ECONOMIC CONDITIONS TO ACHIEVING THE DYNAMIC PV PARITY IN DIFFERENT EUROPEAN COUNTRIES

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Overview

In recent years, market shares of electricity generation from photovoltaics (PV) have been growing continuously. As a result of that, significant cost decreases of the PV technology have been observed (technological learning). This leads to an increased competitiveness of PV generation in comparison to remaining electricity generation technologies (both conventional and renewable) when using levelised cost of electricity generation (LCOE) as a benchmark. In general, LCOE describe the economics of a technology on an aggregated level (i.e. annual basis) only. Due to the variable/intermittent characteristics of PV electricity generation (e.g. day/night characteristics), however, different challenges have to be taken into account when integrating the PV technology into electricity systems where electricity generation and demand have to be met simultaneously at each point in time. Nonetheless, the gradient of LCOE development of PV generation is expected to open a wide range of different applications of this technology in different market segments in the future. In this context, the household customer always has been playing an important role when considering the implementation of decentralised PV technologies. And as a consequence of that, already in the past the retail electricity price (i.e. the end-users electricity bill/statement) always has been some comparative parameters of the LCOE of PV generation. Straightforward, the term "PV Grid Parity" has been established in recent years; in its static definition the determination of the point in time in the future when the trade-off of the retail electricity price and LCOE of PV generation is reached (see e.g. [1]). This definition, however, lacks twofold (see e.g. [2]): (i) there is no dynamic consideration of the dynamic development of different parameters, and (ii) nothing is said about the net present values (NPV) of the economics of PV generation when considering different revenue streams (e.g. self-consumption (reduced electricity purchases from the grid and therefore reduced electricity bill) versus selling into the grid), on the one hand, and cost of PV generation, on the other hand. In this paper, different interpretations of fully dynamic definitions of "PV Parity" over the lifetime of PV generation plants are modelled for different customer groups (taking into account different characteristic load profiles) and utilities in different European countries.

Methods

As already mention above, a simulation model has been developed (i.e. part of the European IEE project "PV Parity") enabling comprehensive dynamic PV parity studies under a variety of different constraints and assumptions on the future development of several important parameters describing LCOE of PV generation (e.g. specific cost, efficiency, etc.), on the one hand, and wholesale/retail electricity price developments as well as further technology options influencing load profiles of different customers (e.g. increase self-consumption due to implementation of additional storage technology), on the other hand. The simulation model's objective is to calculate the Net Present Value (NPV) of several different economic parameters (revenues from selling into the grid, cost of purchases from the grid, cost of PV generation) over the lifetime of the PV generation plant for different customer groups being characterised by different load profiles. Ultimately, the model conducts a comparison with the NPV of electricity purchase cost over the same period for a customer without any PV system. Comprehensive empirical studies on dynamic PV Parity are determined for many different customer groups in different European countries. Sensitivity analyses in each market segment are conducted with the aim to get better insights into the economics of future PV generation. Those customers with the highest retail electricity prices (i.e. household customers) are expected to be the most attractive market segment also in the dynamic definition of PV Parity. But also commercial and industrial customer, being characterised by higher self-consumption of on-site PV generation (compared the household customers) are expected to reach PV Parity also within the next decade.

Results

In calculating the LCOE a variety of parameters (e.g. PV system prices, depreciation time, WACC, efficiency, etc.) have influence. To determine the future PV system prices and the efficiency can be derived through experience curve of learning rates from the past years. Other parameters such as amortization period, WACC, fiscal conditions, etc. are vary sufficiently by a Monte Carlo simulation and this results in a certain bandwidth of future LCOE of PV systems. By different sensitivity analysis under the ceteris paribus clause the influence of different parameters is shown. Future retail, wholesale and primary energy prices will be defined in different scenarios, and thus also results in a certain bandwidth of prices. The cost and trade off analysis is done with the edge and average values of the different bandwidths of parameters. Due to the natural heterogeneity of sun irradiation and artificial heterogeneity of markets in Europe, of different electricity prices and of PV system prices for various European countries different bandwidths of LCOE, of electricity prices and of PV system prices are obtained. By the bandwidth, defined by each scenario and parameter analysis, the LCOE, the electricity prices and PV system prices will determine a possible window of time or rather frame conditions can be achieved in various European countries in which the different "PV Parity" definitions. First preliminary results of the “Grid Parity” in the household sector are shown in Fig. 1 and Fig. 2. It is shown the cumulated NPV of the costs from a household with and without a PV-System. In the first model simulation the “Grid Parity” is reached in 2016 with a PV-System price of 2358,- Euro and in the second simulation in 2017 with a PV-System price of 2155,- Euro. The most important differences between the first and the second simulation are the system size, the market price for feed into the grid and the annual increase of the retail price. At a higher market price is a larger PV system size economical than with a lower market price.

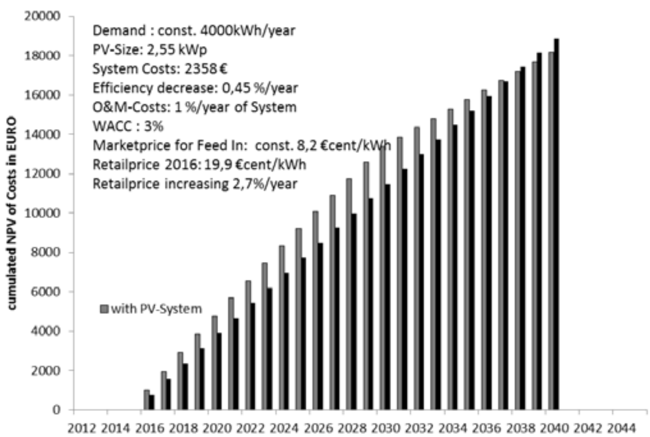

Figure 1 PV Parity Model Simulation 1: Preliminary Result of “Grid Parity” for a Household Austria

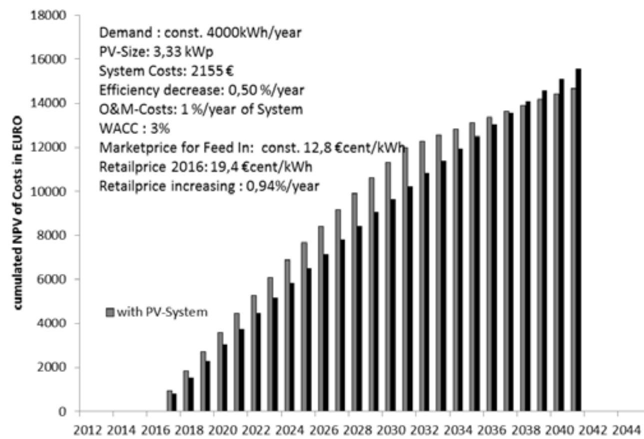

Figure 2 PV Parity Model Simulation 2: Preliminary Result of “Grid Parity” for a Household Austria

Conclusions

The economic efficiency of the PV system depends trivially on the growth of future electricity prices, which clearly shows the two preliminary simulations. Furthermore, the choice of the value of the different parameter for calculation of the LCOE of the PV system and the calculation of the “PV Parity” approach has a very large impact of the results (see e.g. [4]). This dynamic model is being developed in the project "PV Parity", funded by the Intelligent Energy Europe (IEE) Programmed of the European Commission and empirically scaled. Concrete results are expected in the next few months and will be presented in future national and international conferences.

References

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[3] IEE project “PV Parity”: www.pvparity.eu

[4] Singh et al, Renewable Energy 35 (2010) 563-569