EU-COMPARISON OF THE ECONOMIC VIABILITY OF PROSUMER PV SYSTEMS

Verena Fluri1, Klarissa Niedermeier2, Henning Steffens3, Bernhard Wille-Haussmann4, Christoph Kost5*, Thomas Schlegl6, Shivenes Shammugam7

1verena.fluri@ise.fraunhofer.de, Fraunhofer Institute for Solar Energy Systems ISE; 2klarissa.niedermeier@ise.fraunhofer.de, Fraunhofer ISE; 3henning.steffens@ise.fraunhofer.de, Fraunhofer ISE; 4bernhard.wille-haussmann@ise.fraunhofer.de, Fraunhofer ISE; 5christoph.kost@ise.fraunhofer.de, Fraunhofer ISE, +49 761 4588 5750; 6thomas.schlegl@ise.fraunhofer.de, Fraunhofer ISE 7shivenes.shammugam@ise.fraunhofer.de, Fraunhofer ISE

ABSTRACT: In Europe, both the solar irradiation and the support schemes for a household with a PV or a PV battery system differ considerably from country to country. This paper analyses the influence of these factors on economical Key Performance Indicators (KPI) and aims to cluster European countries with similar economic behaviour. The paper focuses on the producer and consumer (=prosumer) concept of residential PV owners. The analysis shows that PV systems are only a positive business case, i.e. a positive NPV calculated based on all economic and technical inputs of each location, in some countries, while in other countries a negative NPV is obtained due to the framework conditions. The PV system in Malta reached the highest NPV due to a high feed-in-tariff. Lowest NPVs were reached for Iceland, Finland, Sweden and UK with no support scheme or only a small feed-in tariff, while also having a lower PV irradiation.

Keywords: Economic Analysis, Financing, Batteries

1 INTRODUCTION

The regulatory framework for prosumers (producer and consumer of electricity) differs in European countries. This is superposed with different environmental conditions, such as solar radiation and consumption. The analysis presented in this paper comprises EU-28 countries plus Norway, Switzerland, Turkey and Iceland. The aim is to assess the economic viability of PV and PV battery systems and how the results can be compared to the countries. The analysis of the viability of a household prosumer concept, based on statistical data for the respective solar irradiation, household consumption and regulatory schemes, is essential to assess the drivers and barriers and thus, know the crucial parameters to improve the share of solar electricity in Europe. Finally a cluster analysis about countries with similar results is performed.

The analysis contributes to the market growth and market integration of PV in European electricity systems as it indicates opportunities in different countries in existing framework conditions.

2 APPROACH AND DATA INPUT

The objective is to analyze the influence of technical, economic and regulatory factors on economical KPIs and to cluster European countries with similar economic behavior. This study groups the countries in Europe according to their support schemes and for each support scheme in further groups of a high, medium and low NPV.

Firstly, the household consumption for a single family house in each country is an important parameter. As no precise data is available it is determined from the consumption in the residential sector divided by the number of households multiplied by a factor 1.52 [2-6]. This factor stated that on site consumption systems are only reasonable for larger consumption. Secondly, the different support schemes for small-scale PV systems up to 10 kWp are assigned for the various countries [7-24]. Thirdly, the typical PV system size for a household in each country is calculated based on the PV generation [25], the electricity price [26] and the different support schemes (net metering, feed-in tariff, feed-in premium, and subsidy). For example, in net metering case the generated energy by the PV plant is equal to the yearly electricity consumption. This defines the optimal/maximal PV capacity. The capacity for batteries of each house is defined with a factor battery to PV ratio.

As the database is not sufficient for every European country, the analysis is limited to 32 countries: all EU-28 countries plus Norway, Switzerland, Turkey and Iceland. The input parameters that are assumed to be common for each country to allow for comparability are shown in Table I. These are e.g. financial and technical parameters like efficiency or degradation.

