ABSTRACT: In April 2008 a new feed-in law for the installation of micro-generation photovoltaic systems took off in Portugal. The program includes a generous feed-in tariff, yearly adjusted depending on the success of the program. The program was accompanied by the introduction of a novel online process for the registration, licensing and inspection of small PV installations that reduces the delay between application and connection to the grid to about 6 months. The aim of this paper is to evaluate the implementation of this new program including an analysis of the payback time and a discussion of the main administrative and technical challenges to the implementation of both the feed-in law and the simplified registration process.

Keywords: Funding and Incentives, Small Grid-connected PV Systems, Economic Analysis.

1 INTRODUCTION

A new feed-in law for the installation of photovoltaic systems took off in Portugal in 2008. The Renewables-on-Demand program, published as Law Decree 363/2007 [1], replaced the unsuccessful Independent Power Producer (IPP) scheme which included a feed-in tariff guaranteed for 15 years (44.7€/kWh for PV systems below 5kW and 31.7€/kWh for larger systems and a special tariff for BIPV: 46.9 €/kWh for small systems and 35.4€/kWh for systems above 5kW) for a total nationwide PV cap of 150MW. Under the Renewables-on-Demand framework, there are two distinct regimes:

- the general regime applicable to any type of micro-generation (or co-generation) source, limited to 5.75kW (25A single-phase) interconnection power; the feed-in tariff is the regulated tariff (true net metering) defined annually by the National Energy Regulator;
- the special regime exclusively for renewable sources: solar PV, wind, hydro, biomass, fuel cells (provided the hydrogen is produced from renewable energy sources), limited to 3.68kW (16 A single-phase) interconnection power.

The PV feed-in tariff for the special regime is initially set to 65€/kWh and then, assuming that the annual cap is fulfilled, suffers a 5% annual reduction. The red line in Fig.1 shows the expected value of the reference tariff. For a PV installation, the initial rate is guaranteed for the first 5 years. Then, the feed-in tariff follows the reference tariff. This is shown in green in Fig.1. Considering an average annual irradiation level of 1.5MWh/kW/year and typical 2008 installation costs, the payback time is of the order of 6 years. The Renewables-on-Demand law facilitates credit loans for PV installations, which may extend the payback time to about 8 years.

2 FEED IN LAW

As mentioned above, the reference feed-in tariff, is initially set to 65€/kWh and then, assuming that the annual cap is fulfilled, suffers a 5% annual reduction. The red line in Fig.1 shows the expected value of the reference tariff. For a PV installation, the initial rate is guaranteed for the first 5 years. Then, the feed-in tariff follows the reference tariff. This is shown in green in Fig.1. Considering an average annual irradiation level of 1.5MWh/kW/year and typical 2008 installation costs the payback time is of the order of 6 years. The Renewables-on-Demand law facilitates credit loans for PV installations, which may extend the payback time to about 8 years.

![Fig. 1 – Red line shows the variation of the expected reference feed-in tariff with time. Blue line shows electricity prices. Green line shows the actual feed in tariff for projects starting in 2008.](image-url)
Assuming a 4.3% yearly increase of electricity price, it is expected that the value of the feed-in tariff will have reached grid parity by 2023 (c.f. blue line in Fig. 1).

The annual cap is initially set to 10MW and, if fulfilled, increases annually by 20%. This annual revision will lead to a total installed power of about 1GW after 15 years, when grid parity is achieved. Fig. 2 shows the cumulative installed power (red line). Due to the decreasing reference rate and the effect of the increasing electricity price, the program investment per kWh (supported by electricity consumers) will steadily decrease for 15 years, reaching parity by 2023 (c.f. blue line in Fig. 1). It is expected that the value of the feed-in tariff will have increased to about 1€/W, and therefore the overall average subsidy corresponds to about 1€/W.

Only 58% of these applications were confirmed (i.e. the registration payment of 250€ was performed within a 5 days deadline). The number of inspections (the final step before grid connection, an indicator of the number of PV systems that were actually installed) averaged about 40% of the total number of applications. These results are summarized in Fig. 3. The interest for the following call, in April 2009, already with a reference rate of 61.75c€/kWh, did not decrease. At the time of writing this paper the average number of requests has actually increased to about 1000 per call, although there are no data on systems actually installed.

3.2 Technical challenges

One of the goals of the Renewables-on-Demand program is the development of a mature industry for PV systems installations. In fact, in spite of formidable solar resources [3] the Portuguese photovoltaic market has been particularly lethargic, with an accumulated installed power of only 68MW [4] dominated by a handful of large solar power plants, such as those in Amareleja (46MW) and Serpa (11MW), and merely a residual market of small scale PV installations. Therefore, there has never been the opportunity for the development of a sustainable PV installation industry (not to mention PV equipment manufacture industry with a couple of exceptions, supported by exportation markets) which is obviously a required premise for the large scale dissemination of PV in the country.

The Renewables-on-Demand PV systems installation procedure requires the pre-registration of system installation companies on an online database. At the time of writing this paper there are over 300 companies registered at the renovaveisnahora.pt site to choose from. The installation guidelines were defined by Certiel in articulation with the General Directorate of Energy and Geology [5] and, at least during the first 10MW, all installations were audited, although it is defined that, for a given installer, after five successful installations the system auditing should be performed by sampling.

According to PV systems installation companies, the most common non-conformities identified during systems’ auditing involved deficiencies in the access to the electricity meter, inappropriate signaling (durable and clear alert/danger signs), lack of suitable solar water heating system (not always connected to piping!) and unavailability of instructions manual for the user [6]. One anecdotal situation refers to telecommunication stations that already had PV modules and requested grid connection under this micro-generation program. The mandatory solar water heating system seemed unsuitable for this genre of application but the installers decided to install the solar heating system connected to a heat pump in order to cool some of the hardware, thus contributing to the energy efficiency of the station.

4 CONCLUSIONS

In conclusion, the Renewables-on-Demand law introduced a generous feed-in scheme that created the conditions for the development of a small-scale PV system market in Portugal. The definition of the value of the feed-in tariff and its yearly adjustments lead to a payback time of about 6 years. Considering a conservative model for the evolution of the cost of...
electricity, the end of this program is expected to be reached in 2023. By then, it is expected that the program will have enabled the installation of a total of 1GW at a cost of 1G€.

One of the goals of the program was to increase the installed power of small PV systems in the country; after one year of implementation we may conclude that it has been successful in disseminating the interest for photovoltaics.

The program was also designed to develop a trained and experienced PV installation industry in Portugal and, in spite of its short-comes and challenges, it has been successful in this goal. There is evidence of a significant improvement in the standard level of installation of the PV systems.

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6 REFERENCES

[6] Private communication