Japan to lose its place

[1] Fiscal year for Japan is from 1 April of the current year until 31 March the following year.