<table>
<thead>
<tr>
<th>Table I: Input parameters and assumptions for the analysis [1]</th>
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<td><strong>PV system</strong></td>
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### Results

The analysis shows that the NPV of PV systems is a positive business case only in several countries, while in other countries a negative NPV is calculated (Figure 1). The PV system in Malta reached the highest NPV due to a high feed-in-tariff. Lowest NPVs were reached for Iceland, Finland, Sweden and UK with no support scheme or only a small feed-in tariff, while also having a lower PV irradiation.

When comparing the NPV for different PV sizes (3 kWp and 6 kWp as a typical system size), it can be concluded that the NPV value is higher for the 6 kWp than for the 3 kWp system size for countries with a positive NPV. In countries with a negative NPV, it was vice-versa. The calculated PV system size did not always show the highest NPV. However, when looking at the IRR, the trends were different. The IRR was generally higher for the calculated size than for the 3 or 6 kWp systems, but only to a small extent.

The LCOE ranged between 6 ct/kWh and 14 ct/kWh for the higher irradiation in the investigated countries. For the lower irradiation values 7 to 19 ct/kWh were reached.

The addition of a battery to the PV system only led to a positive NPV in few countries and in these countries. This was mainly due to the fact that the PV system was economically viable and could support the installation of a battery.

Based on the results of this study, the countries can be summarized in different clusters. A first approach is to arrange them according to the support scheme. In Figure 2 the results for three groups are shown for the PV system: net metering, feed-in tariff or neither. In countries with no support scheme, the NPV was always negative. In countries with a feed-in tariff, the NPV was between -3000 € and +2000 € and in net-metering countries the NPV was either slightly negative or above 4000 €.

### Figure 1: Net present value for PV systems in areas with low irradiation and high irradiation

![Graph showing net present value for PV systems in low and high irradiation areas](image)
A further cluster analysis was performed for the net metering countries according to their electricity price, the PV production and average household electricity consumption. The countries with a feed-in tariff can also be clustered according to the electricity price, the PV production and also according to the different feed-in tariff. A similar analysis has been carried out for feed-in tariff (FIT) countries.

Figures 3 to 5 show the net present value for the net metering countries in dependence on different input parameters. The groups are more distinct than is the case for the FIT countries.

PV systems on Malta have a much higher net present value than in all other countries, due to the high feed-in tariff with the same time high average irradiation. The situation on Malta is therefore not comparable to the other countries. Germany, Portugal, France, Montenegro and Luxembourg can be regarded as one group with medium irradiation, high feed-in tariff and a high to medium electricity price. Serbia, Turkey, Austria, Slovakia, United Kingdom and Estonia have medium to low average irradiation, a low feed-in tariff and medium to low electricity prices, resulting in rather lower net present values for PV systems.

4 CONCLUSION

This study showed that the NPV is influenced by many parameters such as electricity price or funding scheme.

Table II gives an overview of the clusters that are defined in this study. The five countries, which are analysed in the frame of the iDistributedPV project, are marked in bold and are present in four of the seven analysed clusters and thus, represent the different identified clusters in Europe well.

Even though the economic parameters are not yet promising in some cases, it should be mentioned that there can be additional technical gains for the grid, especially from including a battery, as well as increasing autarky, which are both not priced in this study.
Table II: Overview on all country clusters according to the net present value (NPV) of the prosumer PV system and the support scheme. Countries analyzed in the iDistributedPV project are marked bold.

<table>
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<tr>
<th>NPV for prosumer PV</th>
<th>Net metering</th>
<th>Feed-in tariff</th>
<th>neither</th>
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<tr>
<td>Very high / high</td>
<td>Greece, Cyprus</td>
<td>Malta</td>
<td></td>
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<tr>
<td>Medium</td>
<td>Belgium, Denmark, Italy, Germany, Portugal, France, Montenegro, Luxembourg</td>
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<tr>
<td>Low</td>
<td>Poland, Lithuania, Netherlands, Latvia, Romania, Hungary, Slovenia, Serbia, Turkey, Austria, Slovakia, United Kingdom, Estonia, Spain, Bulgaria, Czech Republic, Ireland, Croatia, Finland, Sweden, Iceland</td>
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ACKNOWLEDGMENTS

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REFERENCES

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